Nutrient Digestibility, Organ Weight and Economic Benefits of Broiler Chickens Fed Graded Level of Donkey's Ceacal Meal

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ABSTRACT

The high cost of poultry feed ingredients has become a threat due to challenging demands and climate change that affects crops production. This environmental problem is a severe limitations to both crops yields, livestock and human being on struggle for food. Hence, this study measures the nutrient digestibility of the alternative feed ingredients, organ weights and economic benefits of broilers fed test diets. Three hundred day old Anak breeds were used and the birds were randomly assigned to five diets in a completely randomized design consisting of four replicates with 15 birds per replicate. Five experimental diets were formulated. Diets were replaced with donkey's ceacal meal (DCM) such that diet 1 (T_1) served as control (0%). Diet T_2 contained 2.5% and diets T_3, T_4 and T_5 contained 5.0%, 7.5%, 10% (DCM) respectively. The experiment lasted for eight weeks. The data were subjected to analysis of variance (ANOVA) and Duncan New multiple Range Test. The results of the nutrient digestibility revealed that there were significantly ($P<0.05$) different in all the parameters measured. There was no significant ($P<0.05$) differences in the parameters measured for heart, kidney and lungs. The result revealed that cost/kg feed (₦), cost of feed consume/bird in (₦), the cost of kg/weight gain and cost of production/bird showed that treatment diets improved the birds ($P<0.05$) higher in control diet than the replaced diets 2.5% -10% DCM. Diet (T_2) had highest ($P<0.05$) value in the revenue (at ₦750 /kg)/bird here. The DCM could be replaced up to 10% without any negative outcome on the broiler chickens.

Keyword: Nutrient Digestibility, Organ Weight, Benefits, Broiler Ceacal Meal

INTRODUCTION

The poultry subsector provides thousands of rural farmers in developing countries like Nigeria, food safety and as well deficiency improvement. Therefore, the poultry section can potentially transform Nigeria's economy Adolwa *et a*l., (2021) from its products in the market such as eggs and meat. Effective broiler chicken farming is highly dependent on high-quality protein and energy-feed ingredients, mainly soyabean and maize. Although, the use of these in poultry feeds has become unmanageable due to challenging demands and climate change that affects its yields Masenya *et al*., (2021), this ecological problem is the main constraints to both crops, broiler chicken and farmers. The global warming demands consideration and actions thus must not be disregarded (Wang *et al*., 2023). In reality, the functional ability of temperature regulation is most effective when birds are kept within a thermos neutral zone, ranging from 21 to 28°C, which allows them to maintain stable internal organ temperatures (Apalowo *et al.*, 2024). Researchers have indicated that environmental temperatures exceeding 25°C can induce heat stress in poultry (Shakeri *et al*., 2020). The environmental temperature is one the major challenge in tropical climates and has impacted negatively on poultry production, affecting production performance, live ability, and immune functions in birds (Kpomasse *et al*., 2021). The crude protein contributes to increased metabolic heat production due to its higher heat increment compared with fats and carbohydrates (Wang *et al*., 2022). Hence, reducing dietary protein level not only conserve protein resources and reduces nitrogen excretion but also diminishes pathogenic bacteria, and improves intestinal health (Wang *et al*., 2022). There is need to incorporate dietary protein like animal wastes, for sustainable and affordable alternatives Shittu *et al*., (2022). The utilization of donkey ceacal meal (DCM) to reduce feed cost and its potential to improve performance has attributed to their ability to maintain a healthy environment for the rural dwellers. This feed material from abattoir waste prompted the protection of human health, animal environment, increased supply of animal protein and as well serve as alternative adaptation required for the ongoing monogastric production. It

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contains 22% crude protein and energy 3.85 (GE kcal/kg); low phytate 0.45%, oxalate 0.38%, Tannin 0.003%, Saponnin 0.24%; with the following macro and micro mineral: Sodium (Na) 0.26%, Potassium (K) 0.79%, Calcium (Ca) 0.24%, Phosphorus (P) 0.33%, Magnesium (Mg) 0.28%, Iron Fe (mg/kg) 177.39, Copper Cu 7.39 (mg/kg), Zinc Zn 55.43 (mg/kg) and Manganese (Mn) 0.021 (m/kg) by Nwose *et al*.(2025), The DCM amino acid profile obtained were Arginine 2.282%, Histidine 3.61%, Isoleucine 1.04%, Lysine 2.03%, Leucine 5.14%, Methionine 1.72%, Phenylalanine 2.00%, Threonine 2.68%, Tryptophan 1.60%, Valine 3.23% Alanine 4.35%, Aspartic acid 6.96%, Glutamic acid 4.23%, Glycine 2.09%, Proline 1.08%, Tyrosine 2.14%, ornithine 0.08%, Cystine 1.66% and Serine 3.26% reported by (Nwose *et al.*, 2025).With all these properties, DCM can serve as ideal waste, cheap, locally available and accessible alternatives feed material for broiler chickens diet supplementation. The amount of DCM that can be incorporated in the diet for birds depends largely on the amount of crude protein in the meal. Enhancement of the nutritive value of DCM, however, has the potential to lead to improved exploitation of the meal in broiler chickens nutrition. Processing methods such as cooking and sun drying treatment used to improve the nutritive value of DCM for use in poultry nutrition, with varying results. This study was conducted to assess the nutrient digestibility, organ weight and economic benefits of broilers fed graded level of donkey's ceacal meal.

MATERIALS AND METHODS

Experimental site

The research was conducted at the Teaching and Research farm, Department of Animal Science, Faculty of Agriculture, Alex Ekwueme Federal University Ndufu-Alike, Ebonyi State, Nigeria.

Sources and processing of experimental material

Donkeys' Caecal content was collected from the main abattoir in Ohaukwu at Nkwo-Ezzangbo main market. The intestine was split open with the aid of sharp knife and the content was emptied into a clean 25 litres plastic bucket. The donkeys' caecal content was boiled for 30 minutes. Allow it to cool, Drain the water with basket (if there is water). The donkeys' caecal contents (DCC) were sun dried on concrete floor for 12% moisture. The sun drying was done within the month of April and May. The dried caecal content was milled in a hammer mill and stored for further use.

Experimental Diets

Five experimental diets were formulated such that diet T_1, contained 0% donkey caecal content and without supplementation (control). Diet T_2 contained 2.5% donkey caecal content, Diets T_3 5.0%, T_4 7.5% and T_5 10% donkey caecal content respectively.

Table 3: 1 Gross Composition of Experimental Diets Containing Graded Levels Donkeys' Caecal Meal.

Ingredients (%)	T_1 0%	T_2 2.5%	T_3 5.0%	T_4 7.5%	T_5 10%
Maize	50.00	50.00	50.00	50.00	50.00
Soyabean meal	25.00	22.50	20.00	17.50	15.00
DRCM	0.00	2.50	5.00	7.50	10.00
PKC	9.00	9.00	9.00	9.00	9.00
Wheat Offal	10.00	10.00	10.00	10.00	10.00
Fish Meal	3.00	3.00	3.00	3.00	3.00
Bone Meal	2.00	2.00	2.00	2.00	2.00

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Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated Crude Protein	20.60	21.51	21.43	21.35	21.30
Metabolizable Energy (kcal/kg)	3101.56	3096.09	3090.48	3084.45	3010.11

Premix supplied (Univit 15 Roche) contained: 15001.U, Vit.A;15001.U, Vit.D;30001.U, Vit.E;3.0g, Vit.K;2.5g, Vit,B2;0.3g, Vit.B6; 8.0mg, Vit.B12;8.0g, Nicotinic acid; 3.0, Ca-Panthothenate;5.0mg, Fe;10.0g, Al;0.2g, Cu;3.5mg, Zn;0.15mg, I;0.02g, Cu;0.01g,Sc. DBCM =Donkey's blood-caecal content meal. PKC =Palm kernel cake

Apparent Digestibility Trial

Feacal samples were collected using metabolic cage it was conducted during the last week of the feeding trial to determine dietary nutrient utilization by the broiler chickens. Each live broiler chicken per replicate approximately from each replicate live weights was selected, moved into metabolic cages and allowed to adjust for the period of three (3) days for the digestibility trial. These birds were served daily weighed diets for four (4) days in which they were fed eighty-five percent (85%) of their daily feed intake per day. Left over feed was also collected and weighed to determine feed intake by difference. Fecal samples per replicate were pulled togather, milled and stored in a sample container and a homogenous sample from each dietary replicate was fetched and analyzed for their nutrient composition using the procedure of AOAC (2000) for its proximate nutrient contents. The fecal samples were analyzed for dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE) and ash at the Animal Nutrition Laboratory of the Department of Animal Nutrition and Forage Science, Mr Nwachukwu (Michael Okpara University of Agriculture), Umudike, Abia State. Nitrogen free extract (NFE) was also calculated as:

%NFE = 100 – (%CP + %CF + %EE + %Ash) + %moisture. ……

(i) The quantity of nutrients in diet and fecal were determined by multiplying nutrient percentage in diet and fecal by dry matter in diet respectively. Nutrient retained was determined as nutrient intake minus nutrient voided in feces. D = …….. x 100% ……

(ii) Where; D = digestibility coefficient

I = nutrient intake and

F = nutrient voided in faeces

Statistical Analysis

The data collected was subjected to a one-way analysis of variance according to the method of Snedecor and Cochran (1994). Differences in treatment means were separated using Ducan's New Multiple Range Test as outlined by Obi (2002).

Statistical Model

$Yij = \mu + Ti + eij$

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Where Yij = Response variable

μ = Overall means

Ti = Treatment effect of diet

eij = Experimental error

i = Number of treatment

j = Number of replicate

RESULTS AND DISCUSSION

The Results of the Nutrient Digestibility of Broiler Chickens Fed Diets Containing Graded Levels of Donkey Caecal Meal are shown in Table 4.1.

The results revealed that there were significantly (P<0.05) different in all the parameters measured. The dry matter, crude protein, crude fibre and ash values were significantly (P<0.05) higher on the test diets than the control diet 0% DCM. The ether extract had significantly (P<0.05) higher value in the control diet with 0% DCM. This is followed by diet with 2.5% DCM but diets containing 5.0% - 10% DCM were (P>0.05) the same. It was observed that diets containing 2.5% -10% had its dry matter, crude protein, crude fibre and ash digestibility similar (P>0.05). Similar results was reported by Mondal *et al*. (2013) who revealed that dry matter, crude protein, crude fibre and ash digestibility was not affected by increasing levels of dried rumen content in the diet

Table 4.1: Nutrient Digestibility of Broiler Chickens fed diets containing graded levels of Donkeys' Caecal Meal (DCM)

Parameters %	T_1 (0%)	T_2 (2.5%)	T_3 (5.0%)	T_4 (7.5%)	T_5 (10%)	SEM
Dry matter	68.47^b	74.33^a	74.07^a	74.18^a	74.28^a	0.62
Crude protein	67.70^b	72.36^a	72.42^a	72.43^a	72.46^a	0.51
Crude fibre	67.17^b	76.54^a	78.50^a	78.80^a	78.84^a	1.29
Ethet extract	65.25^a	64.10^b	61.43^c	61.77^c	6158^c	0.41
Ash	92.51^b	93.48^a	93.86^a	93.88^a	93.90^a	0.18

^{a,b,c,d} Means in a row with different superscripts are significantly different (P<0.05). SEM = Standard Error of mean. DCM= donkey caecal meal

The higher values obtained in diets containing DCM indicated that nutrients in feed were adequate for each diet and birds optimized the diets at different inclusion levels. Caecal meals have been reported to enhance the production and activities of digestive enzymes with improved intestinal morphology (villi development) of broilers resulting in increased nutrients digestibility and utilizations by Mariana *et al. (*2018) and Mustafa (2019) who fed diets containing undigested leaves on broiler chickens. This could be attributed to the development of intestinal microbial ecosystem, immune responses and physiological conditions of chicks and may also be as a result of the improved growth rate in broilers fed such diets reported by Fasuyi *et al.* (2008); Liaqat *et al*. (2016); Rahman and Yang (2018) and Mustafa (2019) who fed diets containing leaf meal on broiler chickens. The improved nutrients digestibility of broiler chickens fed donkey caecal meal is an indication that the birds on diets containing DCM utilized the nutrients in their diets. Also, enhanced intestinal morphology of the broiler chickens in this study implies that available nutrients in diets containing DCM were absorbed and better digested which resulted in increased growth rate of broiler chickens.

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The result of the Organ Weights of Broiler Chickens fed Diets containing Graded Levels of Donkeys' Caecal Meal is shown in table 4.2

There was no significant (P<0.05) differences in the parameters measured for heart, kidney and lungs. The variation may be attributed to cooking and sun drying processing methods. Diet 0% (DCM) had (P<0.05) higher value in the liver weight than those on diets containing 2.5%-10% which were (P>0.05) similar within the row. The gizzard for birds fed diets containing 0% -5.0% were statistically (P<0.05) higher than diets 7.5% and 10% DCM.

Table 4.2: Organ Weights (expressed as % dressed weights) of Broiler Chickens fed graded levels of Donkeys' Caecal Meal

Parameters%	T_1 (0%)	T_2 (2.5%)	T_3 (5.0%)	T_4 (7.5%)	T_5 (10%)	SEM
Liver	4.12^a	4.04^b	4.02^b	4.00^b	4.00^b	0.011
Heart	1.50	1.50	1.50	1.50	1.50	0.006
Gizzard	4.09^a	4.11^a	4.09^a	4.05^b	4.02^b	0.009
Kidney	1.50	1.50	1.50	1.50	1.50	0.006
Lungs	0.60	0.59	0.59	0.59	0.59	0.001
Proventiculus	0.81^a	0.81^a	0.80^b	0.80^b	0.80^b	0.001
Intestine	5.12^a	5.07^b	5.07^b	5.04^c	5.02^c	0.008

^{a,b,c} Mans in a row with different superscripts are significantly different (P<0.05). SEM = Standard error of mean.

For proventiculus value, diets containing 0% and 2.5% were significantly (P<0.05) higher than diets containing 5.0%, 7.5% and 10% DCM which were similar (P>0.05). The intestine weight (P<0.05) increased in diet containing 0% DCM but decreased as the level of DCM increased in the diets. Diets containing 2.5% and 5.0% DCM were (P>0.05) higher than diets contining 7.5% and 10% donkeys' caeca meal which similar (P>0.05) had the least values.

It was observed that the value of the liver reduced as level of donkey rumen meal in the diets increased. This decrease in the size of liver with increase in the level of donkeys' caeca meal in this study could be due to the low/safe level of anti-nutritional factors in donkey caeca meal. There was no toxicity produced which could have caused inflammation of the liver. It was similar to that reported by Kpanja *et al*. (2019) who found that liver was not affected by very low anti nutritional factors because sun drying may have reduced their level. Liver plays a major role in detoxification of anti-nutritional factors.

The values of gizzard for birds fed diets 0% -5.0% were significantly (P<0.05) higher than those birds fed 7.5% and 10% DCM This is similar to that revealed by Ukim *et al*. (2012). The higher values were on the same range for healthy birds and this implies that there were no abnormalities in these organs. Although it was in disagreement with the reports of Esonu *et al*. (2011) who observed insignificant differences in the organs weight of broiler chickens fed fermented bovine blood and rumen digesta.

The Cost Benefits of Inclusion of Graded Level of Donkeys' Caecal Meal in Broiler Chickens Diets are shown in Table 4.3**.**

There were significant (P<0.05) differences in all the parameters considered. The result revealed that cost/kg feed (₦), cost of feed consume/bird in (₦), the cost of kg/weight gainand cost of production/bird were (P<0.05) higher in control diet than the substituted diets 2.5% -10% DCM. The values reduced as the percent substitution

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of DCM increased in the diets containing 2.5% -10% DCM. As the percent of donkey caecal meal increased in diets containing 2.5%-7.5% DCM in the revenue were improved.

Table 4.3: Cost benefits of inclusion of graded level of Donkeys' Caecal Meal in Broiler Chickens Diets.

Parameters (₦)	T_1 (₦)	T_2 (₦)	T_3 (₦)	T_4 (₦)	T_5 (₦)	SEM
Cost/kg feed (₦)	160.98	147.16	145.38	142.60	139.81	2.03
Cost of feed consumed/ bird	659.64^a	605.24^b	599.55^b	598.59^b	594.95^c	6.58
Cost/kg weight gain/bird	305.93^a	287.51^b	286.95^b	281.02^c	273.66^d	4.20
Cost of production/bird	659.64^a	605.28^b	599.55^b	598.59^b	594.95^c	6.58
Revenue(@ ₦750/kg)/bird	1674.17^c	1720.00^a	1715.00^a	1712.50^a	1687.50^b	6.14
Gross margin/ bird	1014.46^c	1114.62^a	1115.45^a	1113.91^a	1092.55^b	11.1

SEM = Standard Error of mean. Kg = kilogramme

The revenue was ($P<0.05$) higher in diet 2.5% - 7.5% than others. Thi is followed by diets 10% donkey caecal meal which is ($P<0.05$) higher than control diets 0% DCM. The gross margin was higher ($P<0.05$) in group fed 2.5%-5.0% followed by 10% $P<0.05$) higher than the least value recorded for control diet 0% donkey caecal meal.

The results obtained may be due to reduced unit cost of ingredients used in feed consumed by the broiler chickens fed diets containing 2.5% -10% donkey caecal meals respectively. This agreed with the result of Mohammed *et al*. (2014) who observed that cost per kilogram of feed decreased as the donkey caecal meal increased in the diets. This indicates that the feed material is viable alternative feed ingredient. Also, it can be attributed to the safe level anti-nutritional factors that could not negatively affect the availability of nutrients to the birds in the test diets. The economics of donkey caeca meal can serve as a substitute for soya bean meal in broiler diets. Diet 2.5% had the highest return of (₦1, 720.00) followed by diet 5.0%and 7.5% (₦1, 715.00 and ₦1, 712.50) which were ($P<0.05$) higher than diet 10% (₦1, 687.50) which had significantly ($P<0.05$) higher value when compared to control diet 0% (₦1, 674.17).

The lower ($P<0.05$) values obtained for revenues of the control diet 0% could be attributed to the lower weight of birds observed. The higher gross margin of diets $T_2 – T_4$ than others would be attributed to moderate cost/kg of feed, cost of production/bird and better revenue than other diets. Diet T_2 (2.5%) becomes more economically viable than others since the higher the gross margin the superior the diet (Ogbonna, 2000).

CONCLUSION

Considering the improvement of birds fed donkey caecal meal in relation to apparent digestibility trial, organ weights, and economics of producing broiler chickens, DCM can replacement soya bean even at 7.5% and 10% level of replacement without any negative effect on the health of broiler chickens.

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