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Performance of broiler chickens fed rice milling waste based diets

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Abstract

The growing concern about the cost of feed ingredients, use of least cost feed formulation and maintenance of a reliable nutritional requirement for broiler birds irrespective of the season is almost compelling to look for alternatives. Thus, this experiment was conducted to evaluate the performance of broiler chickens fed rice milling waste (RMW) as a replacement for maize. Chemical composition of rice milling waste was determined, while eleven experimental diets each were formulated to contain RMW as replacement for maize at 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100%. Three hundred (300), 7-day-old chicks were allocated to the 11 dietary treatments each having 3 replicate pens with 10 birds per pen in a Completely Randomized Design (CRD). Feed and water were provided ad libitum for 6 weeks. Growth performance, carcass yield, organ proportions and economics of production were monitored. Data were subjected to ANOVA at P<0.05. The result from the chemical composition showed that rice milling waste has 89.84% dry matter, 10.80% crude protein and 24.09% crude fibre, while the gross energy was 3789 kcal/g, this showed that RMW is suitable as feed ingredient and as well would not hinder absorption and nutrient utilization. The result of the growth performance showed that broiler chickens fed 10% - 40% RMW had greater average daily weight gain (55.33g- 47.97g), reached a greater slaughter and carcass weight (1500g – 1650g) and were more feed efficient than broiler chicken of the other treatments (P<0.05 for each). In addition, from an economical point of view birds fed 10 - 40% were superior to the other treatments where the cost/kg weight gained (N292.21K – N315.96K) were lower than the remaining treatment groups. Thus, the inclusion of RMW in diet of broiler chickens as a replacement for maize improved nutrient utilization and economic value. It can therefore be recommended that RMW can be used to replace maize between 10% -40% in the diets of broiler chickens.

Keywords: Rice milling waste, proximate analysis, performance and broiler chickens.

La Performance des poulets à griller nourris au dechets de fraisage du riz

Résumé

La préoccupation croissante au sujet du coût des ingrédients alimentaires, de l'utilisation de la formulation d'aliments pour animaux les moins coûteux et du maintien d'une exigence nutritionnelle fiable pour les oiseaux de gril, quelle que soit la saison, est presque convaincante pour chercher d'autres solutions. Ainsi, cette expérience a été menée pour évaluer la performance des poulets à griller nourris aux déchets de fraisage du riz (le 'RMW') comme remplacement du maïs. La composition chimique des déchets de fraisage du riz a été déterminée, tandis que onze régimes expérimentaux ont été formulés pour contenir le 'RMW' comme remplacement pour le maïs à 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% et 100%. Trois cents (300), poussins de 7 jours ont été alloués aux 11 traitements diététiques *ayant chacun 3 stylos de répétition avec 10 oiseaux par stylo dans un design complètement randomisé (CRD). L'alimentation et l'eau ont été fournies ad libitum pendant 6 semaines. Les performances de croissance, le rendement de la carcasse, les proportions d'organes et l'économie de la production ont été surveillés. Les données ont été soumises à ANOVA <0,05 P. Le résultat de la composition chimique a montré que les déchets de fraisage du riz ont 89,84% de matière sèche, 10,80% de protéines brutes et 24,09% de fibres brutes, tandis que l'énergie brute était de 3789 kcal/g, ce qui a montré que le 'RMW' est approprié comme ingrédient d'alimentation et ainsi n'entraverait pas l'absorption et l'utilisation des nutriments. Le résultat de la performance de croissance a montré que les poulets a griller nourris 10% - 40% RMW avaient un gain de poids quotidien moyen plus élevé (55.33g-47.97g), ont atteint un plus grand poids d'abattage et de carcasse (1500g - 1650g) et étaient plus économes en aliments pour des animaux que le poulet de gril des autres traitements (P<0.05 pour chacun). En outre, d'un point de vue économique, les oiseaux nourris de 10 à 40 % étaient supérieurs aux autres traitements où le coût/kg de poids gagné (N292,21 K – N315,96 K) était inférieur à celui des autres groupes de traitement. Ainsi, l'inclusion du RMW dans l'alimentation des poulets de poulet a griller comme remplacement du maïs a amélioré l'utilisation des nutriments et la valeur économique. Il peut donc être recommandé que le 'RMW' peut être utilisé pour remplacer le maïs entre 10% -40% dans les régimes des poulets à griller.*

Mots-clés : Déchets de fraisage du riz, analyse immédiate, performance et poulets à griller.

Introduction

Maize is a major ingredient in the poultry diets and its availability and price are influenced by competition between man, industry and livestock. According to Maize Outlook Report (2016), findings have shown that the cost of ingredients for the composition of poultry feeds, particularly maize, has increased by 100 per cent and invariably affecting the price of poultry products in the market. With these trends, researchers/ farmers have continued to search for reliable and cheap alternatives on how to reduce cost of production of feed despite increase in cost of ingredients. Most of the alternative feed ingredients for maize contain Non-Starch Polysaccharide (NSP) (Dalibord, 2006). These are forms of carbohydrates found in feedstuffs such as wholegrain cereals which is not digested in the small intestine and so provides no source of calories. However, the broilers' digestive enzyme profiles are not designed to digest NSP, thereby limiting the broilers ability to utilize high fibre feedstuffs.

The use of rice milling waste as an ingredient in animal feed, especially ruminants and poultry has been well documented (Dafwang and Shwarmen, 1996; Awesu *et al.,* 2002). In broilers, high fibre tends to limit the amount of intake of available energy by the birds and it also results in the secretion of excessive nutrients (Kung *et al.,* 2000). Again, Agbede *et al.* (2002) had shown that high fibre and lignin contents of rice milling waste are capable of reducing nutrient utilization and also precipitate metabolic dysfunction when ingested by non-ruminants. Thus, rice milling waste which is also known as rice offal or rice milling residue, is the by-product obtained from small-scale rice mills that process parboiled rice. Dafwang and Shwarmen (1996) stated that rice milling waste is the by-product which is obtained from small milling that produce parboiled rice through a mechanism which combines the removal of husk and polishing into one operation to produce the clean grain and rice offal which contains husk, bran, polishing and small quantities of broken grains.

According to the report of the Nigeria Institute of Animal Science on National Listing of Feed Ingredients (2019), rice milling waste which is also known as rice offal or rice milling residue is a common by-product of rice milling that is high in crude fibre (about 36%), metabolizable energy (1200kcal/kg) and crude protein (3.5%). Birds are known to require a minimal amount of fibre in the diet for proper functioning of the digestive organs. Dietary fibre has been observed as a diluent of the diet and, often an anti-nutritional factor. Nonetheless, moderate amount of fibre has the ability to improve the development of organs, enzyme production, and nutrient digestibility in poultry. However, the potential benefits depend on the physicochemical characteristics of the fiber source. Hence the focus on rice milling waste in this study. It was therefore the objective of this study is to investigate the effect of dietary substitution of rice milling waste for maize on the growth performance of broiler chickens.

Materials and methods

The experiment was carried out at the Poultry Unit of the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. The area falls within the tropical rain forest zone, with an annual average rainfall of 2177mm, temperature range between 20^{o} - 30^{o}C, with relative humidity of 50-59%, depending on season (NRCRI, 2017).

The rice milling waste were obtained from a local rice mill in Bendel Local Government Abia State at no cost.

Chemical analysis of rice milling waste.

Chemical composition of rice milling waste was determined according to the methods of A.O.A.C (2003), where the dry matter, crude fibre, crude protein, ether extract nitrogen free extract, fibre fractions and gross energy was determined using Gallenkamp Ballistc Bomb Calorimeter.

Experimental birds and management

A total of 330 day-old Arbor acre broiler chicks were procured from Chi® Farms Ibadan for this study. The chicks were brooded together with a 60W bulb in a brooding pen for the first seven days, thereafter; they were randomly divided into 33 groups of 10 birds each. Each group was raised in floor pens with wood shavings as litter material and contained feeders and drinkers for the provision of *ad libitum* access to feed and water respectively for duration of six weeks. Birds were vaccinated against Gumboro disease at 7^{th} and 18^{th} days of life while Newcastle disease was vaccinated at 12^{th} day. Coccidiostats was administered to the birds during the experiment.

Experimental diets

Eleven (11) experimental straight broiler diets were formulated such that the control diet did not contain rice milling waste, while substituting the dietary maize composition at the following levels of 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80 %, 90% and 100%. The composition of the diets and calculated analysis are shown in Table 1.

Data collection

Growth performance

The initial live weight of birds was taken at the beginning of the experiment and subsequent weighing was done weekly on individual basis in the morning hours (7-8 am). Weight gain was obtained respectively by subtracting initial live weight from the live weight at the end of the trial. Data on feed intake were determined by difference between the quantity offered and quantity left over each day. Feed conversion ratio was determined by dividing feed intake by weight gain.

Carcass yield

At the end of experiment (42 days), 66 chickens from each experiment, of similar body weight to the group average were selected from the treatment groups (2

Table 1: Ingredients composition of diets

Ingredients	Diet A	Diet B	Diet C	Diet D	Diet E	Diet F	Diet G	Diet H	Diet I	Diet J	Diet K
Maize	56.30	50.67	45.04	39.41	33.78	28.15	22.52	16.89	11.26	5.63	-
RMW	-	5.63	11.26	16.89	22.52	28.15	33.78	39.41	45.04	50.67	56.30
SBM	26	26	26	26	26	26	26	26	26	26	26
FFS	10	10	10	10	10	10	10	10	10	10	10
Fish meal	4	4	4	4	4	4	4	4	4	4	4
Bone meal	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Methionine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Lysine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated composition											
Crude protein %	22.46	22.18	21.90	21.62	21.34	21.06	20.78	20.49	20.21	19.93	19.65
ME Kcal/kg	2923.6	2811	2698.4	2585.8	2473.2	2360.6	2248	2135.4	2022.8	1910.2	1797.6
Crude fiber %	4.05	5.42	6.82	8.23	9.64	11.05	12.95	13.86	15.26	16.68	18.08
Calcium %	1.45	1.45	1.45	1.45	1.45	1.45	1.37	1.45	1.44	1.44	1.44
Analyzed composition %											
Dry matter	88.48	88.94	88.68	89.18	89.23	89.28	89.41	89.53	89.59	89.76	89.96
Crude protein	23.48	23.02	22.31	22.02	21.76	21.44	20.05	19.88	19.43	19.02	18.95
Ether extract	3.93	2.48	2.42	2.89	3.35	4.02	4.25	4.52	4.63	4.77	5.26
Crude fiber	3.63	4.56	5.31	7.10	9.55	12.74	14.15	16.01	18.48	19.97	21.58
NFE	56.90	58.82	58.59	55.70	50.50	47.48	46.52	43.77	40.10	39.02	36.64
ME Kcal/kg	2801.25	2713.89	2653.55	2628.01	2466.90	2401.22	2386.45	2283.40	2214.80	2198.23	2148.70

RMW: Rice milling waste; SBM: Soya bean meal; FFS: Full fat soya; NFE: Nitrogen free extract; ME: Metabolizable energy; *Each 2.5 kg vitamin-mineral premix provided the following: A 8,000,000 iu, D_3 2,000,000 iu, E 5000 mg, K_3 2000 mg, Folic acid 500 mg, Niacin 15,000mg, Calpan 5,000 mg, B_2 8000 mg, B_{12} 10,000 mg, B_1 1,500 mg, B_6 1,500 mg, Biotin 20 mg.

Table 2.0: Chemical composition and gross energy of rice milling waste

Parameters	% Composition
Dry matter	89.84
Crude protein	10.80
Crude fiber	24.09
Ether extract	4.15
Ash	15.08
Nitrogen free extract	35.72
Neutral detergent fiber (NDF)	65.73
Acid detergent fiber (ADF)	49.68
Acid detergent lignin (ADL)	17.57
Hemicellulose	16.05
Cellulose	32.16
Gross energy kcal/kg	3789

chickens per replicate), weighed and slaughtered by severing the jugular vein, they were thoroughly bled and scalded by dipping in warm water with temperature of 50-55^{0}C before de-feathering. The internal organs were removed. After evisceration, warm carcasses were weighed immediately to determine the carcass yield. The weights of the carcass cuts; breast, thigh, drumstick, backcut and wings were recorded individually. The weights of these selected parts were expressed as a percentage of dressed weight of the broilers, while the weight of selected organs gizzard, liver, spleen, heart and proventriculus were recorded and expressed as a percentage of live weight.

Feed-cost benefit

The economic analysis was done to determine the economic advantage of using rice milling waste with or without enzyme in diets of broiler chickens. Cost/kg feed were obtained by summing the price per kg of feed ingredients multiplied by their proportions in the feed formula, and then divided by 100. Daily feed cost (DFC) was obtained by multiplying cost per kg feed by daily feed intake while the total feed cost (TFC) was obtained by multiplying total feed intake by cost per kg feed. The cost per kg weight gained was also gotten by multiplying feed conversion ratio by cost per kg feed. Revenue was calculated by multiplying price per kg of meat by weight gained, while gross margin was obtained by finding the difference between revenue and cost of production.

Data analysis

The experiments were laid out in a Completely Randomized Design (CRD). All data analyses were done using IBM® SPSS version 20.0. The data were then subjected to analysis of variance (ANOVA). Where treatment means are significant, separation of means were done using the Duncan's Multiple Range Test (Duncan, 1955) at 5% level of significance.

Completely randomized design model: $Y_{ij} = \mu + T_i + ᵒ_{ij}$

Where:

Y_{ij} = individual observation

μ = Overall mean

T_i = Treatment Effect

$ᵒ_{ij}$ = Random error.

Results and discussion

Chemical analysis of rice milling waste

The chemical composition of rice milling waste is shown in Table 2. It includes 89.84% of dry matter which is lower than 93.65% as reported by Ani *et al*. (2013) and Olusiyi and Wafar (2017) but within the range reported by Makinde *et al.* (2014).

The crude protein content of 10.80% obtained for rice milling waste was higher than 8.75% reported by Olusiyi and Wafar (2017) and Olusiyi *et al*. (2019) but within the range reported by Ambashankar (1998). The crude fibre of 24.09% obtained was lower than 33.18% reported by Ani *et al.* (2013). The ether extract 4.15% was higher than 3.9% as reported by Ani *et al.* (2013)., while the ash 15.08 was lower than 20.12% as reported by Ambashankar (1998). The nitrogen free extract 35.72% was lower than 46.89 as reported by Makinde *et al.* (2014). Although there are few reports on the results of the NDF, ADF, ADL, Hemicellulose and Cellulose, but the value of the NDF (65.73%) and ADF (49.68%) were high in RMW when compared to rice husk (13.42% and 13.42%) as reported by Dairo *et al.* (2017), also Muhammad *et al.* (2008) reported that RMW has 16.46% ADF which is lower. Studies have attributed variations in nutrient composition to climatic conditions, edaphic factors as well as methods of processing and laboratory analysis (Taiwo *et al.,* 2005).

Growth performance

Table 4 shows the growth performance of broiler chickens fed diets containing varying levels of rice milling waste (R.M.W). Initial weight of the chickens was not significant (P>0.05) across treatment groups. Similar trend was obtained for final weight, weight gained and average daily weight gained as chickens fed control diet, 10%, 20%, 30% and 40% RMW were not significantly different (P>0.05) from each other but were significantly higher (P<0.05) than other treatment groups. The result of the total feed intake and average daily feed intake showed that broiler chickens fed diet containing 20%, 30%, 40%, 60%, 70% and 80% RMW was not significantly different (P>0.05) across the treatment groups but they were significantly higher (P<0.05) than those fed 90% and 100% RMW respectively, while the feed conversion ratio showed that broiler chickens fed control diet, 10%, 20%, 30% and 40% RMW was not significantly different (P>0.05) from each other but they were significantly lower (P<0.05) to the remaining treatment groups.

Carcass yield

Carcass yield of broiler chickens fed diet containing varying levels of rice milling waste (RMW) is shown in Table 5. The result of the live weight showed that broiler chickens respectively fed control diet, 10%, 20%, 30% and 40% of RMW were not significantly different (P>0.05) from each other but they were significantly higher (P<0.05) than the remaining treatment groups, while the dressed weight showed that broiler chickens fed control diet, 10%, 20% and 30% RMW were not significantly different (P>0.05) from each other but were significantly higher (P<0.05) than those fed 50%, 60%, 70%, 80%, 90% and 100% RMW. The result of the dressing percentage showed that broiler chickens fed control diet and 10% RMW were significantly higher (P<0.05) than those fed 50%, 90% and 100% RMW respectively, while the result of the breast cut showed that broiler chickens fed control diet, 10%, 20%, 30%, 40%, 60% and 70% RMW were not significantly different (P>0.05) from each other but they were significantly higher (P<0.05) than those fed 100% RMW. The result of the thigh showed that broiler chickens fed 30% RMW was significantly higher (P<0.05) than those fed control diet while the remaining treatment groups were not significantly different (P>0.05) from each other, the result of the wings showed that broiler chickens fed 100% RMW was significantly higher (P<0.05) than those fed control diet, 10%, 20%, 30%, 40%, 60%, 80% and 90% RMW respectively. The result of drumstick showed that broiler chickens fed control diet, 10%, and 30% RMW were significantly lower (P<0.05) to those fed 50%, 70% and 100% RMW respectively, while the back cut showed that broiler chickens fed control diet, 10%, 20%, 50% and 100% RMW were significantly higher (P<0.05) than those fed 70%, 80% and 90% respectively.

Organ yield

Table 6 shows the result of organs and offals proportions of broiler chickens fed diet containing varying levels of rice milling waste (RMW). The result of the liver showed that broiler chickens fed 20% and 30% RMW were significantly higher (P<0.05) than those fed 100% RMW, while the result of the gizzard showed that broiler chickens fed diet containing 90% and 100% RMW were significantly higher (P<0.05) than the remaining treatment groups. The result of the spleen showed that broiler chickens fed diet containing 10% and 40% RMW were significantly higher (P<0.05) than those fed 90% RMW but they were not significantly different (P>0.05) from the remaining treatment groups, while the heart showed that there were no significant differences (P>0.05) across the treatment groups. The result of the lungs showed that broiler chickens fed control diet and 20% RMW were significantly higher (P<0.05) than those fed diet containing 30%, 80% and 100% RMW respectively but they were not significantly different (P>0.05) from the remaining treatment groups, while the proventiculus showed that broiler chickens fed diet containing 90% and 100% were significantly higher (P<0.05) than the remaining treatment groups. The result of the neck showed that broiler chickens fed diet containing 10% RMW were significantly higher (P<0.05) than those fed diet containing 40%, 60%, and 70% RMW respectively but they were not significantly different (P>0.05) from the remaining treatment groups, while the result of the head showed that broiler chickens fed diet containing 70%, 90% and 100% RMW were significantly higher (P<0.05) than the remaining treatment groups. The result of the shank showed broiler chickens fed diet containing 90% RMW were significantly higher (P<0.05) than those fed control diet, 10%, 30% and 60% respectively but they were not significantly different from the remaining treatment groups.

Economics of production

Table 7 shows the economics of production of broiler chickens fed diet containing varying levels of rice milling waste (RMW). The result of the cost/kg feed showed that there was a significant decrease in cost as the inclusion of RMW increases across the treatment groups with a difference of N5.69K. The result of the daily feed cost (DFC) and cost of production showed that broiler chickens fed control diet, 10%, 20%, 30% and 40% RMW were higher in value than the remaining treatment groups. The result of the cost/kg weight showed that broiler chickens fed diet containing 50%, 60%,70%, 80%, 90% and 100% RMW had higher values (N359.52K - N404.51K) than those fed remaining treatment groups (N292.21K - N315.96K).

Discussion

Performance

There have been wide variations in broiler responses to use of RMW in poultry diets. These were attributed to differences in quality, variety of rice, storage periods, climatic conditions to mention but a few. However, there are various literature reports on the inclusion levels of this unconventional, agro by-product in broiler diets without adverse effect by animal nutritionists in Nigeria (Oyeyiola, 1991, Dafwang and Damang, 1995; Oyawoye and Nelson, 1999; Maikano, 2005; Duru and Dafwang, 2010).

In the present study, it was observed that final weight, weight gained and average daily weight gained followed the same pattern of significances where broiler chickens fed control diet – 40% RMW had significantly higher (P<0.05) body weight compared to the remaining treatment group. This may be due to lower level of crude fiber (3.63-9.55% crude fiber) in the diet as compared to those fed 50% - 100% RMW (12.74%-21.58% crude fiber). Although, Amodu (1985) reported that poultry can digest fibre to between 10 and 20%, while Maikano (2005) stated 15% crude fiber. Lower inclusion of RMW in diet showed that broiler chickens were able to utilize appreciable amount of insoluble diet without disrupting digestion and utilization of soluble fiber (maize) which are then converted to flesh. These result are similar to the report of Salami (2009); Akpet and Ibekwe (2018) and Maikano (2005) who showed that inclusion of RMW up to 20% and 30% in broiler diets had no adverse effects on performance. Broiler chickens fed higher level of fiber don't have well developed gastrointestinal tract to handle higher amount of coarse feed materials thus the lower weight gained as supported by Kehinde (2012). This studies did not agree with the report of Odeh *at el.* (2016); Abdulraheem *et al.* (2006); Parr *et al.* (1988) who postulated that up to up to 100% level of the maize in the diets could be replaced by RMW without adverse effect on the health and productive performance of broiler chickens.

The result of the total feed intake and average daily feed intake showed that broiler chickens fed 20% - 80% RMW had higher feed intake compared to the remaining treatment groups which might be due to the lower energy intake because broiler chickens eat to satisfy their energy requirement with exception to those fed 50% RMW which had relatively lower feed intake which might be due to health challenges, while those fed 90% and 100% RMW had the least feed intake which might be due to bulkiness of the feed and as a result had reduced lower passage in the gastro intestinal tract. Although it is expected as the crude fiber of the feed increases, the rate of consumption decreases because of bulkiness of the feed but other factors such as texture of the feed and balanced ration may enhance feed intake and utilization. The feed conversion ratio showed that broiler chickens fed control diet – 50% RMW had a better conversion rate compared to the remaining treatment groups, this showed that an enhanced feed utilization. Generally, broiler chickens on RMW- based diets did not show any particular trend in their pattern of feed consumption though there were no significant differences in treatment means, the result obtained is related to the findings of Odeh *et al.* (2016) where feed intake increased with the increase in RMW levels. Such increase can be attributed to the bulky nature and low total digestible nutrient of the feed. Moran (1977); Isikwenu *et al.* (2000); Ani *et al.* (2011) and Ani *et al.* (2013) had also attributed high feed intake to high dietary fibre level. The feed conversion ratio showed that broiler chickens fed high RMW based diet had higher feed conversion ratio which resulted in decreased in the efficiency of feed utilization.

Carcass yield

There was an observed increase in live and dressed weight of broiler chickens fed control diet, 10%, 20%, 30% and 40% RMW when compared to those fed higher level of RMW, this is an indication that control diet – 40% RMW gave better weight and higher conversion of feed to meat gain. The dressing percentage of broiler chickens fed 10% RMW was the best (69.59%) followed by those fed with control diet (68.68%), 30% RMW (67.68%) and 20% RMW (67.62) as compared to the rest of the treatment. The higher dressed carcass weights of broilers fed RMW-based diets is considered to be a direct consequence of the better final body weight and FCR of the broiler chickens in these treatments. It also suggests that RMW was not inferior to maize especially when there was no significant difference between broiler chickens fed on maize and RMW – based diets. The result also implies that RMW had a good effect on utilization of feed by birds. These results are consistent with the studies of Kehinde (2012), Odeh *et al*. (2016), while Akpet and Ibekwe (2018) deduced that the result of the dressing percentage did not follow a corresponding pattern as the inclusion of RMW increased in the diet. The result of the breast showed that broiler chickens fed control diet had higher value (36.21%) compared to the remaining treatment groups which had similar values as compared with the control, it was observed that the weight didn't show any definite trend differences which may be due to biological variability, while the result of the thigh, wings and drumstick showed that broiler chickens fed RMW diets at varying levels had higher values as compared to the control where it indicated that birds can produced more meat when fed RMW diets. The result of

Table 4: Growth Performance of broiler chickens fed diets containing varying levels of rice milling waste.

Parameters	T1 (control)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	T7 (60%)	T8 (70%)	T9 (80%)	T10 (90%)	T11 (100%)	S.E.M
Initial weight g/b	109.41	114.82	110.37	112.04	110.37	112.22	110.74	111.30	110.74	110.74	110.74	0.50
Final weight g/b	2433.33^{a}	2340.00^{a}	2382.41^{a}	2272.22^{a}	2125.00^{a}	1678.33^{b}	1726.19^{b}	1611.11^{b}	1407.41^{bc}	1122.68^{cd}	1030.83^{d}	90.31
Weight gained g/b	2323.93^{a}	2225.18^{a}	2272.04^{a}	2160.19^{a}	2014.63^{a}	1566.11^{b}	1615.45^{b}	1499.81^{b}	1296.67^{bc}	1011.94^{cd}	920.09^{d}	90.30
ADWG g/b	55.33^{a}	52.98^{a}	54.09^{a}	51.43^{a}	47.97^{a}	37.29^{b}	38.46^{b}	35.71^{b}	30.87^{bc}	24.09^{cd}	21.91^{d}	2.15
TFI g/b	4332.41^{abc}	4420.37^{ab}	4725.93^{a}	4734.49^{a}	4748.15^{a}	4286.74^{abc}	4725.92^{a}	4721.17^{a}	4668.52^{a}	3855.56^{bc}	3691.29^{c}	81.38
ADFI g/b	103.15^{abc}	105.26^{ab}	112.52^{a}	112.72^{a}	113.05^{a}	102.07^{abc}	112.52^{a}	112.41^{a}	111.16^{a}	91.80^{bc}	87.89^{c}	1.93
FCR	1.86^{d}	1.99^{cd}	2.08^{cd}	2.20^{cd}	2.36^{c}	2.89^{b}	2.93^{b}	3.15^{b}	3.60^{a}	3.81^{a}	4.02^{a}	0.13

^{a,b,c} Means across rows with different superscripts differ significantly at P< 0.05; S.E.M: Standard Error of the Mean; ADWG: Average Daily Weight Gained; TFI: Total Feed Intake; ADFI: Average Daily Feed Intake; F.C.R: feed conversion ratio; g/b: Gram/Bird.

Table 5: Carcass yield of broiler chickens fed diets containing varying levels of rice milling waste.

Parameters	T1 (control)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	T7 (60%)	T8 (70%)	T9 (80%)	T10 (90%)	T11 (100%)	S.E.M
Live weight g/bird	2400.00^{a}	2300.00^{a}	2366.67^{a}	2216.67^{a}	2150.00^{a}	1700.00^{bc}	1766.67^{b}	1616.67^{bc}	1450.00^{c}	1116.67^{d}	1000.00^{d}	87.69
Dressed weight g/bird	1650.00^{a}	1600.00^{a}	1600.00^{a}	1500.00^{a}	1400.0^{ab}	1066.67^{c}	1166.67^{bc}	1066.67^{c}	933.33^{c}	666.67^{d}	533.33^{d}	68.17
Dressing %	68.68^{a}	69.59^{a}	67.62^{ab}	67.68^{ab}	65.12^{abc}	61.52^{bc}	65.97^{ab}	65.94^{ab}	64.37^{abc}	59.52^{c}	53.33^{d}	0.93
Breast %	36.21^{a}	33.71^{ab}	34.26^{ab}	35.27^{ab}	34.16^{ab}	32.71^{abc}	35.91^{a}	34.22^{ab}	30.67^{abc}	29.80^{bc}	28.26^{c}	0.06
Thigh %	15.34^{b}	17.52^{ab}	17.06^{ab}	18.16^{a}	16.59^{ab}	16.55^{ab}	17.28^{ab}	17.55^{ab}	15.58^{ab}	17.10^{ab}	16.93^{ab}	0.24
Wings %	10.77^{e}	11.99^{de}	11.81^{de}	11.36^{de}	12.24^{cd}	13.47^{abc}	12.66^{bcd}	13.60^{ab}	12.02^{de}	13.43^{abc}	14.35^{a}	0.21
Drumstick %	14.22^{d}	14.71^{cd}	15.34^{bcd}	14.15^{d}	15.65^{abcd}	16.79^{ab}	16.04^{abcd}	16.90^{ab}	16.41^{abc}	16.20^{abc}	17.32^{a}	0.23
Backcut %	21.00^{ab}	20.71^{ab}	21.83^{a}	18.89^{bcd}	19.48^{bc}	20.83^{ab}	19.17^{bcd}	18.27^{cd}	17.06^{d}	17.95^{cd}	20.58^{ab}	0.31

^{a,b,c} Means across rows with different superscripts differ significantly at P<0.05; S.E.M: Standard Error of the Mean.

Table 6: Organs and offals proportions of broiler chickens fed diets containing varying levels of rice milling waste.

Parameters %	T1 (control)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	T7 (60%)	T8 (70%)	T9 (80%)	T10 (90%)	T11 (100%)	S.E.M
Liver	2.23^{ab}	2.06^{ab}	1.93^{b}	1.92^{b}	2.12^{ab}	2.20^{ab}	2.21^{ab}	2.29^{ab}	2.19^{ab}	2.27^{ab}	2.42^{a}	0.04
Gizzard	1.70^{d}	1.77^{d}	1.86^{d}	1.88^{d}	1.97^{cd}	2.07^{cd}	2.06^{cd}	2.34^{bc}	2.64^{b}	3.08^{a}	3.31^{a}	0.10
Spleen	0.14^{ab}	0.19^{a}	0.11^{ab}	0.12^{ab}	0.18^{a}	0.13^{ab}	0.15^{ab}	0.12^{ab}	0.14^{ab}	0.09^{b}	0.14^{ab}	0.01
Heart	0.48	0.46	0.46	0.44	0.44	0.46	0.45	0.44	0.40	0.44	0.47	0.01
Lungs	0.71^{a}	0.52^{ab}	0.71^{a}	0.47^{b}	0.56^{ab}	0.61^{ab}	0.58^{ab}	0.62^{ab}	0.50^{b}	0.52^{ab}	0.48^{b}	0.02
Proventiculus	0.42^{b}	0.42^{b}	0.39^{b}	0.40^{b}	0.39^{b}	0.45^{b}	0.43^{b}	0.47^{b}	0.50^{b}	0.68^{a}	0.66^{a}	0.02
Offals												
Neck	4.99^{ab}	5.80^{a}	5.31^{ab}	4.82^{ab}	4.72^{b}	4.98^{ab}	4.58^{b}	4.69^{b}	4.86^{ab}	4.85^{ab}	4.90^{ab}	0.09
Head	2.04^{e}	2.16^{de}	2.32^{cde}	2.18^{de}	2.46^{bcd}	2.50^{bc}	2.40^{bcd}	2.85^{a}	2.66^{ab}	2.96^{a}	2.89^{a}	0.06
Shank	3.45^{d}	3.79^{bcd}	4.23^{abc}	3.74^{cd}	4.28^{abc}	4.26^{abc}	3.81^{bcd}	4.56^{ab}	4.53^{ab}	4.61^{a}	3.89^{abcd}	0.09

^{a,b,c} Means across rows with different superscripts differ significantly at $P<0.05$; S.E.M: Standard Error of the Mean

Table 7: Economics of production of broiler chickens fed diets containing varying levels of rice milling waste.

Parameters ₦	T1 (control)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	T7 (60%)	T8 (70%)	T9 (80%)	T10 (90%)	T11 (100%)
Cost/kg feed	156.82	151.13	145.45	139.76	134.07	128.39	122.70	117.02	111.33	105.64	99.96
DFC	16.18	15.91	16.37	15.76	15.16	13.10	13.81	13.15	12.38	9.70	8.78
Cost of prod	679.41	668.05	687.39	661.69	633.27	550.38	579.87	552.47	519.74	407.30	368.98
Cost/kg weight	292.21	300.25	302.54	307.00	315.96	370.62	359.51	369.00	400.79	402.51	401.51

DFC: Daily Feed Cost; Prod: Production.

cut parts obtained in this study agreed with those of Amaefule *et al.* (2006) and Odeh *et al*. (2016) who observed no significant differences in some of the broiler chickens fed RMW-based diets.

Organs proportion

The result of the liver showed that some broiler chickens fed RMW based diet had higher values than hose fed control diet as this agrees with the studies of Odeh *et al*. (2016) while the result of the gizzard showed that broiler chickens fed RMW based diet had higher values and this increased as the level of RMW was increasing in the diet which may be due to increasing dietary fibre as the levels of RMW were increased; this probably stimulated the activity of the gizzard resulting in its increased musculature. This agreed with the report of Acton *et al*. (1982), Deaton *et al*. (1979), Maikano (2005) and Yakubu *et al*. (2007). In the gizzard, the particle size of ingesta is reduced by means of grinding, while the chyme is mixed with the secretions of the proventriculus. To function properly, the gizzard requires mechanical stimulation. Once ingested items have been ground to a critical size, the particles are moved into the small intestine. Poultry reflux digesta between various locations of the alimentary canal and fibres present in the feed are believed to influence gastro duodenal reflux of digesta in poultry (Duke, 1988).

The result of the heart, lungs, proventiculus, head, shank and neck was in agreement with the report of Uzzih and Iheagwam (2008), Akpet and Ibekwe (2018) and Kehinde (2012) whom stated that increase in weight of gizzard, kidney, liver and intestinal weights of broilers increase with dietary energy density.

Economics of production

The economic analysis of the production of broiler chickens fed RMW as a partial replacement of maize is affected by the level of replacement since there is a relationship between the cost of total feed intake, total weight gain and feed cost. The use of RMW has resulted in cost savings of N5.68 for every kg of feed formulated. This implies that feeds cost decreased with increased levels of RMW inclusion as stated by Olusiyi *et al*., (2019); Abu *et al*., (1999). RMW inclusion generally leads to a reduction in feed cost. The cost/kg weight was increasing as the level of inclusion of RMW was increasing which is a function of the feed conversion ration and the cost of a kg of feed, the result showed that higher levels of RMW depressed growth and increased cost per Kg weight. This was in agreement with the work of Maikano, A (2012) and Dafwang and Damang (1995) in which they observed that higher levels of RMW (30 – 40%) depressed growth and increased cost per Kg weight significantly because of the poor efficiency of feed utilization.

Conclusion

The study examined the nutritional value of rice milling waste as possible replacement alternative for maize in the diets of broiler chickens and from the results obtained, the following conclusions were drawn:

Rice milling waste was found to have appreciable amount of crude protein, crude fiber, ether extract and gross energy which can relatively be compared to maize, the anti nutritional factors and mineral levels were observed to be acceptable without causing obstruction in nutrient digestibility and utilisation.

Rice milling waste can replace maize up to

40% of the control value without the addition of enzyme and thus having significant effect on performance. The general performance of RMW based diets were comparable to the control. The replacement levels were also found to yield higher economic value as their inclusion reduced cost/kg of feed and higher gross margin as this would result to significant savings in the quantity of maize which is in greater need for human food. RMW can replace maize up to 40% to achieve optimum performance and economic gains.

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