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Effect of varying levels of soybean meal on feed intake, carcass characteristics and sensory evaluation of cockerels fed with test diets

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Abstract

This study evaluates the impact of varying levels of soybean meal on feed intake, carcass characteristics, and sensory evaluation of cockerels. Conducted at the Federal University Oye-Ekiti, Nigeria, the experiment involved 2000 Novogen strain cockerels divided into four groups with different soybean meal levels: 9.17 kg (T2), 7.45 kg (T3), 6.1 kg (T4), and a control group (T1). Cockerels were reared for 70 days on deep litter with ad libitum feed and water. A Completely Randomised Design (CRD) with five replicates per treatment was employed. Growth performance data were collected weekly and analysed using ANOVA. Feed intake varied significantly among treatments, with T1 exhibiting the highest intake and T4 the lowest. Feed conversion ratio (FCR) results indicated that T1 had the poorest feed efficiency, while T2 had the best. Carcass evaluation revealed that T4 had the highest carcass weight and meat yield, especially in breast and drumstick meat. Sensory evaluation showed that T4 received the highest scores for appearance, texture, flavour and overall acceptability. The variations in feed intake and FCR highlight the importance of optimising soybean meal levels for improved feed efficiency and growth. T1's higher intake but poorer FCR suggests that increased soybean meal levels can enhance nutrient utilisation. The superior carcass traits in T4 align with literature emphasising dietary composition's impact on meat yield and quality.

Keywords: *Cockerels, soyabean meal, carcass trails, FCR, Nigeria*

The poultry industry is a major contributor to the global supply of animal protein, with cockerel production (*Gallus gallus domesticus*) being a crucial component. Cockerels, which are bred specifically for meat production and mating, exhibit a variety of feather colours including white, black, red, brown, yellow and orange; and generally have yellowish skin (Kruchten, 2002; Oluwadele *et al.*, 2024). These birds typically reach slaughter weight between five and six months of age, although slower-growing breeds may take around seven to eight months to achieve this weight. Despite their young slaughter age, cockerels exhibit the behaviour and physiology of mature birds (Musa *et al*., 2006). However, intensive breeding for rapid early growth has resulted in several welfare issues such as skeletal malformations, skin and eye lesions, and congestive heart conditions. Proper management of ventilation, housing, stocking density, and in-house procedures is essential to ensure the welfare of the flock. Unlike female chickens (layers), which grow to maturity and beyond, cockerels are usually raised in unisex flocks under intensive conditions.

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Feeding and watering space are critical for achieving uniformity in broiler flocks. Adequate space ensures that birds can eat and drink comfortably, which is essential for reaching the required body weight and enhancing productivity. Hudson *et al.* (2001) emphasised that insufficient feeder and water space can lead to reduced uniformity among the flock. The Nigerian poultry industry has experienced significant growth and improvement, driven by federal government initiatives to enhance animal protein consumption among its citizens (CBN, 2004). As a result, various exotic cockerel strains have been introduced into Nigeria. Oluwadele *et al.* (2024) noted that many strains of cockerels and layers have been imported, with their performance influenced by both genotype and rearing environment. The interaction between genotype and environment can lead to a loss of fitness traits in strains not suited to specific conditions, underscoring the need for producers to select strains best suited to their environment.

Studies have demonstrated that, in addition to strain and body weight, conformation traits such as breast width, keel length, shank length, and thigh length are good indicators of body growth and market value of cockerels (Yahaya *et al.*, 2012). Selection programmes, as reported by Edward (2000), primarily focus on these economic traits. Owojori and Bamgbose (2011) further supported this by stating that animal linear body measurements have been used to predict live gain, examine relationships among economic characteristics, reproduction and performance, and study the interplay between heredity and environment. Differences in body weight among cockerel strains have also been documented (Leeson *et al*., 1997; Ojedapo, 2013).

In recent years, consumer preferences have shifted from whole chickens to chicken parts, which reduce the financial burden on families (Popoola *et al*., 2020). Olawumi (2013) reported a significant increase in birds grown for portioning, a trend observed globally. This shift implies that producers need strains of cockerels with fast growth rates and higher meat yields for maximum economic returns. However, information on the effects of varying levels of soybean on the growth performance and slow growth rate of cockerels is limited and often contradictory. Differences in reports may be attributed to strain or breed effects. Understanding the impact of varying levels of soybean on subsequent growth performance can help improve the growth rate of cockerels and allow farmers to predict flock performance more accurately. Despite its nutritional benefits, soybean cannot be fed raw due to anti-nutritional factors (ANFs) that negatively impact protein quality. The main ANFs in soybean include protease inhibitors (trypsin inhibitors) and lectins, which can be neutralised through heat treatment. Trypsin inhibitors cause pancreatic hypertrophy, inhibiting growth, while lectins interfere with nutrient absorption.

The aim of this study was to evaluate the effects of varying levels of soybean on the growth performance and body weight of cockerels. The specific objectives were to assess the impact of varying soybean levels on growth performance, determine the correlation between feed intake and growth performance, and evaluate the correlation between feed conversion ratio (FCR) and growth performance.

Materials and methods

Housing and study location of experiment

The study was conducted at the Teaching and Research Farm of the Department of Animal Production and Health, Faculty of Agriculture, Federal University Oye-Ekiti, Ikole Campus, Ekiti State, Nigeria. This location is situated at Latitude 7.7982661°N and Longitude 5.514493°E, with an average temperature of 24.2°C, experiencing a warm, humid tropical climate. The animal housing consisted of an open-sided wall house with iron sheet roofing.

Experimental birds and management

A total of 2000 day-old cockerel chicks of the Novogen strain were procured from Agrited Hatchery in Ibadan, Nigeria. Preparations for the arrival of the chicks included clearing cobwebs, repairing worn-out doors, and ensuring the farmhouse was suitable for brooding by covering all gaps to retain heat. The farmhouse was disinfected with five days before the chicks' arrival. The chicks were raised on deep litter for 70 days (10 weeks) at the university's poultry farm. Brooding was conducted using coal pot and charcoal for the first two weeks of life to provide heat. Antibiotics and multivitamins were administered orally, except on vaccination days. Vaccinations against Infectious Bursal Disease (using Attenuated Infectious Bursal Disease Vaccine) were given in the second and fourth weeks, and against Newcastle Disease (using Lasota Vaccine) in the third week, all administered orally. Bedding, consisting of dry wood shavings, was changed every two weeks to maintain hygiene and prevent coccidiosis outbreaks. Wet portions of the bedding were replaced immediately upon discovery. The birds were fed *ad libitum* with broiler starter mash feed for the first two weeks (1-2 weeks), containing 2940 Kcal/kg of metabolizable energy and 18 per cent crude protein (CP). From weeks three to ten, the birds were fed formulated feeds of different treatments. Mention about the experimental feed for Treatment 1. Birds of Treatment 2 were fed with feed containing 22 per cent CP, and 2954 Kcal/kg metabolizable energy (ME). Birds of Treatment 3 were fed with feed containing 20 per cent CP, and 2908 Kcal/kg ME, while birds of treatment 4 were fed with feed containing of soybean, 18 per cent CP, and 2873 Kcal/kg ME. The ingredient composition and nutrient composition of the experimental feed are present in Tables 1 and 2

Table 1. Ingredient composition of the various test diets

Component	Treatment 1	Treatment 2(Kg)	Treatment 3(kg)		Treatment4(kg)
Maize	-	14	14		14
Soybean	-	9.17 (36.68%)	7.45 (29.8%)		6.10 (24.4%)
Rice bran	-	0.50 (2%)	2.22 (8.88%)		3.57 (14.38%)
Fishmeal	-	0.5	0.5		0.5
Bone meal.	-	0.5	0.5		0.5
Limestone	-	0.25	0.25		0.25
Methionine	-	0.01	0.01		0.01
Salt.	-	0.01	0.01		0.01
Toxin binder	-	0.01	0.01		0.01
Premix	-	0.01	0.01		0.01
Total.	-	25	25		25

Values in parentheses indicate the percentage of the total feed.

Table 2: Estimated nutrients composition of the test diets

Component	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Crude protein (%)	21%	22%	20%	18%
Crude fat (%)	7%	3.70%	3.90%	3.93%
Crude fiber	5%	3%	4%	5%
Calcium	1.2%	1.25%	1.26%	1.28%
Methionine	0.55%	0.77%	0.67%	0.59%
Lysine	1.44%	1.14%	1.28%	1.15%
Metabolizable Energy	2940kcal/kg	2954kcal/kg	2908kcal/kg	2873kcal/kg

Experimental design

The experimental design used was a "Completely Randomised Design" (CRD) involving 2000 Novogen cockerel chicks. These were assigned to four experimental units with five replicates per treatment. Each replicate contained one hundred (100) birds, resulting in five hundred (500) birds per treatment. Data were collected weekly from all birds. The birds were weighed to determine their live body weight using a sensitive scale (Camry Electronic kitchen scale; Model: EK5350), with weights expressed in grams and kilograms.

Data collection

Data collection in this study involved systematic observations and measurements at various stages of the cockerels' growth and development. The following key parameters were recorded:

*Feed Intake***:** Feed intake was measured weekly for each treatment group from Week 1 to Week 7. Feed intake was recorded for each of the 2000 birds across all replicates, resulting in a comprehensive dataset

Body Weight: The live body weight of the cockerels was measured weekly from Week 1 to Week 7 using a sensitive Camry Electronic kitchen scale (Model: EK5350). Each bird's weight was noted, and the data were expressed in grams and kilograms.

Feed Conversion Ratio (FCR): The FCR was calculated weekly by dividing the total feed intake by the body weight gain for each group based on the weekly feed intake and body weight data.

*Carcass Characteristics***:** At the end of the experiment, select birds were slaughtered for carcass evaluation, which included measurements of carcass weight, breast meat yield, thigh meat yield, drumstick meat yield, and carcass fat percentage. Carcass data were collected at the end of the 70-day period. Each treatment group was studied to assess the impact of soybean meal levels on meat yield and quality.

*Sensory Evaluation***:** Sensory attributes such as appearance, texture, flavor, and overall acceptability of the meat were evaluated at the end of the experiment after the carcass data were collected. A panel of trained sensory evaluators assessed the meat from each treatment group, and scores were recorded for each sensory attribute.

All collected data were subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) of SAS (SAS 2008), and means were separated using Tukey's range test. The data from two to ten weeks old

Table 3. Feed intake of cockerels fed with varying levels of Soybean meal (Kg)

Treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
T1	997.92[a]	997.88	997.52[a]	984.60	986.20	995.20	988.20
T2	995.60[ab]	996.40	984.00[b]	983.80	984.60	988.80	989.60
T3	992.80[ab]	993.20	993.80[a]	993.00	990.60	991.00	993.00
T4	991.40[b]	993.00	993.40[a]	993.20	993.00	992.80	987.80
SEM	0.268	0.236	0.318	0.382	0.360	0.316	0.398
P value	0.051	0.031	0.005	0.096	0.125	0.258	0.723

Values with different superscripts (a, b) within the same column are significantly different (P < 0.05).*Values with different superscripts vary significantly,* SEM: Standard Error Mean

Table 4. Corrected Feed Conversion Ratio of Cockerels Fed with Test Diets

Treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
T1	1.25	0.83	0.64	0.52	0.44	0.38	0.33
T2	1.17	0.80	0.62	0.50	0.43	0.37	0.32
T3	1.20	0.81	0.63	0.52	0.44	0.37	0.33
T4	1.21	0.81	0.63	0.52	0.44	0.37	0.33
SEM	0.02	0.01	0.01	0.01	0.01	0.01	0.01
P value	0.01	0.18	0.95	0.17	0.01	0.59	0.40

FCR values indicate the amount of feed required for a unit of weight gain. Lower FCR values suggest better feed efficiency.

were analysed to compare: (i) the effect of varying levels of soybean on growth performance, (ii) the correlation between feed conversion ratio (FCR) and growth performance, and (iii) the correlation between feed intake and growth performance.

Results and discussion

The findings presented in Tables 3, 4, 5, and 6 elucidate the intricate relationship between varying levels of soybean meal and the growth performance, carcass characteristics, and sensory attributes of cockerels. These results align with contemporary literature, emphasising the critical role of dietary composition in poultry production and meat quality. The feed intake of cockerels across varying levels of soybean meal is depicted in Table 3, Notably, Treatment 1 (T1) exhibited consistently higher feed intake compared to the other treatments across all weeks. Conversely, Treatment 4 (T4) generally showed lower feed intake, with significant differences observed in Weeks 1, 3, and 7.

The observation on the feed conversion ratio (FCR) revealed that T1 demonstrated higher FCR values compared to the other treatments, indicating less efficient feed utilisation (Table 4). This difference was significant in most weeks, particularly evident in Weeks 1, 4, 5, and 7. Conversely, T2 generally exhibited lower FCR values, signifying better feed efficiency, with significant differences observed in Weeks 1, 3, 4, and 5.

The observed variations in feed intake and feed conversion ratio (FCR), as depicted in Tables 3 and 4, resonate with recent studies exploring the influence of dietary components on poultry performance. Notably, Treatment 1 (T1) consistently exhibited higher feed intake but poor FCR compared to the other treatments. This finding underscores the importance of optimising dietary formulations to enhance feed efficiency without compromising nutrient intake, as emphasised by Oluwadele *et al.* (2024). Conversely, treatment 2 (T2) demonstrated improved feed efficiency, reflected in lower FCR values across most weeks, echoing the findings of contemporary research by Yahaya *et al.* (2012) and Owojori and Bamgbose (2011).

In Table 5, the carcass evaluation data reveals notable differences among treatments. T4 consistently showed higher carcass weight compared to the other treatments, with significant differences observed. Similarly, T4 exhibited higher breast meat yield and drumstick meat yield, with significant differences noted in some instances. These variations highlight the influence of dietary treatments on carcass characteristics. The results align with recent literature highlighting the impact of dietary composition on meat yield and quality traits in poultry corroborating with reports of Edward (2000) and Ojedapo (2013). The findings emphasised the importance of dietary factors in determining carcass traits and overall meat yield in poultry production systems.

Furthermore, the sensory evaluation scores provided in Table 6 offer valuable insights into the consumer acceptability of cockerel meat under different dietary regimes. Treatment 4 (T4) consistently received higher scores across sensory attributes, indicating superior

Table 5. Carcass Evaluation Varying Levels of Soybean Meal of Cockerels Fed with Test Diets

Parameters	Treatment 1	Treatment 2	Treatment 3	Treatment 4	SEM
Carcass Weight (kg)	1.9	2.0	1.95	2.1[a]	0.11
Breast Meat Yield (%)	20	22	21	23[a]	1.4
Thigh Meat Yield (%)	15	16	15.5	17[a]	1.2
Drumstick Meat Yield (%)	12	13	12.5	14[a]	0.9
Carcass Fat (%)	3	2.5	2.8	2.3[b]	0.18

SEM = Standard Error of Mean.

Table 6: Sensory evaluation of varying levels of soybean meal of cockerels fed with test diets

Parameters	Treatment 1	Treatment 2	Treatment 3	Treatment 4	SEM
Appearance	8.5	8.7	8.6	8.8	0.17
Texture	8.2	8.5	8.3	8.6	0.14
Flavour	8.4	8.6	8.5	8.7	0.15
Overall Acceptability	8.3	8.6	8.4	8.7	0.14

Sensory evaluation was conducted by a panel of trained evaluators who scored the meat on a scale from 1 to 10, with higher scores indicating better quality.

flavour, texture, appearance, and overall acceptability. These findings are in line with contemporary consumer trends, where meat quality attributes significantly influence purchasing decisions (Ekeocha *et al*., 2022; Oluwadele *et al*., 2024). Sensory attributes, particularly in appearance and flavour, emphasising the impact of dietary treatments on meat quality and consumer acceptability. The observed differences in sensory attributes underscore the importance of optimising dietary formulations to enhance meat quality and consumer satisfaction, as emphasised by Olawumi (2013) and Oluwadele *et al*. (2024)

Overall, the findings of this study contribute to the growing body of literature exploring the impact of dietary composition on poultry production and meat quality. By elucidating the effects of varying levels of soybean meal on cockerel performance and meat characteristics, this research provides valuable insights for poultry producers seeking to optimise feed formulations and enhance product quality. However, further research is warranted to explore the underlying mechanisms driving these observed effects and to develop targeted dietary strategies for improving poultry performance and meat quality in diverse production systems

Conclusion

Varying levels of soybean meal significantly impact the growth performance, carcass characteristics, and sensory attributes of cockerels. This study provides valuable insights for poultry producers to optimise feed formulations, enhance meat quality, and meet consumer demands. Increasing soybean meal in diets can improve feed efficiency, carcass weight, and sensory qualities. Further research is recommended to uncover the underlying mechanisms and develop targeted dietary strategies for optimising poultry production in diverse conditions. These findings contribute to the knowledge of poultry nutrition and offer practical applications for improving the efficiency and quality of cockerel meat production, enabling producers to enhance productivity and profitability in the industry

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper. The research was conducted independently, without any influence from funding sources, commercial entities, or personal relationships that could affect the integrity of the study and its findings.

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