Effect of Substitution of Bovine Rumen Epithelial Tissue Scrapings for Fishmeal on the Growth Performance, Nutrient Utilization and Carcass Characteristics of Broiler Chickens

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Abstract. An eight-week feeding trial was conducted to evaluate the performance, nutrient utilization and carcass characteristics of broiler chickens fed varied levels of bovine rumen epithelial tissue scrapings (BRETS) in replacement for fish meal at 0, 50 and 100% levels of substitution. Fifty four birds were used for the study and the birds were randomly distributed into three (3) dietary treatments which were randomly assigned to the rations. Feed and water were supplied *ad libitum* and data were collected on the feed intake, weight gain, feed conversion ratio and nutrient utilization. Data were also collected on the carcass characteristics after some birds had been slaughtered at the end of the experiment. Data collected were subjected to one-way analysis of variance and significant differences were indicated using Duncan multiple range test to separate the means. Results indicated that there was significant difference (P<0.05) in the feed intake, feed conversion ratio, nutrient utilization and cut-up parts, except for the lung and heart. However, there was no significant difference (P>0.05) in the weight gain, heart and lung weights. It was concluded that up to 50% BRETS inclusion as substitute for fish meal protein could be employed without any adverse effect, to maintain the quality of the broiler chicken while minimizing the high cost of whole fishmeal since BRETS is an abattoir by-product that is readily available locally.

Keywords: Broiler chicken, epithelial tissue scrapings, fish meal, bovine rumen.

Abstrak. Sebuah percobaan pakan selama delapan minggu dilakukan untuk mengevaluasi kinerja, pemanfaatan nutrisi dan karakteristik karkas ayam broiler yang diberi berbagai tingkat kerokan jaringan epitel (BRETS) rumen sapi sebagai pengganti tepung ikan pada 0 , 50 dan 100% tingkat substitusi. Lima puluh empat ayam broiler yang digunakan untuk penelitian dibagi secara acak ke dalam tiga (3) perlakuan pakan. Pakan dan air minum diberikan secara tak terbatas dan dicatat data konsumsi pakan, pertambahan bobot badan, rasio konversi pakan dan pemanfaatan nutrisi. Data lainnya yang diamati adalah karakteristik karkas setelah ayam dipotong pada akhir percobaan. Data yang dikumpulkan dianalisis dengan analisis ragam satu arah dan perbedaan nyata ditunjukkan dengan uji jarak berganda Duncan untuk memisahkan nilai tengah. Hasil penelitian menunjukkan bahwa ada perbedaan yang signifikan (P<0,05) pada konsumsi pakan, rasio konversi pakan, pemanfaatan nutrisi dan bagian-bagian potongan ayam, kecuali paru-paru dan jantung. Namun demikian, tidak ada perbedaan yang signifikan (P>0,05) pada bobot badan, jantung dan bobot paru-paru. Disimpulkan bahwa pemberian BRETS hingga 50 % sebagai pengganti protein tepung ikan dapat digunakan tanpa efek samping, untuk menjaga kualitas ayam broiler sambil menekan biaya tepung ikan yang mahal karena BRETS adalah hasil samping rumah pemotongan hewan yang tersedia secara lokal.

Kata kunci: Ayam broiler, kerokan jaringan epitel rumen sapi, tepung ikan,

Introduction

Poultry products-meat and eggs, are important sources of animal protein and their intake can help alleviate the global problems of low protein intake and malnutrition. However, large-scale production of poultry meat is threatened by scarcity and high cost of feed ingredients, particularly, protein-source feedstuffs such as fishmeal, groundnut cake (GNC) and soybean meal (SBM) which are unaffordable, expensive and scarce (Babayemi et al., 2006). Consequently, this has greatly constituted an impediment to the expansion of the poultry industry of developing countries as a result of high cost of production, leading to further reduction in animal protein intake.

However, in the quest to find a sustainable panacea to this problem, studies have indicated that some proteineous abattoir wastes such as rumen epithelial scrapings (RES), blood meal, rumen digesta and meat meal can replace the conventional protein sources (Bawala et al., 2003; Skrede and Nes 1988; Howie et al., 1996; Abubakar, 1998) respectively.

BRETS is an abattoir by-product is obtained from the papillae layer of slaughtered cattle during evisceration and processing of their rumen for food. They are readily available in areas where cattle are pre-dominantly reared and slaughtered for food and also, a similar by-product is generated from slaughtered sheep and goats (Isah and Babayemi, 2010).

Being high in protein and mineral contents (Bawala et al., 2003), the use of bovine rumen epithelial tissue scrapings (BRETS) could be one way of providing non-conventional dietary protein at a minimal cost, as well as a way of reducing disposal and pollution problems through proper recycling, hence, contributing to a clean, friendly and healthy environment. However, in order to avoid transmission of diseases to birds through the incorporation of BRETS in poultry diets like other abattoir by-products, proper processing is vital for the destruction of pathogens, improvement of storage, handling and enhancement of palatability (CAST, 1978).

The present study was designed to evaluate the effects of the replacement of fish meal protein with varying levels of BRETS in the diet of broiler chickens on the growth performance, nutrient utilization and carcass characteristics of the broiler birds.

Materials and Methods

Experimental test ingredient. Fresh bovine rumen epithelia tissues scrapings were collected from Bodija abattoir, Ibadan and Attenda abattoir, Ogbomoso, both in Oyo State. The collected samples of BRETS were then boiled in hot water at 100^0C for 30 minutes. The boiled BRETS were then sun-dried for 5 days to reduce the moisture content to the minimum. The sun-dried sample of BRETS was then milled and stored. Other feed ingredients used in the study were purchased from SEGFUN (NIG) Enterprises, Ogbomoso, Oyo State, Nigeria.

Experimental diets. Three experimental diets were formulated with varying inclusion level of BRETS. The diets were designated as diet A, B and C. Diet A served as the control diet with 0% BRETS, diet B and C had 50% BRETS and 100% BRETS respectively, all in substitution for fish meal.

The various ingredients used were ground with hammer mill, weighed in the correct proportion and thoroughly mixed manually. Table 1 and 2 show the gross composition of the broiler starter and finisher diets respectively.

Management of experimental birds and experimental layout. Fifty four day-old Ross broiler chicks used for the study were raised at the poultry unit of the Teaching and Research Farm, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Oyo State, Nigeria. The birds were purchased at day old from NU Breeds Farm, Abeokuta, Ogun State. Prior to the arrival of the birds, all necessary cleaning and disinfection of the brooder house were carried out. The birds were randomly distributed into three dietary treatments. Eighteen birds were allocated per treatment. Each treatment consists of three replicates with 6 birds in each replication. Each diet was fed to the three replicates in each treatment.

All the birds were weighed on the day of arrival and subsequent weights were recorded at weekly intervals. Water and feed were in constant supply. Light was also supplied constantly and mortality record was kept. Heat was supplied for the first two weeks to provide adequate brooding temperature of 37^{0}C for the chicks. The birds were fed the experimental diets for the first four (4) weeks and then fed with the finisher diets at the beginning of the fifth week up to the eighth weeks. During the experimental period, records of the average feed consumption and average body weight gain were taken in each dietary treatment. Faeces voided during the last three days were collected and weighed.They were first air dried during the period of collection and then later oven dried at a temperature of 60^{0}C for a period of 3 days and afterward, it was ground using a pestle and mortar.

Carcass evaluation. One bird each was randomly selected from each replication (3 birds per treatment) at eight weeks of age for carcass evaluation. They were fasted for ten hours to allow the crop partly empty. They were then slaughtered using the cut-throat method and then allowed to bleed completely. The slaughtered birds were then scalded, defeathered and eviscerated. The measured parameters included weight, de-feathered weight, eviscerated weight, dressed weight and dressing percentage.

Organ measurement. Each organ from the eviscerated carcass was carefully removed by cutting and was weighed using an electronic scale. These organs included the spleen, liver, lung, heart and kidney.

Cut-up parts measurement. Each part of the carcass was carefully cut and then weighed. The parts cut and weighed are thigh, breast, shank, back, wing, drumstick, head and the neck. The flesh was carefully removed to have total meat and bone separately. The abdominal fat was also collected and weighed.

Table 1. Gross composition of experimental diets for broiler starter (0-4 weeks)

Ingredients %	A(0% BRETS)	B (50% BRETS)	C(100%BRETS)
Maize	49.00	49.00	49.00
Groundnut Cake	12.00	12.00	12.00
Soybean meal	16.00	16.00	16.00
Palm kernel Cake	6.00	6.00	6.00
Fish meal	3.00	1.50	-
BRETS	-	1.50	3.00
Wheat offal	8.75	8.75	8.75
Oyster shell	1.50	1.50	1.50
Bone meal	3.00	3.00	3.00
Salt	0.20	0.20	0.20
Methionine	0.10	0.10	0.10
Lysine	0.10	0.10	0.10
*Vit./Mineral Premix	0.35	0.35	0.35
Total (%)	100	100	100
Calculated Crude protein (%)	21.75	21.76	21.78
Calculated Metabolizable Energy(kcal/kg)	2811.39	2768.49	2725.59
Calculated Crude Fibre (%)	4.11	4.19	4.26

BRETS: Bovine rumen epithelial tissue scrapings

Composition per 2.5kg Premix: Vitamin A: 10,000,000I.U; Vitamin B2: 2,000,000I.U; Vitamin K: 250mg; Thiamine, B1: 450mg; Pyridoxine,B6: 750mg; Niacin: 27,500mg; Vitamin B12:15mg; Pantothenic acid: 7500mg; Folic acid: 7500mg; Biotin: 50mg; Cholin Chloride: 400g; Antioxidant: 125g; Manganese: 80g; Zinc: 50g; Iron:20g; Copper: 5g; Iodine: 1.2g; Selenium: 200mg; Cobalt: 200mg.

Table 2. Gross composition of experimental diets for broiler starter (4-8 weeks)

Ingredients		A(0% BRETS)	B (50% BRETS)	C(100%BRETS)
Maize		58.00	58.00	58.00
groundnut Cake		10.50	10.50	10.50
Soybean meal		10.55	10.55	10.55
Palm kernel Cake		6.00	6.00	6.00
Fish meal		2.50	1.25	-
BRETS		-	1.25	2.50
Wheat offal		8.25	8.25	8.25
Oyster shell		1.50	1.50	1.50
Bone meal		2.00	2.00	2.00
Salt		0.20	0.20	0.20
Methionine		0.10	0.10	0.10
Lysine		0.10	0.10	0.10
*Vit./Mineral	Premix	0.30	0.30	0.30
Total (%)		100	100	100
Calculated	Crude protein (%)	19.24	19.25	19.26
Calculated	Metabolizable Energy(kcal/kg)	2910.05	2874.30	2838.55
Calculated Crude Fibre (%)		3.82	3.88	3.94

BRETS: Bovine rumen epithelial tissue scrapings

*Composition per 2.5kg Premix: Vitamin A: 10,000,000I.U; Vitamin B2: 2,000,000I.U; Vitamin K: 250mg; Thiamine, B1: 450mg; Pyridoxine,B6: 750mg; Niacin: 27,500mg; Vitamin B12:15mg; Pantothenic acid: 7500mg; Folic acid: 7500mg; Biotin: 50mg; Cholin Chloride: 400g; Antioxidant: 125g; Manganese: 80g; Zinc: 50g; Iron:20g; Copper: 5g; Iodine: 1.2g; Selenium: 200mg; Cobalt: 200mg.

Chemical analysis. Proximate analysis of the diets, BRETS and faeces were determined according to the methods of AOAC (2000).

Statistical analysis. All data were subjected to one-way analysis of variance using completely randomized design by SAS package (2000) and Duncan multiple range test was used to separate the significant of the treatment mean values (Field, 2000).

Results and Discussion

Proximate composition of bovine rumen epithelial tissue scrapings. The result obtained in Table 3 showed that BRETS has crude protein (CP) content of 73%. However, the result obtained for the ether extract (EE), crude fibre (CF), ash, nitrogen free extract (NFE), methionine and lysine in BRETS were 4.05%, 4.35%, 2.03%, 11.28%, 0.92%, 4.00% respectively, and the ash content has a value of 2.03%. The crude protein obtained for BRETS was higher than the CP obtained from the proximate composition of fishmeal (FM) observed by Awoniyi et al. (2003) and Odunsi (2003), who reported a CP content of 64.5% and 68.5% respectively for FM. However, Faremi et al. (2010) reported a contradictory lower CP and lysine contents of 53% and 0.87% respectively, for BRETS which if compared with the CP and lysine contents reported for FM, were significantly lower than that of FM. The significant difference between the CP and lysine contents obtained in this result and that reported by Faremi et al. (2010) might have been due to the difference in the nutritional status of the rumen of the slaughtered cattle from which the BRETS were obtained.

Despite the higher content of CP in BRETS compared to FM, the values of the two major essential amino acids (methionine 0.92% and lysine 4.0%) analyzed in BRETS were lower than those observed in FM by Ijaiya and Eko (2009), who reported that FM contained 2.20% of methionine and 4.56% of lysine. However, BRETS showed its superiority in terms of higher CP over other non-conventional protein sources such as maggot meal which contain 55.1% CP (Awoniyi et al., 2003) and shrimp waste meal which contain 46.3% CP (Fanimo and Oduguwa, 1999).

Performance Characteristics. The various performance parameters of broiler chickens fed graded levels of bovine rumen epithelial tissue scrapings were shown in Table 4. There was no significant difference (P>0.05) in mean final body weights for the three dietary treatments. From the result it could be deducted that, as the inclusion level increases, the final body weight of the birds in each dietary treatment also increases. This could be attributed to higher crude protein content of BRETS which hence favour growth of birds as the inclusion level of BRETS increases. There was no significant difference (P>0.05) in both the mean total weight gain and mean daily weight gain. The mean total weight gain and mean daily weight gain of birds in treatments A and B were significantly lower than those in treatment C and this was in contrast with the results obtained by Faremi et al. (2010).

There was significant difference in (P<0.05) in both the total feed intake and daily feed intake. Birds in dietary treatment A (0% BRETS) consumed most, followed by birds in dietary treatment C (100% BRETS) while birds fed diet A (50% BRETS) consumed least. The higher feed intake of birds fed diet A suggested that they consumed more to meet their protein requirement due to lower CP content in fish meal compared to BRETS. However, the high feed intake of birds fed diet C despite higher inclusion level of BRETS, might be due to other reasons than for them to meet their protein requirement. Significant difference (P<0.05) was observed in the FCR of the three dietary treatments with birds fed diet A having the highest FCR, followed by birds fed diet C and birds fed diet B has the least value. This implied that birds fed diet B consumed the least feed to yield 1kg of their bodyweight followed by birds fed diet C, with birds in diet A consumed more feed to gain 1kg of body weight. The non-significant difference (P>0.05) observed in the final body weight, total body weight and daily body weight agree with those observed by Ijaiya and Eko (2009) who replaced dietary fish meal with silkworm (Anapheinfracta) caterpillar meal. This however contrast with the findings of Oduguwa et al*.* (1999) when substituting sun-dried shrimp waste meal based diet for fish meal in broilers. Furthermore, the significant difference (P<0.05) observed in the total feed intake, daily feed intake and feed conversion ratio was in conformity with those observed by Faremi et al*.* (2010), for the replacement of fish meal protein with rumen epithelial scrapings in broiler-chicks and also in the evaluation of shrimp wastes as a probable animal protein source for broiler chicken by Okoye et al*.* (2005). No mortality was recorded in the three dietary treatments. This reinforces the confidence that BRETS could be an unscathed non-conventional protein source when processed properly despite the microbial nature of the rumen from which it was obtained.

Carcass Characteristics. The various carcass characteristics parameters of broiler chickens fed graded level of bovine rumen epithelial tissue scrapings (Table 5) showed that significant differences (P<0.05) were observed for the values obtained for the live weights, defeathered weights, eviscerated weights and carcass weights. Treatment A (0% BRETS) had the highest live weights, defeathered weights, eviscerated weights and carcass weights, followed by treatment B (50% BRETS) and treatment C (100% BRETS) had the least values. Significant differences (P<0.05) were observed for the values obtained for the head, neck, wing, breast, back and thigh. The breast, thigh and back are regarded as the major meaty parts of the broiler chicken. Birds fed diet B (50% BRETS) had the highest weights of breast, thigh and back. These parts command the highest market prices, hence birds fed diets B tend to give higher returns. Birds in dietary treatment C (100% BRETS) followed, in terms of their breast, back and thigh weight while birds fed diet A (0% BRETS) had the least weight.

The drumstick, shank, abdominal fat, kidney, liver, spleen and gizzard weights were significantly different. However, birds fed diet C had the highest abdominal fat weight, followed by those fed diet A with birds in dietary Treatment B having the least abdominal fat weight. The low abdominal fat weight of birds fed diet B was desirable as this enhance low cholesterol content which hence, reduce the risk of heart diseases such as arteriosclerosis associated with consumption of high-fat broiler chickens. Birds fed diet C has the highest kidney weight followed by those fed diet A and those fed diet B have the least kidney weight. Birds fed diet C were also observed to have the highest liver weight. High liver and kidney weight observed in birds fed diet C may have suggested an adaptation by the birds to regulate excess amino acid through the process of deamination and further excretion as urea.

There was no significant difference (P>0.05) observed in the lung and heart weights. Birds in dietary treatment A had the highest lung weight value followed by birds fed diet B and birds fed diet C had the least value. Birds fed diet A had the highest heart weight value while those fed diet B and C have the same heart weight value. Results obtained for the different carcass characteristics parameters shows significant difference (P<0.05) except for the lung and heart weights. This is in contrast with that observed by Ijaiya and Eko (2009) who reported that there was no significant difference (P>0.05) in the carcass and cut-up parts of broiler chickens when silkworm caterpillar meal was used to replaced dietary fish meal protein. The report of Ojewola et al., (2005) contrast with the findings of this study, as significant difference was only observed for kidney weights when evaluating comparative utilization of three animal protein sources by broiler chickens on various organ proportions. However, the non-significant difference observed in the lung and heart weights corroborated with that of Ojewola et al., (2005).

Nutrient utilization. Table 6 shows the nutrient utilization of broiler chickens fed graded levels of bovine rumen epithelial tissue scrapings. Dry matter digestibility decreased as the level of inclusion of BRETS increases in the diets but was optimal at 0% BRETS.

Crude protein digestibility was highest in diet A (0% BRETS). This result was expected because of the low fibre and fat content of fish meal which encouraged digestibility. This result opined with that of Deshmukh and Pathak (1991) that the intake of crude protein, its digestibility and total digestible nutrient was highest at the highest protein level and lowest at low protein level. Birds fed diet C has the highest ether extract digestibility. This might have accounted for the optimal value of abdominal fat weights observed in birds fed diet C. Birds fed diet A follows with birds in dietary treatment B having the lowest ether extract digestibility. The results obtained for the ether extract digestibility which follows the same trend with that obtained for the abdominal fat weight for the three dietary treatments established a positive correlation between ether extract digestibility and abdominal fat weight. Optimal ash digestibility was obtained in birds fed diet B, followed by birds fed diet C and birds in dietary treatment A had the least value.

The nitrogen free extract digestibility was optimal for birds in dietary treatment C followed by those fed diet A and those in dietary treatment B had the lowest nitrogen extract digestibility. The overall high digestibility of birds fed diet A could have been due to the more balanced amino acid profile of fish meal which enhances nutrient utilization by the birds. This corroborated with the report of

Ademosun (1973) that the high digestibility obtained in feeding brewer's dried grain (BDG) to growing chicken was due to the balanced amino acid composition in BDG.

Table 3. Proximate composition of bovine rumen epithelial tissue scrapings

Moisture (%)	Dry Matter (%)	Crude protein (%)	Ether Extract (%)	Crude Fibre (%)	Ash (%)	Nitrogen Free Extract (%)	Methionine (%)	Lysine (%)
5.29	94.71	73.00	4.05	4.35	2.03	11.28	0.92	4.00

Table 4. Performance characteristics of broiler chickens fed graded levels of bovine rumen epithelial tissue scrapings

Parameters (g/bird)	A (0% BRETS)	B(50% BRETS)	C(100% BRETS)	S.E.M±
Mean initial body weight	34.00	34.00	34.00	0.00
Mean final body weight	2770.00	2773.30	2836.70	0.02
Mean total weight gain	2736.00	2739.30	2802.70	0.02
Mean daily weight gain	48.86	48.92	50.05	0.01
Mean total feed intake	7065.30^{a}	6540.00^{c}	6900.00^{b}	0.05
Mean daily feed intake	126.17^{a}	116.79^{c}	123.21^{b}	0.01
Feed conversion ratio	2.58^{a}	2.39^{c}	2.46^{b}	0.02
Mortality	0.00	0.00	0.00	0.00

S.E.M: Standard Error of mean

a, b, c : Values bearing different superscripts on the same row differ significantly (P<0.05)

Table 5. Carcass characteristics of broiler chickens fed graded levels of bovine rumen epithelial tissue scrapings

Parameters	A (0% BRETS)	B (50% BRETS)	C (100% BRETS)	S.E.M±
Live weight (g)	2486.7^{a}	2373^{a}	2173.3^{b}	0.04
Defeathered weight (g)	2230^{a}	2000^{b}	2000^{b}	0.05
Eviscerated weight (g)	2043.3^{a}	1800^{b}	1800.3^{b}	0.04
Carcass weight (g)	1726.7^{a}	1540^{ab}	1516.7^{b}	0.04
Head (%)	3.00^{c}	4.15^{a}	3.35^{bc}	0.09
Wing (%)	11.33^{c}	13.86^{a}	12.14^{bc}	0.22
Neck (%)	6.38^{b}	7.91^{a}	7.30^{a}	0.29
Breast (%)	26.55^{c}	33.68^{a}	30.59^{b}	0.51
Back (%)	18.39^{b}	26.41^{a}	20.14^{b}	0.57
Thigh (%)	13.37^{b}	16.98^{a}	15.95^{a}	0.30
Drum stick (%)	11.82^{c}	16.34^{a}	13.90^{b}	0.33
Shank (%)	5.36^{b}	7.03^{a}	5.62^{b}	0.19
Abdominal fat (%)	2.69^{a}	1.40^{b}	3.02^{a}	0.18
Kidney (%)	0.77^{bc}	0.74^{bc}	0.96^{a}	0.02
Liver (%)	2.42^{b}	2.54^{ab}	2.74^{a}	0.05
Spleen (%)	0.12^{ab}	0.11^{ab}	0.12^{a}	0.01
Gizzard (%)	2.90^{bc}	2.89^{bc}	3.32^{a}	0.05
Lung (%)	0.82	0.81	0.74	0.02
Heart (%)	0.48	0.43	0.43	0.01

S.E.M: Standard Error of mean

a, b, c: Means with different superscripts on the same row differ significantly (P<0.05).

Table 6. Nutrient utilization of broiler chickens fed graded levels of bovine rumen epithelial tissue scrapings

Parameters (%)	A (0% BRETS)	B (50% BRETS)	C (100% BRETS)	S.E.M ±
Dry matter Digestibility	69.87[a]	69.23 [ab]	68.82 [ab]	0.19
Crude protein Digestibility	81.77 [a]	71.81 [b]	72.59 [b]	0.56
Ether extract digestibility	68.03 [b]	67.78 [b]	69.43 [a]	0.25
Ash digestibility	60.37 [c]	72.43 [a]	65.04 [b]	0.61
Crude fibre digestibility	66.44 [a]	51.43 [b]	51.49 [b]	1.35
Nitrogen free extract digestibility	77.39 [b]	71.86 [c]	78.37 [a]	0.37

S.E.M: Standard Error of mean

a, b, c: Means with different superscripts on the same row differ significantly (P<0.05)

Conclusions

The conspicuous superiority of birds in dietary treatment B over other dietary treatments indicated that BRETS at 50% inclusion level results in better performance and carcass characteristics in broiler chickens. This was in conformity with the inference of Faremi et al.,(2010) that fish meal protein replaced at 25% and 50% inclusion level of rumen epithelial scrapings could perform well as broiler-chicks diet in the finisher phase without adverse effects on the feed intake, average life weight gain, nitrogen retention, serum protein, haematological indices and liver enzymes of the broiler birds.

Furthermore, zero mortality recorded in BRETS-inclusion dietary treatments gives credence to BRETS as an unscathed non-conventional protein source when processed properly despite the microbial nature of the rumen from which it was obtained. Hence, BRETS which is a non-competing, readily available and non-conventional protein source feed stuff can be a useful replacement for fish meal at 50% dietary inclusion and consequently, will result into a low cost feed.

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