American Journal of

Food Technology

ISSN 1557-4571

Academic
Journals Inc.

www.academicjournals.com

American Journal of Food Technology 7 (12): 726-735, 2012
ISSN 1557-4571 / DOI: 10.3923/ajft.2012.726.735

Evaluating Nutritional Potential of Bio-fermented Rice Husk in Broilers Diets

A.O. Fasuyi and T.A. Olumuyiwa
Department of Animal Production and Health Sciences, Faculty of Agricultural Sciences, Ekiti State University, Ado-Ekiti, P.M.B. 5363, Ado-Ekiti, Ekiti, Nigeria

Corresponding Author: Ayodeji Oludare Fasuyi, Department of Animal Production and Health Sciences, Faculty of Agricultural Sciences, Ekiti State University, Ado-Ekiti, P.M.B. 5363, Ado-Ekiti, Ekiti, Nigeria

ABSTRACT
Evaluation of the nutritional potential of Rice Husk (RH) ensiled with 5% molasses at varying ensiling lengths was carried out on 360-day old chicks by feeding trials using rice husk at varying ensiling durations of 0, 1, 2, 3 and 4 weeks. Mixtures of RH and molasses were ensiled in air-tight plastic containers to ensure anaerobic fermentation. The post-ensiled RH on day 7, 14, 21 and 28 were sundried and analyzed for proximate compositions. The six formulated diets were isocaloric and isonitrogenous and fed *ad libitum*. Diet 1 had no RH inclusion; diet 2 contained RH supplementation without ensiling and diets 3, 4, 5 and 6 contained RH ensiled for 1, 2, 3 and 4 weeks, respectively. Analysed data showed that birds on diets in which RH was ensiled for 1 and 3 weeks had the lowest FCR values of 0.54±0.2 and 0.55±0.4 ($p>0.05$), respectively while the highest value of 0.61±0.2 ($p>0.05$) was obtained for birds on diet 6 (4 weeks RH ensiling). Data on carcass and organ characteristics favoured birds fed 3-week ensiled RH. Haematological indices such as PCV, HBC, MCHC, MCV and MCH showed no significant differences among treatment means ($p>0.05$), indicating that the husk-containing diets at 10% inclusion levels and at different ensiling durations did not predispose the chicks to any detectable diseases or malformation. The inclusion of rice husk ensiled with 5% molasses for 21 days appeared optimum and most suitable for effective utilization by broilers considering the growth performance, haematological indices and cost analyses.

Key words: Bio-fermentation, chick, growth performance, digestibility and haematology

INTRODUCTION
In a bid to meet the sudden upsurge in demand and acceptability of locally grown rice (Ofada) in Nigeria as well as enhance the realization of the government long term and sustainable policy to make the country self sufficient in rice production within five years, the Federal Government of Nigeria has staked ten billion Nigeria naira on rice production (PUNCH, 2012). This will help in utilizing the capability of Nigeria to grow enough rice and feed the whole of West Africa. With this done, there will be abundant quantity of rice by-products (husk) available for possible incorporation into poultry diet as an alternative to the conventional expensive feed ingredients used in poultry feed formulation (Omotola and Ikechukwu, 2006).

Husk is one of the by-products of rice processing making up to about 20% of the whole rice. Before the husk can be obtained, the rice must undergo processing which involves the separation of rice into component parts (Fig. 1).

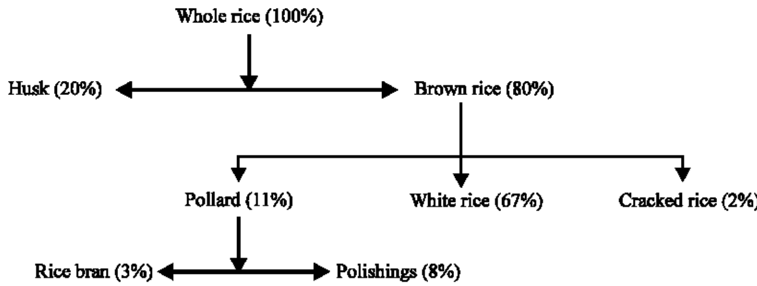

Fig. 1: Rice processing by-products as livestock feed (Foulkes, 1998)

Rice processing by-products (Foulkes, 1998) are obtained from rice milling and these are abundant in the rice producing regions of Nigeria (Omotola and Ikechukwu, 2006). Ensiling is the anaerobic fermentation process used to preserve immature green corn, legumes, grasses, grains and plant by-products with about 70-80% moisture and put in air tight environment or the preservation of forages (or crop residue or by-products) of high moisture content-based on lactic acid (ideally) fermentation under anaerobic condition (Moran, 2005). The high DM content of rice husk about 90% assisted in its easy ensilability. The colour and odour of the ensiled rice husk at different weeks indicated that it can be preserved for longer periods. This implies that the activity of yeast has been reduced to improve preservation.

The ensiling of plant by-product is the most suitable method of conservation for long periods (Lien *et al*., 1994). Ensiling improves palatability, reduces significantly toxic substances present in fresh leaves or plant by-products to safe level concentrations such as cyanogenic glycosides in fresh cassava leaves. Ensiling also increases digestibility of crude protein by breaking linkages between protein and fibre. It destroys harmful microorganisms possibly present in poultry litters or fish waste to be used as feed (Lee and Kayouli, 1998). It increases dry matter, lactic acid contents and NH_3-N (Hang and Preston, 2007). To take correct step in ensiling any plant by-product like rice husk, it is important to know the ensilability characteristics which have resulted from its chemical and microbial composition.

This study is thereby aimed at harnessing the nutritional potentials of rice husk in poultry rations when subjected to various ensiling lengths prior to incorporation into feed formulation.

MATERIALS AND METHODS

Pre-experimental operations: The research study was conducted in the Teaching and Research Farm of Ekiti State University, Ado-Ekiti in year 2011. Rice husk (RH) was obtained from a local rice miller in Igbemo Ekiti, Ekiti State, Nigeria. The RH was obtained by the rice milling process described by Foulkes (1998). The RH was later transported to the Teaching and Research Farm of Ekiti State University, Ado Ekiti, Nigeria. Mixtures of the RH and molasses were prepared using a ratio of 50 L of water to 50 kg of RH and 2.5 L of molasses and gently compressed into 120 L plastic container. The compressing of the material into container was done manually at about 1 foot height interval until the containers were about ¾ filled. Immediately, the containers were carefully covered with thick nylon covering and sand was poured to fill the rest of the spaces left. Further compression was done and another thick nylon spread across the rims of the containers before the containers lids were used to cover the containers ensuring air-tightness.

Containers containing the Ensiled Rice Husk (ERH) were opened on day 7, 14, 21 and 28. Samples were taken for laboratory analysis. The ERH was later sun-dried to obtain a moisture content of 12%. Dried samples of the ERH were later used for feed formulation.

Site preparation: Prior to the arrival of broiler chicks, the poultry house and metabolism cage were thoroughly washed and fumigated with diskol (a disinfectant containing 4% benzalkonium chloride, 3% glutaraldehyde, 14% formaldehyde, stabilizers, antioxidants and activators. The house was well covered to prevent heat loss and brooding equipment were put in place.

Experimental diets: Table 1 shows the 6 experimental diets in which formulations were based on the proximate analysis of the rice husk ensiled for different periods. Diet 1 was the control diet without the inclusion of ERH. Diet 2 was the reference diet with un-ensiled rice husk. Diet 3 contained 1 week ERH; diet 4 had 2 weeks ERH; diet 5 had 3 weeks ERH and Diet 6 contained 4 weeks ERH. All diets except the control diet 1 had RH inclusion level of 10%. Table 2 indicates the proximate composition of ensiled and un-ensiled rice husk before incorporation into the formulated experimental diets.

Table 1: Composition of experimental diets for broiler chicks placed on different fermented rice husk

			Fermentation period of rice husk			
Ingredients	Control (diet 1)	Ref. (diet 2)	7 day (diet 3)	14 day (diet 4)	21 day (diet 5)	28 day (diet 6)
Maize	51.00	41.00	41.00	41.00	41.00	41.00
Soybean meal	26.00	26.00	26.00	26.00	26.00	26.00
BDG	10.00	10.00	10.00	10.00	10.00	10.00
Wheat offal	7.00	5.00	5.00	5.00	5.00	5.00
Fish meal	2.00	2.00	2.00	2.00	2.00	2.00
ERHM	-	-	10.00	10.00	10.00	10.00
URH	-	10.00	-	-	-	-
Palm oil	-	2.00	2.00	2.00	2.00	2.00
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50
Oyster shell	0.50	0.50	0.50	0.50	0.50	0.50
Premix	0.50	0.50	0.50	0.50	0.50	0.50
DL-Met.	0.15	0.15	0.15	0.15	0.15	0.15
Lysine	0.15	0.15	0.15	0.15	0.15	0.15
Salt	0.20	0.20	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated						
CP (%)*	22.60	21.60	21.60	21.60	21.60	21.70
ME (kcal kg^{-1})	2839.40	2758.60	2758.60	2758.60	2758.60	2758.00
Ether extract	3.90	4.30	4.30	4.30	4.30	4.30

*Av. crude protein content of rice husk is 4.76% at 7th day, 4.92% at 14th day, 5.07% at 21st day and 5.26% at 28th day, ERHM: Ensiled rice husk meal, URH: Un-ensiled rice husk, BDG: Brewers dried grains, DL-Met.: Dextrorotatory and Levorotatory methionine, CP: Crude protein, ME: Metabolizable energy

Table 2: Proximate composition of ensiled and unensiled rice husk meal

Weeks	ASH (%)	Moisture content (%)	Crude protein (%)	Crude fibre (%)	FAT (%)	NFE (%)
1	19.0	10.6	4.8	42.5	1.7	32.0
2	23.2	14.6	4.9	42.4	1.6	27.9
3	23.7	10.5	5.1	41.7	1.6	28.0
4	22.8	10.7	5.3	43.3	1.5	27.1
RAW	21.2	8.3	4.9	42.3	1.7	29.8

Values are means of duplicate values, n = 2, NFE: Nitrogen free extracts

Management of experimental birds: Three hundred and sixty broiler chicks were used for the experiment. They were purchased from a reputable hatchery in Ibadan, South Western part of Nigeria. The chicks were brooded in a brooder house using electricity supplied constantly by a stand-by power generating set at the Ekiti State University Teaching and Research Farms. During the first week, the chicks were fed on commercial chicks mash containing 23% Crude Protein (CP). Chicks were sexed on the 3rd day of arrival (Laseinde and Oluyemi, 1997). The chicks were managed on the floor for the two phases of experiment. The following veterinary routines were observed from day old:

- Intraocular vaccination against Newcastle disease at day one
- Neoceryl (Antibiotics) for a period of 4 days from 3 days of age
- Coccidiostat for the treatment/control of coccidiosis and chronic respiratory diseases.
- Gumboro vaccine at 2 weeks of age
- Lasota vaccine (New castle booster) administered in a day at the age of about 3 weeks

Experimental design: At the beginning of the experiment, 60 chicks were randomly placed on each of the 6 dietary treatments. Each group contained 3 replicates comprising of 20 chicks in a completely randomized experiment. The average weight of birds in each replicate were taken and carefully balanced to ensure uniformity of average weights in all treatments.

Data collection: Feeds were supplied *ad libitum* for the 21-day experimental period with records of feed consumption and 3-day periodic weight gain recorded. Estimation of nitrogen intake, nitrogen retention and protein efficiency ratio were done in a nitrogen balance study. Total faeces voided during the last 5 days were collected, weighed, dried at 65-70°C in an air circulating oven for 72 h and preserved while the corresponding feed consumed was also recorded for nitrogen studies. Nitrogen content of the samples was determined by the method of AOAC (AOAC, 1995). Nitrogen retention of the chicks was calculated as the difference between nitrogen in the feed and fecal nitrogen. Protein efficiency ratio was calculated as the ratio of weight gained to total protein consumed. Nitrogen digestibility was computed by expressing the nitrogen retained as a fraction of the nitrogen intake multiplied by 100.

Blood collection for analysis: At the end of the feeding trial all birds were starved overnight. One male chick from each replicate was randomly picked and blood collected through the wing-web vein using a 2 mL syringe and needle. Blood samples were put inside labeled bijou bottles containing a speck of EDTA. The bottles were covered and content mixed by inversion. The blood samples collected were used for haematological studies. The Packed Cell Volume (PCV%) was estimated in heparinized capillary tubes in an haematocrit micro centrifuge for 5 min with 1400 RPM, total Red Blood Cell (RBC) count was determined using Drabkin solution to easily recognize red blood cells from other component of the blood under microscope. The haemoglobin concentration (HBC) was estimated, whereas Mean Corpuscular Haemoglobin Concentration (MCHC) and Mean Corpuscular Volume (MCV) were calculated.

Carcass and organ characteristics: After slaughtering and bleeding the chicks, the carcasses were scalded at 55-60°C in water bath for 30 sec before de-feathering. The dressed chicks were eviscerated. The data taken were fasted weight, dressed weight %, eviscerated weight, thigh, drumstick, shank, chest, back, neck, wing, fat and head weight. Also organs (heart, spleen, liver, lungs, kidney, gizzard, intestine and bursa of fabricius) were dissected out and weighed.

Cost implication/benefit analysis in Nigeria local currency: The cost of feed was ascertained based on the prevailing prices of the component ingredient and the economic cost of the tested ensiled rice husk. Other costs including medication and labour which were constant for all treatments were not included in the analysis.

Statistical analysis: Data collected were subjected to Analysis of Variance (ANOVA) and means among treatment were separated (Duncan, 1955) using Computer Minitab Statistical Package (Minitab Computer Software Package, 2005).

RESULTS AND DISCUSSION

Performance characteristics: Performance data are presented in Table 3. The average feed consumption of birds fed Diet 6 (4 week ERH) was the lowest at 49.6±1.2 g $chick^{-1}$ day^{-1} although similar ($p>0.05$) to values obtained for other diets except diet 5 (3 week ERH) which had the highest feed intake of 53.1±0.7 g $chick^{-1}$ day^{-1}. This value was similar ($p>0.05$) to value obtained for birds on diet 1 (control diet) of 51.3±0.9 g $chicks^{-1}$ (Table 3).

The average Weight Gain (WG) for the experimental period of 21 days indicated that birds on diet in which RH was ensiled for 21 days had the highest WG of 96.1±7.4 g $chick^{-1}$ day^{-1}. This value was similar ($p>0.05$) to treatment means obtained for birds on control diet and diet in which RH was not ensiled (reference diet) at 91.7±2.7 and 89.3±0.7 g $chick^{-1}$ day^{-1}, respectively. These values were also similar to values obtained for birds on diets in which RH was ensiled for 7 and 14 days at 95.4±4.1 and 87.0±6.1 g $chick^{-1}$ day^{-1}, respectively. Birds on diets with RH ensiled for 28 days had the lowest WG at 80.9±0.3 g $chick^{-1}$ day^{-1} which was significantly different ($p<0.05$) from others.

Birds fed on diet 3 (1 week ERH) had FCR of 0.53±0.2 which was similar ($p>0.05$) to values obtained for bird on diet 5 (3 week ERH) and diet 1 (control diet) at 0.55±0.4 and 0.56±0.3, respectively.

The performance characteristics investigated such as weight gain, feed consumption, feed conversion ratio all indicated that chicks on diet 5 (3 week ERH) had the best performance indices. The effective utilization of Ensiled Rice Husk (ERH) based diets by broiler chicks at the levels of inclusion without any visible side effect or mortality showed that the fibre content of ERH was within tolerable level for broilers starter. The ensiling process was effective in breaking the linkages between the fibre and protein (Hang and Preston, 2007). This was confirmed by increase in crude protein level as the ensiling length increased.

Table 3: Performance of broiler chicks fed rice husk of varying ensiling lengths

			Fermentation period of rice husk (Days)			
Parameters	Control (diet 1)	Ref. (diet 2)	7 (diet 3)	14 (diet 4)	21 (diet 5)	28 (diet 6)
Av. weight gain (g $chick^{-1}$ day^{-1})	91.70±2.7[ab]	89.30±0.7[ab]	95.40±4.1[a]	87.00±6.1[ab]	96.10±7.4[a]	80.90±0.3[b]
Feed intake (g $chick^{-1}$ day^{-1})	51.30±0.9[a]	51.90±0.9[a]	51.20±0.3[a]	50.50±0.4[a]	53.10±0.7[a]	49.60±1.2[a]
FCR	0.56±0.3[a]	0.59±0.2[a]	0.54±0.2[a]	0.62±0.5[a]	0.55±0.4[a]	0.61±0.2[a]

Mean values within rows with different superscripts are significantly different at $p<0.05$, FCR: Feed conversion ratio

It has been reported that the addition of molasses at 4-6% inclusion in silages increased palatability (McDonald *et al.*, 2002). This was manifested in the uniformity of feed consumption for all the experimental birds. The length of ensiling seemed to have significant effect on the overall performance of experimental chicks. There seemed to be a favourable and beneficial disposition to increased ensiling duration particularly at the 21-day fermentation of rice husk. The uniformity in feed consumption of all chicks including chicks that were not fed RH or ERH indicated that the rice husk fibre was not a major limitation to feed intake by chicks and that ensiling of rice husk might have successfully broken down complex linkages between fibre and protein. Addition of molasses at 4-6% level of inclusion might have contributed to the increased palatability of ERH as corroborated by earlier report (McDonald *et al.*, 2002). However, further prolonged fermentation of rice husk beyond 21 days had a deteriorating effect on the overall performance characteristics in spite of the highest crude protein and crude fibre compositions in rice husk fermented for 28 days at 5.26 and 43.3%, respectively. This was in agreement with earlier reports (McDonald *et al.*, 2002; Fasuyi *et al.*, 2010). Ensiling materials for longer periods than necessary causes decrease in crude protein content due to the denaturation of the proteins by excess organic acids. Adding molasses at 4% of ensiled material and later ensiling for a period between 14 and 21 days appeared optimum and most suitable for effective ensiling of *Tithonia diversifolia* (Fasuyi *et al.*, 2010).

Increased dietary fibre levels may also be contributory to poor nutrient utilization. It was observed that high fibre content of diets caused decrease nutrient utilization by chicken (Savory and Gently, 1976). The high fibre content in diet 6 must have reduced its utilization since high crude fibre feed have been found to depress feed efficiency through the impaction of the intestinal tract (Clark and Myra, 1977).

Carcass characteristics and relative organs weight: Carcass characteristics are presented in Table 4. The lowest fasted weight was observed for birds fed diet 6 (4 weeks ERH) at 422.0±2.8 g kg^{-1} b.wt. which was significantly different ($p<0.05$) from birds on other diets. Birds on diet 5 (3 week ERH) had the highest fasted weight of 656.5±3.5 g kg^{-1} b.wt. which was also significantly different ($p<0.05$) from the value obtained for birds on control diet 1 (626.0±7.1 g kg^{-1} b.wt.) (Table 4).

Table 4: Carcass characteristics of broiler chicks fed ensiled rice husk of varying ensiling lengths

			Fermentation period of rice husk (days)			
Carcass (g kg^{-1})	Control (diet 1)	Ref. (diet 2)	7 (diet 3)	14 (diet 4)	21 (diet 5)	28 (diet 6)
Fasted weight	626.0 ± 7.2^{a}	570.5 ± 12.0^{b}	563.5 ± 2.8^{bc}	543.5 ± 5.00^{c}	656.5 ± 3.5^{d}	422.0 ± 2.8^{e}
Dressed weight (%)	52.9 ± 0.4^{a}	65.2 ± 0.14^{b}	61.2 ± 0.2^{c}	61.1 ± 0.20^{c}	65.8 ± 0.3^{b}	61.1 ± 0.3^{c}
Eviscerated weight	430.0 ± 1.4^{a}	433.5 ± 3.50^{a}	392.5 ± 3.5^{a}	380.6 ± 16.2^{a}	456.5 ± 7.0^{a}	348.5 ± 3.5^{a}
Carcass weight	330.5 ± 2.1^{a}	376.5 ± 2.10^{b}	340.0 ± 1.4^{a}	338.1 ± 4.20^{a}	431.0 ± 1.4^{c}	262.0 ± 3.5^{d}
Head	21.5 ± 2.1^{a}	27.5 ± 2.10^{a}	20.5 ± 2.1^{a}	24.0 ± 4.20^{a}	24.0 ± 2.8^{a}	25.2 ± 2.8^{a}
Neck	43.0 ± 1.4^{a}	30.0 ± 1.40^{b}	31.5 ± 0.7^{bc}	36.5 ± 0.70^{c}	42.5 ± 2.2^{a}	28.0 ± 1.4^{b}
Wings	26.5 ± 3.5^{c}	31.5 ± 2.10^{b}	32.0 ± 1.4^{b}	33.5 ± 0.70^{b}	38.0 ± 1.4^{a}	21.0 ± 1.4^{d}
Thigh	31.5 ± 0.7^{ab}	31.0 ± 1.40^{ab}	30.0 ± 2.8^{b}	25.0 ± 1.40^{c}	35.5 ± 5.0^{a}	26.0 ± 1.4^{c}
Drumstick	36.5 ± 0.7^{a}	30.5 ± 0.70^{ab}	26.5 ± 3.5^{b}	24.5 ± 2.10^{b}	37.5 ± 2.1^{a}	16.6 ± 1.4^{ab}
Upper back	37.5 ± 0.7^{a}	27.5 ± 2.10^{b}	22.0 ± 2.8^{b}	24.5 ± 3.50^{b}	23.5 ± 0.7^{b}	23.0 ± 2.8^{b}
Lower back	43.5 ± 3.5^{a}	38.0 ± 1.40^{ab}	32.0 ± 2.8^{bc}	37.0 ± 1.40^{ab}	42.5 ± 0.7^{a}	25.5 ± 2.1^{c}
Chest	77.5 ± 2.1^{ac}	72.5 ± 3.50^{ad}	91.5 ± 2.1^{b}	75.0 ± 1.40^{ad}	86.0 ± 4.2^{bc}	65.0 ± 1.4^{d}
Shank	17.0 ± 2.8^{a}	16.5 ± 0.70^{a}	15.0 ± 1.4^{a}	19.0 ± 1.40^{a}	15.6 ± 2.1^{a}	14.5 ± 2.1^{a}

Mean values within rows with different superscript are significantly different at $p<0.05$

The carcass weight of birds on diet 5 was the highest at 431.0±1.4 g kg^{-1} body weight and this was significantly different ($p<0.05$) from the value obtained for birds on diet 1 (330.5±2.1 g kg^{-1} b.wt.). Birds on diet 6 (4 week ERH) had the lowest carcass weight of 262.0±3.5 g kg^{-1} b.wt. The mean dressed weight of birds on diet 1 (control diet) was the lowest at 52.9±0.4% live weight while birds on diet 5 (3 week ERH) had the highest live weight at 65.8±0.4%. There were no significant differences ($p>0.05$) amongst all the treatment means for eviscerated weight, shank and head of experimental chicks placed on all diets.

Birds on diet 1 (control diet) had the highest neck weight of 43.0±1.4 g kg^{-1} b.wt. which was similar ($p>0.05$) to birds on diet 5 (42.5±2.1 g kg^{-1} b.wt.). Birds on diet 6 (4 week ERH) had the least neck weight of 28.0±1.4 g kg^{-1} body weight, although similar ($p>0.05$) to those placed on diets 2 (no ensiling of RH) and diet 3 (1 week ERH) of 30.0±1.4 and 31.5±0.7, respectively) The mean chest weight of birds placed on diets 3 and 5 were similar ($p>0.05$) at 91.5±2.12 and 86.0±4.2 g kg^{-1} of body weight, respectively but significantly different ($p<0.05$) from mean chest weight value obtained for birds on diet 6 with the lowest chest weight of 65.0±1.4 g kg^{-1} body weight.

The weight of the lower back of birds on diet 1 was the highest at 43.5±3.5 g kg^{-1} and similar ($p>0.05$) to birds on diet 5 at 42.5±0.7 g kg^{-1}. Birds on diet 6 had the significantly lowest weight of lower back at 25.5±2.1 g kg^{-1} of body weight. Birds on diet 5 had the highest average drumstick weight of 37.5±2 g kg^{-1} body weight although similar ($p>0.05$) to weight of drum stick of birds on diet 1 of 36.5±0.7 g kg^{-1}. The average weight of drumstick of birds on diets 1-3 were similar ($p>0.05$) at 36.5±0.7, 30.5±0.7, 26.5±3.5 g kg^{-1} body weight, respectively. Birds on diet 6 had the lowest drum stick weight of 16.6±1.4 g kg^{-1} body weight.

The thigh of birds on diet 4 (2 weeks ERH) had the lowest average value of 25.0±1.4 g kg^{-1} body weight although similar ($p>0.05$) to those on diet 6 of 26.0±1.4 g kg^{-1} body weight. Birds on diet 5 (3 week ERH) had the highest mean weight value of thigh at 35.5±5.0 g kg^{-1} albeit similar ($p>0.05$) to values obtained for chicks on diets 1 and 2 at 31.5±0.7 g kg^{-1} and 31.0±1.4, respectively. Birds on diet 5 (3 week ERH) has the highest mean weight of wing of 38.0±1.4 g kg^{-1} significantly different ($p<0.05$) from all other values for wings. Chicks on diet 6 (4 week ERH) had the lowest mean wing weight value of 21.0±1.4 g kg^{-1}.

The favourable carcass characteristics in birds on diet 5 (3 week ERH) might be due to the successful breakdown and conversion of fibre in the ensiled RH to more soluble and easily utilized sugars. Cellulose and lignin might have been converted to hemicellulose and pectin. Prolonged fermentation of rice husk beyond 21 days had a deteriorating effect on the overall performance characteristics including carcass/organ characteristics of the experimental chicks in spite of the highest crude protein and crude fibre compositions in rice husk fermented for 28 days as corroborated (McDonald *et al.*, 2002; Fasuyi *et al.*, 2010). It was suggested that the carcass cuts with the highest weight in broilers are the drumstick, thigh and chest and that this weight cuts depends on sex, size and age of the bird (Leeson and Summers, 1980). This experiment seemed to agree with this report since the birds used for carcass characteristics were similar in age and sex. The source of variation in their carcass cuts might only be due to their body sizes.

Most relative organs' weights of birds on diet 1 (control) were not significantly different ($p>0.05$) from those fed the test diets (2-6), whereas only the relative weight of heart, intestine, gizzard and fat were significantly ($p<0.05$) influenced by dietary treatments (Table 5).

The relative weight of intestine of birds on diets 1 (control) was the highest 60.5±0.7 g kg^{-1} although similar ($p>0.05$) to those on diet 5 (3 week ERH) of 56.0±2.8 g kg^{-1}. Birds on diet 6 (4 week ERH) also had the lowest relative weight of intestine at 35.0±2.8 g kg^{-1} b.wt.

Birds on diet 5 (3 week ERH) also had the highest significant ($p<0.05$) relative weight of gizzard at 35.0±1.4 g kg^{-1}. The relative weight of gizzard was also lowest for birds on diet 6 (4 week ERH) at 20.0±1.4 g kg^{-1} body weight but similar ($p>0.05$) to values obtained for birds on diets 1, 2, 3 at 23.5±2.1, 22.0±1.4 and 23.5±2.1 g kg^{-1}, respectively. Only gizzard, heart and intestine had significant variations amongst birds on the experimental diets. Fat deposition around the heart might have caused the increased weights of the hearts of chicks.

Haematological indices of experimental birds: All indices measured showed no significant differences among treatment means as shown in Table 6. Blood variables mostly affected by dietary influences were the RBC count, HBC, plasma protein, PCV and clotting time (Ologhobo *et al*., 1986; Aletor and Egberongbe, 1992). All these tend to suggest that the replacement of maize with varying ensiling lengths of rice husk did not have adverse effect on the health status of the experimental chicks. It is instructive if blood parameters were to be brought to reckoning that the use of ensiled rice husk did not predispose the experimental chicks to any detectable health hazards.

Economics of production/cost implication (in Nigerian local currency, naira, ₦): The cost implication indices are shown in Table 7. The costs of diets were calculated using the prevailing current prices of the feed ingredients. The cost of the diets were calculated with the basic

Table 5: Relative organs weight of broiler chicks fed ensiled rice husk of varying length

			Fermentation period of rice husk (days)			
Organs (g)	Control (diet 1)	Ref. (diet 2)	7 (diet 3)	14 (diet 4)	21 (diet 5)	28 (diet 6)
Liver	15.0±0.7[a]	12.5±0.7[a]	15.0±1.4[a]	135.0±2.1[a]	17.0±1.4[a]	7.0±0.7[b]
Kidney	1.0	1.0	1.0	1.0	1.0	1.0
Spleen	1.0	1.0	1.0	1.0	1.0	1.0
Bile	1.0	1.0	1.0	1.0	1.0	1.0
Intestine	60.5±0.7[a]	40.0±1.4[b]	57.5±2.1[a]	40.5±2.1[b]	56.0±2.8[a]	35.0±2.8[b]
Bursa	2.5±1.4[a]	2.5±0.7[a]	1.5±0.7[a]	1.5±0.7[a]	3.0±0.7[a]	2.5±0.7[a]
Lungs	1.5±0.7[a]	3.5±0.7[a]	2.0±0.7[a]	3.5±0.7[a]	3.5±2.1[a]	2.5±0.7[a]
Heart	4.0±1.4[a]	3.5±0.7[a]	2.5±0.7[a]	4.0±1.4[a]	7.5±0.7[b]	2.5±0.7[a]
Gizzard	23.5±2.1[b]	22.0±1.4[c]	23.5±2.1[b]	28.5±2.1[b]	35.0±1.4[a]	20.0±1.4[d]
Proventriculus	4.5±0.7[a]	6.0±1.4[a]	5.5±0.7[a]	3.5±0.7[a]	7.5±2.1[a]	8.0±1.4[a]
Fat	6.5±0.7[a]	3.5±0.7[b]	4.0±1.4[b]	6.0±1.4[ab]	6.5±0.7[ab]	3.0±0.1[b]

Mean values within rows with different superscripts are significantly different at $p<0.05$

Table 6: Haematological indices of birds fed differently ensiled rice husk

			Fermentation period of rice husk			
Parameters	Control (diet 1)	Ref. (diet 2)	7 (diet 3)	14 (diet 4)	21 (diet 5)	28 (diet 6)
PCV (%)	27.0±4.5	25.3±2.3	30.±3.00	24.3±8.3	28.7±1.2	27.0±4.0
RBC count ($\times 10^6$ mm^{-3})	2.1±0.5	2.3±0.1	2.3±0.2	2.0±0.7	2.3±1.0	2.1±0.2
Hb count	6.3±1.7	6.8±0.7	7.0±0.5	6.1±1.5	6.0±0.9	6.3±1.0
MCHC (g dL^{-1})	23.0±5.2	23.4±1.1	23.4±1.1	25.9±3.4	21.0±3.4	23.4±5.2
MCH (pg)	3.1±0.3	2.9±0.3	3.1±0.3	3.1±0.5	2.9±0.7	3.1±0.4
MCV	134.0±0.2	123.0±0.2	133.0±0.3	122.0±0.1	147.0±0.4	134.0±0.2

PCV: Packed cell volume, RBC: Red blood cell, HBC: Haemoglobin concentration, MCHC: Mean cell haemoglobin concentration, MCH: Mean cell haemoglobin, MCV: Mean cell volume

Table 7: Cost implication (Nigeria local currency, ₦) of broiler chicks fed ensiled rice husk of varying length

			Fermentation period of rice husk (days)			
Parameters	Control (diet 1)	Ref. (diet 2)	7 (diet 3)	14 (diet 4)	21 (diet 5)	28 (diet 6)
Average weight gain (g)	91.6	89.3	95.4	87.1	96.1	80.9
Average feed intake	51.3	51.9	51.2	50.5	53.1	49.6
Cost of feed N/100 g	30.0	20.3	21.9	21.9	21.9	21.9
Cost of feed intake (g bird^{-1})	15.4	10.5	11.2	11.0	11.6	11.0
Cost of feed intake/weight	0.2	0.1	0.1	0.1	0.1	0.1

Cost of feed excludes overhead cost such as labour and transportation

assumption that labour and other overhead costs were similar for all diets prepared and did not need to be considered in the calculation. The cost of the finished feed (diets) expectedly revealed that the control diet of ₦ 30.00 was the most expensive, while other diets 3, 4, 5 and 6 were similar having a cost of ₦ 21.85/100 g. The cost per weight gain of chick was lowest for birds on diets 5 (₦ 0.11) and the highest (₦ 0.17) for birds on diet 1 (control). The cost of feed consumed per weight gain calculated to obtain the least cost formula indicated that broiler birds on diet 5 had the least cost of feed per weight gain. Diets with ensiled rice husk were clearly cheaper than the control diet (Table 7).

CONCLUSION

Ensiling RH before incorporation into broilers diets had a nutritionally beneficial effect. Rice husk ensiled for 21 days with 5% molasses silage additive had the most beneficial effect on the growth and other performance and carcass characteristics of the experimental broiler chickens.

Economy of production also favoured the use of RH ensiled for 21 days and incorporated at 20% inclusion level. It therefore suffices to conclude that broiler birds can perform well on diets in which RH is ensiled for a period of 21 days and fed at inclusion levels not exceeding 20%.

REFERENCES

AOAC, 1995. Official Methods of Analysis. 16th Edn., Association of Official Analytical Chemists, Washington, DC., USA.

Aletor, V.A. and O. Egberongbe, 1992. Feeding differently processed soya bean. Part 2. An assessment of haematological responses in chickens. Die Nahrung, 36: 364-369.

Clark, E.G.C. and L.C. Myra, 1977. Veterinary Toxicology. 1st Edn., Boeltiere Tindall, New York, USA., pp: 343-344.

Duncan, D.B., 1955. Multiple range and multiple F tests. Biometrics, 11: 1-42.

Fasuyi, A.O., F.A.S. Dairo and F.J. Ibitayo, 2010. Ensiling wild sunflower (*Tithonia diversifolia*) leaves with sugar cane molasses. Livestock Res. Rural Dev., Vol. 22.

Foulkes, D., 1998. Rice as a livestock feed. No. J22 Agdex No: 121/10 ISSN No: 0157-8243. https://transact.nt.gov.au/ebiz/dbird/TechPublications.nsf/A7BA6A055B2C671169256EFE004F65FC/$file/273.pdf

Hang, D.T. and T.R. Preston, 2007. Taro leaves as a protein source for growing pigs in central vietnan. Proceedings of the MEKARN International Conference on Matching Livestock Systems with Available Resources, November 26-27, 2007, Ha Long Bay, Vietnam.

Laseinde, E.A.O. and J.A. Oluyemi, 1997. Sexual dimorphism in the growth pattern of broiler under different dietary and housing conditions. Nig. J. Anim. Prod., 24: 1-6.

Lee, S. and C. Kayouli, 1998. Supplementary Feeding for Dairy Small Holders in the Pacific Island Countries: Fiji, Samoa, Vanuatu, Cook islands, Solomon islands and Tonga. In: Manual of Small Holder Milk Production in the south Pacific, Lee, S., R. Kennard and C. Kayouli (Eds.). FAO Sub-Regional Office for the Pacific, Apia, Samoa.

Leeson, S. and J.D. Summers, 1980. Production and carcass characteristics of the broiler chicken. Poult. Sci., 59: 786-798.

Lien, L.V., R. Sansouncy and N. Thien, 1994. Preserving shrimps heads and animal blood with molasses and feeding them as a supplement for pigs. Proceedings of the National Seminar-Workshop on Sustainable Livestock Production on Local Feed Resources, November 22-27, 1993, Ho Chi Minh City.

McDonald, P., R.A. Edwards, J.F.D. Greenhalgh and C.A. Morgan, 2002. Animal Nutrition. 6th Edn., Prentice Hall, UK., ISBN: 9780582419063, Pages: 693.

Minitab Computer Software Package, 2005. One-way analysis of variance (ANOVA). Developed by Minitab inc. http://www.minitab.com

Moran, J., 2005. Feeding Management for Small Holder Dairy Farmers in the Humid Tropics. Landlinks Press, Collingwood, Victoria, Pages: 312.

Ologhobo, A.D., O.O. Tewe and D.O. Adejumo, 1986. Haematological and neutral metabolites in broilers fed soyabean based rations. Proceedings of the 11th Annual Conference of the Nigeria Society for Animal Production, March 23-27, 1986, Ahmadu Bello University, Zaria, pp: 101-103.

Omotola, K.M. and A. Ikechukwu, 2006. Rice milling in Nigeria. http://www.ricenigeria.com

PUNCH, 2012. 2015 self-sufficiency target for rice production feasible. http://www.punchng.com/business/business-economy/2015-self-sufficiency-target-for-rice-production-feasible-stakeholders/

Savory, C.J. and M.J. Gentle, 1976. Effects of dictany dilution with fibre on the food intake and gut dimension of Japanese quail. Br. Poult. Sci., 17: 571-580.