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Biochemical Evaluation of Millet Offal as Feeds for Broiler Chickens

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Abstract: Studies were conducted to chemically characterize and biologically evaluate millet offal as a replacement for maize in the diets of broiler chickens. Two types of millet offal were chemically characterized: the one obtained as a by-product of brewing industry and the other a by-product of pap manufacture. Studies were further carried out to further determine the effects of varying levels of millet offal obtained from the brewing industry on the performance of broiler chickens. The results of the studies indicated that millet offal from the brewery contained 14.60% CP, 4.57% CF, 2.25% EE, 2.90% Ash and 2148.0kcal/kg ME while the one from pap manufacture contained 20.65% CP, 3.12% CF, 3.01% EE, 3.36% Ash and 2506.0kcal/kg ME. The results further indicated final body weight values of 602.02, 605.85, 605.83 and 561.72g/bird for starter chicks (5 weeks old) and 2283.7, 2192.2, 2145.9 and 1904.5g/bird for finisher chickens (9 weeks old). Generally, there was an increase in feed intake as dietary millet offal increased. Feed cost per bird generally decreased when millet offal replaced maize in the diets. Therefore, millet offal can be classified as medium energy and protein sources in poultry diets. Moreover, millet offal can replace up to 50% maize in the diet without any adverse performance of broiler chickens and at reduced cost of feed production.

Key words: Millet offal, feed for broiler, maize

Introduction

Livestock consume more than a third of all the world's grains particularly maize (Thompson and Weber, 1981). Maize has remained the chief source of energy in compound feeds and constitutes about 50-60% in most poultry diets. Consequent upon its high demand, maize has been in short supply with resultant price increase at an average of 11% per annum since 1976 (Thompson and Weber, 1981). Several attempts have been made to reduce cost of feed production by replacing part of the maize in the diet with industrial by-products such as maize offal, brewers' dried grains, wheat offal and others (Ademosun, 1973; Dafwang Shwarmen, 1996; Ogbonna *et al*., 2000). Such alternative feedstuffs have the advantage of low cost and possess very low human food preference, thereby reducing competition between man and animals. Millet offal is one of the industrial by-products which could substitute for maize as an energy source in poultry diets. However, two types of millet offal have been identified. One is obtained as a by-product of the brewing industry and the other as a by-product of local manufacture of pap both of which are readily available in Nigeria.

Much of the research work on the use of agro-industrial by-products for non-ruminant animal feeding have concentrated on their utilization in terms of growth and production with limited data available on chemical characterization. An in-depth understanding of the nutro-chemical characteristics of millet offal types vis-à-vis their effects on broiler chicken performance would ensure a more judicious utilization of the ingredient. The aim of this study therefore, is to chemically characterize two types of millet offals in terms of their proximate composition and metabolizable energy values. This study is also designed to investigate the effects of varying levels of millet offal from the brewery on live performances and apparent nutrient retention in the diet of broiler chickens.

Materials and Methods

The millet offal type from the brewing industry was obtained from Guinness Nigeria PLC, while the other type was obtained from a small scale pap manufacturer. Each of the types of millet offal was obtained wet and sun-dried to reduce the moisture content.

Proximate analysis: To determine the proximate composition, representative samples were assayed for moisture, crude protein, crude fibre, fat and ash. Nitrogen free extracted was computed accordingly (A.O.A.C., 1990).

Metabolizable energy study: To determine the metabolizable energy values of the millet offal types, 6 weeks old Anak broiler chickens were used. The birds were managed in standard wire cages equipped with dropping pans. At the beginning of the studies, the birds were divided into 9 similar groups on equal weight basis at 3 birds per group. Three groups were randomly assigned to each of the 3 dietary treatments. Among the treatments, a standard broiler finisher diet served as the basal diet. (Diet 1, Table 1) Diet 2 contained 80% of the basal diet and 20% millet offal from the brewery while Diet 3 contained 80% basal diet and 20% millet offal

Table 1: Percentage composition of Starter and finisher diets

	Diet 1		Diet 2		Diet 3		Diet 4	
Ingredients	Starter	Finisher	Starter	Finisher	Starter	Finisher	Starter	Finisher
Maize	50.00	60.00	37.50	45.00	25.00	30.00	12.50	15.00
Millet offal	00.00	00.00	12.50	15.00	25.00	30.00	37.50	45.00
Soyabean meal	35.00	26.00	35.00	26.00	35.00	26.00	35.00	26.00
Palm kernel meal	10.00	10.30	10.00	10.30	10.00	10.30	10.00	10.30
Bone meal	3.00	2.00	3.00	2.00	3.00	2.00	3.00	2.00
Oyster shell	1.20	1.00	1.20	1.00	1.20	1.00	1.20	1.00
Premix	0.25	0.15	0.25	0.15	0.25	0.15	0.25	0.15
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Methionine	0.10	0.10	0.10	0.10	0.20	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.20	0.10	0.10	0.10
Cost/kg diet N	53.78	54.77	47.91	47.72	42.02	40.37	36.16	33.62
Calculated composition								
Crude protein %	23.51	20.10	23.91	20.60	24.31	21.00	24.71	21.50
Metabolizable energy (kcal/kg)	2866.00	3000.30	2747.00	2859.90	2627.30	2716.60	25080.00	2573.40
Crude fibre (%)	4.24	4.13	4.25	4.47	4.79	4.80	5.07	5.13
Methionine + Cystine (%)	0.71	0.62	0.73	0.65	0.75	0.60	0.77	0.70
Lysine	1.40	1.18	1.46	1.18	1.48	1.19	1.43	1.20
Calcium	1.46	1.07	1.47	1.08	1.48	1.08	1.48	1.10
Total Phosphorus (%)	0.91	0.73	0.93	0.74	0.94	0.76	0.95	0.80

Table 2: Proximate composition and metabolizable energy value of millet offal types (on dry matter basis)

	Millet offal from the brewery	Millet offal from pap manufacture
Crude protein (%)	14.60	20.65
Crude fibre (%)	4.57	3.12
Ether extract (%)	2.25	3.01
Ash (%)	2.90	3.36
Nitrogen free extract (%)	65.39	59.74
Metabolizable energy (Kcal/kg)	2148.00	2506.00

from pap manufacture. To acclimatize the birds to the cages and feed, a 3-day adaptation period was allowed. After this period, total excreta voided were collected quantitatively for 3 days at 24-hourly intervals. Feed and water were provided *ad libitum* during the period and the feed maintained at low levels in the troughs to avoid spillage. The feed for each group was weighed at the start and end of the collection period to determine feed consumption during the trial period. On each collection day, the excreta was blown free of feathers and other debris before collection. The excreta collected were weighed, labeled and oven dried to a constant weight to determine moisture content. The three-day collection for each group was bulked and finely ground to obtain a homogenous mixture. Samples of the diets and dried excreta as well as millet offal types were assayed for Gross Energy (GE) using an adiabatic bomb calorimeter. The Apparent Metabolizable Energy (AME) of the basal diet and substituted diets were calculated as follows.

$$\text{AME (kcal/kg)} = \frac{\text{GE of feed-GE of excreta}}{\text{Feed intake}}$$

From the metabolizable energy of the basal and substituted diets, the metabolizable energy of the millet offal types were calculated using algebraic equations.

Live performance and nutrient retention studies: Studies were conducted to determine the effects of replacing maize with millet offal from the brewery in broiler diets on live performance and nutrient retention by broiler chickens. The experiment was conducted in two stages: broiler starter and broiler finisher stages. Four diets were tested during the broiler starter stage. Diet 1 which served as the control diet was formulated to meet the nutrient requirements of broiler starter chicks according to the recommendation of Olomu (1995). In Diets 2, 3 and 4, 25%, 50% and 75% by weight respectively of the maize contained in Diet 1 was replaced with millet offal. No attempt was made to make the diets iso-nitrogenous or iso-carlic in order not to underestimate the value of the ingredient. Thus, the levels of other ingredients remained constant. The compositions of the broiler starter diets are shown in Table 1.

One hundred and twenty Anak broiler chickens obtained at day-old were used for the study. The chicks were brooded during the first 4 weeks. During this period, the chicks were vaccinated according to schedule. Coccidiostat and antibiotics were administered at regularly intervals all through the experimental period to prevent coccidiosis and bacterial infections. The birds were reared on deep litter in a standard tropical poultry building divided into 12 pens each measuring about $2.52m^2$.

The chicks were placed on commercial broiler starter mash for one week to stabilize them prior to the

Table 3: Effect of partial replacement of maize with millet offal on performance of broiler starter chicks (1-5 weeks old)

Performance parameter	Diet 1 (Control) 50% Maize 0% Millet offal	Diet 2 37.5% Maize 12.5% Millet Offal	Diet 3 25% Maize 25% Millet Offal	Diet 4 12.5% Maize 37.5% millet offal	SEM
Initial body weight (g/bird)	89.53	89.53	86.75	86.54	2.23
Final body weight (g/bird)	602.02	605.85	605.83	561.72	28.23
Weight gain (g/bird)	512.49	516.02	518.90	463.05	28.84
Feed intake (g/bird)	1312.4^{d}	1403.3^{c}	1520.8^{b}	1626.8^{a}	34.45
Feed to gain ratio	2.57^{c}	2.73^{bc}	2.95^{b}	3.55^{a}	0.134
Feed cost per bird (N)	70.58^{a}	66.22^{ab}	63.92^{b}	58.83^{c}	1.79
Feed cost per kg gain (N)	138.21	130.95	127.40	124.13	5.89
Water intake (ml/bird/day)	117.9^{d}	141.4^{c}	173.6^{b}	190.9^{a}	2.71
Water to feed ratio	2.53	2.82	3.11	3.00	0.095
Water to gain ratio	6.47^{c}	7.73^{c}	9.48^{b}	10.96^{a}	0.157

a,b,c,d implies that means within rows followed by same or no superscripts are not significantly (p>0.05) different. SEM, standard error of means

commencement of the study. At 1 week of age, the chicks were weighed and randomly allotted to 12 similar groups of 15 birds per group on equi-weight basis. Each group constituted a replicate. Three replicates were allocated to each dietary treatment in a randomized complete block design. Throughout the experiment, feed and water were provided *ad libitum*. The birds were observed daily and a recorded of mortality was kept. Weight gain and feed intake per bird were determined at weekly intervals and feed to gain ratio was computed accordingly. Average daily water intake per bird was also determined for each week. The starter stage lasted from 1-5 weeks of age.

At 5 weeks of age, 3 birds were randomly selected from each group and transferred to metabolism cages to determine nutrient retention. Thus, there were 3 replicates of 3 birds each per treatment. The management and feeding of the birds were as described under metabolizable energy above. Excreta collection and handling were the same as in metabolizable energy study also. The dried faecal samples for each group over the 3 days period were bulked and finely ground to obtained a homogenous mixture. Representative samples of feed and excreta were analyzed for proximate composition using the procedure of A.O.A.C. (1990). From the proximate composition of the feed and excreta, percentage nutrient retentions were determined. At the end of the broiler starter stage, all the birds used for the trial were fed the control diet from 5 to 6 weeks of age.

The broiler finisher stage lasted from 6 to 9 weeks of age. At 6 weeks of age, all the birds were mixed up and randomly divided into 12 similar groups in terms of starting weight. Each group constituted a replicate. Three replicates were assigned to each treatment diet in a randomized complete block design. Four diets were tested as with the broiler starter trial. The replacement regimen was the same as described for the broiler starter diets (Table 1). The parameters studied and methods of data collection were similar to those described for the starter stage.

Data obtained were subjected to analysis of variance in a randomized complete block design using the method described by Steel and Torrie (1980). Duncan multiple range test was used to determine significant differences among means as recommended by Alika (2006).

Results and Discussion

The results of the proximate analyses and metabolizable energy study are presented in Table 2. The results showed that millet offal from local manufacture of pap had higher amount of crude protein (20.65%) than that from the brewing industry (14.60%). Crude fibre contents were 4.57 and 3.12% for millet offal obtained from the brewing industry and pap manufacture respectively. Percentage ether extract and ash were higher with millet offal from pap than with the one from the brewery. Millet offal from the brewery gave a higher value of nitrogen free extract than that obtained from pap manufacture. The results of the metabolizable energy studies (Table 2) showed that millet offal from pap manufacture gave higher apparent metabolizable energy value (2506.0 kcal/kg) than that obtained from the brewing industry which gave a value of 2148.0 kcal/kg.

The results of the trial with broiler starter chicks are presented in Table 3. The results indicated that final body weight and body weight gain were not significantly (p>0.05) affected by diet. However, there was a slight depression in final body weight and weight gain on Diet 4, with 75% replacement of maize with millet offal. Feed intake per bird increased significantly (p<0.05) with increasing level of millet offal in the diet. There was also increase in feed to gain ratio with increasing levels of millet offal in the diet, significantly so when millet offal replaced 50% or 75% of the maize in the diet. Feed cost per bird decreased with increasing level of millet offal in the diet at the expense of maize. However, the decrease in feed cost per bird on with 25% replacement of maize with millet offal was not significant. Feed cost per kilogram live weight gain was lower on the millet offal diet, but significantly so. Average daily water intake per bird increased significantly as the level of millet offal in the diet increased.

Table 4: Effect of partial replacement of maize with millet offal on performance of broiler finisher chickens (6-9 weeks of age)

Performance parameter	Diet 1 (Control) 100% Maize 0% Millet offal	Diet 2 75% Maize 25% Millet Offal	Diet 3 50% Maize 50% Millet Offal	Diet 4 25% Maize 75% millet offal	SEM
Initial body weight (g/bird)	703.33	701.00	713.33	706.67	6.04
Final body weight (g/bird)	2283.7^{a}	2192.2^{ab}	2145.9^{a}	1904.5^{c}	39.35
Weight gain (g/bird)	1573.6^{a}	1465.6^{b}	1432.6^{b}	1197.8^{c}	40.31
Feed intake (g/bird)	3157.0^{b}	3675.9^{a}	3892.4^{a}	4034.4^{a}	190.08
Feed to gain ratio	2.00^{b}	2.48^{b}	2.72^{b}	3.37^{a}	0.17
Feed cost per bird (N)	172.91^{a}	175.41^{a}	157.12^{a}	135.63^{b}	8.72
Feed cost per kg gain (N)	109.54	118.53	109.80	113.41	5.06
Water intake (ml/bird/day)	460.43^{d}	619.25^{c}	666.44^{b}	747.50^{a}	15.15
Water to feed ratio	3.06^{b}	3.56^{a}	3.70^{a}	3.89^{a}	0.19
Water to gain ratio	6.13^{s}	8.87^{c}	9.77^{b}	13.13	0.36

a,b,c,d implies that means within rows followed by same or no superscripts are not significantly (p>0.05) different. SEM, standard error of means

Table 5: Effect of partial replacement of maize with millet offal on percentage nutrient retention by broiler chickens

Response Criteria	Diets 1	2	3	4	SEM
Dry matter	75.87^{c}	76.71^{c}	79.11^{b}	81.63^{a}	0.80
Crude protein	72.41^{b}	72.16^{b}	73.3^{b}	77.31^{a}	1.39
Crude fibre	43.22^{c}	44.81^{c}	61.15^{b}	73.47^{a}	1.51
Fat	70.08	69.86	70.34	69.66	1.55
Ash	64.13^{b}	60.69^{b}	64.22^{b}	68.84^{a}	1.82
Nitrogen free extract	80.86^{d}	83.41^{c}	86.35^{b}	88.15^{a}	0.56

a,b,c,d implies that means within rows followed by same or no superscripts are not significantly (p>0.05) different. SEM, standard error of means, Diet 1, 2, 3 and 4 are respectively Diets 1, 2, 3 and 4 shown in Table 3

The results of the trial with broiler finisher chickens are presented in Table 4. The results showed that body weight gain was significantly lower on the millet offal diets. The birds fed Diets 2 and 3 (with 25 and 50% levels of replacement) gave almost similar values of weight gain which were significantly higher than that of Diet 4 (with 75% level of replacement). Feed intake values were significantly higher on the millet offal diets than on the control diet. Feed intake values were not significantly different among the millet offal diets (Diets 2, 3 and 4). Feed to gain ratio increased as the level of millet offal in the diet increased. However, the increase only became significant at 75% level of replacement. Feed cost per bird was lower on Diets 3 and 4 as compared to the control but only significantly so on Diet 4 with 75% level of replacement. Feed cost per kilogram gain was not significantly affected by diets. Water intake significantly increased with increasing levels of millet offal in the diet.

The results of the nutrient retention study are presented in Table 5. The result showed that percentage dry matter retention significantly decreased as the level of maize in the diet decreased. Percentage crude protein retention was almost similar for the control diet and Diets 2 and 3 with 25% and 50% replacement respectively of maize with millet offal. Diet 4 with 75% replacement level gave a significantly higher crude protein retention as compared to the other diets. Crude fibre retention increased with increasing level of millet offal in the diet. However, the increase was not significant at 25% level of replacement. Percentage fat retention was almost similar for all the diets. Ash retention was significantly higher on Diet 4 with 75% replacement of maize with millet offal compared to other diets which gave almost similar values. Nitrogen free extract retention increased linearly as the level of millet offal in the diet increased.

(p<0.05) From the results of the proximate chemical analysis, millet offal from pap manufacture gave higher crude protein value than millet offal from the brewery. The difference in percentage crude protein may be related to difference in processing method adopted. The higher degree of extraction resulting from mechanical processing and the level of heat treatment of the raw material in the brewery may have affected the crude protein level of the material. Only slight differences existed between the two millet offal types in terms of crude fibre, ether extract and ash contents suggesting that processing method may not have had any effect on the nutrients.

The metabolizable energy of the millet offal from pap production was higher than that from the brewery. The reason for this is not immediately apparent. It is likely that in the brewery, more of the energy yielding materials is extracted than in the local manufacture of pap since the process in the brewery is mechanical. It is however, pertinent to note that the metabolizable energy value of the millet by-products are much higher than those of other by-products like wheat offal, maize gluten feed and brewers' dried grains with metabolizable energy values of 1145 kcal/kg, 1700 kcal/kg and 1900 kcal/kg respectively (Olomu, 1995). The metabolizable energy values of 2148 and 2506 kcal/kg for millet offals from beer and pap manufacture respectively place the millet offals in the category of medium energy ingredients. The metabolizable energy value of millet offal from pap manufacture (2506 kcal/kg) compares very well with the value of 2500 kcal/kg reported for palm kernel cake

($p<0.05$) (Olomu, 1995). This clearly implies that millet offal may be effective if used as an energy source in poultry diets.

The comparable performance of the birds on millet offal diets inspite of the lower metabolizable energy levels of the diets compared to that of the control diet may be related to the increase in feed intake by the birds as the dietary millet offal increased. The increase in feed intake may be due to the attempt by the birds to eat to meet their energy requirement (Olomu, 1995). The increased feed intake by the birds is associated with increased protein intake at a time when protein requirement was critical. The increased feed intake could also be an attempt by the birds to satisfy energy needs as fibre serves as an energy diluent (Thompson and Weber, 1981; Uko *et al*., 1991). The increase in feed to gain ratio observed on the millet offal diets can be attributed to the increase in feed intake on the diets since weight gain was apparently similar for all the groups. The decrease in feed cost per bird as millet offal in the diet increased is due to the lower market price of the millet as compared to that of maize. The linear increase in average daily water intakes of the birds with increasing levels of millet offal in the diet may be related to the increase in feed intake of the birds which was accompanied with increase in dietary crude fibre. This observation in agreement with the findings of Ezieshi and Olomu (2003; 2004). It has been reported that more water is needed to soften the fibrous tissues in the gastro-intestinal tract preparatory to digestion (Neumann, 1977). The depression in body weight at the highest level (75%) of replacement may be related to the low M.E. level of the diet coupled with the high crude fibre intake. Results of the retention study showed that the inclusion of millet offal in the diet did not adversely affect nutrient retention. The range of values for nutrient retention is in agreement with the findings of Ezieshi and Olomu (2003; 2004).

Conclusion: Information on proximate chemical composition and metabolizable energy values of the two types of millet by-products presented here should form important reference data for feed millers, researchers and farmers who may wish to use millet offals as feed stuffs in poultry diets. From the result of this study, millet by-products can be classified as medium energy and protein sources in poultry diets. Millet offal can replace up to 50% maize in the diet of broiler chickens without any significant effect on performance of the birds and at reduced cost of feed production.

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