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Original research paper

EVALUATION OF SELECTED AGRICULTURAL SOLID WASTES ON BIOCHEMICAL PROFILE AND LIVER HISTOLOGY OF ALBINO RATS

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ABSTRACT: Wheat bran, groundnut shell, watermelon peel and corn bran were analyzed for chemical composition and amino acid profile. A feeding trial was conducted to assess their effect on biochemical profile and liver histology of rats. Watermelon peel obtained the highest dry matter content (91.93±0.03 g/100g), followed by groundnut shell meal (89.57±0.31 g/100g). Carbohydrate content ranged between 35.28±0.08 g/100g and 65.19±0.13 g/100g. Crude protein content ranged between 6.53±0.06 g/100g (groundnut shell meal) and 10.88±0.02 g/100g (wheat bran). Liver histopathology revealed normal architecture. The nutritional analyses of the wastes revealed rich nutritional content which may be explored for feed ingredient in livestock production. Further processing of these wastes may further enhance their nutritional composition; thereby providing alternative cheap animal feed for improved animal production and consequently improved animal protein consumption in developing countries.

Key words: *corn bran, groundnut shell, environmental pollution, feeding trial, liver histology, watermelon peel*

INTRODUCTION

Disposal of agricultural by-products which are produced in large tons in Nigeria is currently a major economic and ecological challenge. In many parts of Nigeria and other developing countries, these agricultural wastes are allowed to accumulate in large quantities, allowed to decay or are burnt indiscriminately thereby impacting negatively on the environment by releasing harmful volatile compounds into the atmosphere, water, and soil and as a result, poses a serious threat to human health. The potential pollutants from the decomposition of agricultural wastes are usually pathogens, nutrients, methane, and ammonia gas emissions. The resultant effect of uncontrolled decomposition of agricultural wastes can be a large-scale contamination of soil, water and lair (Ghosh et al., 1997; EPA, 2007; Kwon et al., 2009). It has been estimated that the decomposition of one metric ton of organic solid waste can release 50.11 m^3 of carbon dioxide and 90 to 140 m^3 of methane into the atmosphere (Ghosh et al., 1997; Kwon et al., 2009).

Agricultural by products are underutilized in Nigeria because little is known of their nutritional composition. There are varieties of methods of waste disposal, which include land application, burning, feeding to livestock or a source of methane. The objective of this study was to assess the nutritional effect of selected agricultural wastes on biochemical profile and liver histology of albino rats in

order to assess their safe use as potential livestock feed ingredients. It is hypothesized that the selected agricultural wastes contain relevant nutrients that could make them potential feed ingredients for livestock feeding.

MATERIAL AND METHODS

Procurement of material and compositional analyses

The groundnut shell, watermelon peel and corn bran were sourced from Southwestern part of Nigeria, while wheat bran was procured from a feed mill in Southwestern part of Nigeria. The agricultural wastes were oven-dried at 50 ^{o}C for 24 hours. Each agricultural waste constituted a treatment while when bran was designated as the control. Chemical composition and amino acid profile of selected agricultural solid wastes were carried out using the procedure of AOAC (1990). Each treatment was done in triplicates. Each treatment (processing technique) served as the experimental unit. Results are presented as means plus standard deviation with $p<0.05$ defined as significant. Carbohydrate content of each treatment was calculated according to equation:

Carbohydrate = dry matter – (ash + crude fiber + crude protein + fat).

Experimental animals

The experimental protocol and feeding trial was as approved by the Animal Ethics Committee, Landmark University, Nigeria (ANBC 10201612AANRE), in accordance with Principles of Laboratory Animal Care (NIH publication No. 85-23, revised 1985). Effect of wheat bran (control), corn bran, watermelon peel and groundnut shell were tested on organ body ratio, biochemical profile and liver histopathology of albino rats. Wheat bran was selected as the control because it is commonly used as a feed ingredient in Nigeria while corn bran, watermelon peels, and groundnut shell were purposively selected because they are abundantly available in the experimental site. The feeding trial was carried out at the Animal House, Biochemistry Unit, Department of Biological Sciences, Landmark University, Nigeria. Twenty albino rats were used for the feeding trial in a completely randomized design which lasted for 14 days. Each animal served as a replicate. The animals were provided with fresh feed and water *ad libitum* throughout the period of the experiment.

Histology studies

The rats in each group were sacrificed and the livers exercised separately according to group for histological study. The livers were preserved in small white plastics and were fixed in 10 % buffered formalin solution. Histological sections were prepared, fixed in bouin's solution and stained using hematoxylin-eosin dye and observed under microscope at 400x magnification (Galighor and Koziff 1976).

Biochemical assay

On the last day of the experiment, the animals were sacrificed and blood samples were collected from the jugular vein into a set of sample bottles without anti-coagulant and it was used for serum chemistry. Separation of serum was done by centrifugation at 3500 xg for 10 min and kept frozen at -20 ^{o}C for analysis of total protein, aspartate aminotransferase (AST) and alanine aminotransferase (ALT) using Randox commercial assay kits (Randox Laboratories Ltd., BT29 4QY, United Kingdom). Acid phosphatase (ACP) and alkaline phosphatase enzyme activity were determined by the method described by Wright *et al.* (1972).

Statistical analysis

The values obtained for proximate composition, amino acid profile, and serum enzymes were subjected to an analysis of variance using SPSS (version 21). Significant means were separated using Duncan's multiple range test (Duncan, 1955).

RESULTS

The nutrient composition of the experimental diets is presented in Table 1. Tables 2 and 3 show the chemical composition and amino acid profile of selected agricultural solid wastes respectively. Watermelon peel obtained the highest dry matter content (91.93±0.03 g/100g), followed by groundnut shell meal (89.57±0.31 g/100g), while corn bran obtained the least value (87.02±0.09 g/100g). Carbohydrate content ranged between 35.28±0.08 g/100gand 65.19±0.13 g/100g. The highest mean was obtained by corn bran (65.19±0.13 g/100g), followed by watermelon

peel (61.69±0.04 g/100g) while the least value was obtained by groundnut shell meal (35.28±0.08 g/100g). Crude protein content ranged between 6.53±0.06 g/100g (groundnut shell meal) and 10.88±0.02 g/100g (wheat bran). Wheat bran (10.88±0.02 g/100g) and corn bran (10.85±0.01 g/100g) obtained the highest values.

Watermelon had the highest ash content (5.43±0.01 g/100g), while corn bran had 3.96±0.04 g/100g. The neutral detergent fiber (NDF), acid detergent fiber (ADF) and fiber content were significantly (P<0.05) highest for groundnut shell meal while the least values were obtained by corn bran. Groundnut shell meal obtained the highest means for arginine (3.00±0.01 g/100g), cysteine (2.67±0.05 g/100g), isoleucine (1.82±0.01 g/100g), threonine (1.95±0.01 g/100g) and valine (1.63±0.05 g/100g) (Table 3). Corn bran obtained the highest value for leucine (1.42±0.04 g/100g), lysine (3.85±0.02 g/100g), methionine (0.43±0.03 g/100g) and tryptophan (0.12±0.01 g/100g).

The percentage liver-body ratio and biochemical parameters of albino rats and liver micrograph of albino rats fed selected agricultural wastes are presented in Table 4 and Figure 1, respectively. The total protein concentration and AST activity did not show any significant change in all the test groups compared to the control group. ALT values were significantly (P<0.05) lower for experimental diets when compared with the control. ALP values obtained for the experimental diets were statistically similar to the control.

Watermelon peel-based diet obtained significantly (P<0.05) lower ACP value (50.237 ± 2.299 nM/min/mg protein) than the control (87.111 ± 4.001 nM/min/mg protein), but the value was statistically similar to the values obtained for corn-bran-based diet (75.975 ± 9.342 nM/min/mg protein) and groundnut shell-based diet (70.778 ± 10.260 nM/min/mg protein) which were in turn statistically similar to the control. The histological micrographs of the liver showed normal hepatic cells in all the test groups as in the control groups. Livers of albino rats fed with wheat bran-based diet (R1) showed a mildly infiltrated hepatic tissue; those fed with corn bran-based diet (R2) showed a mildly infiltrated and proliferated hepatic tissue; those fed with watermelon peel-based diet (R3) showed a grossly normal hepatic tissue while those fed with groundnut shell-based diet (R4) showed an infiltrated and mildly proliferated hepatic tissue.

Table 1.
Nutrient composition of experimental diet

Ingredients (g/100g)	**Wheat bran-based diet**	**Corn bran-based diet**	**Watermelon peel-based diet**	**Groundnut shell-based diet**
Maize	50.00	54.00	53.00	50.00
Soybean meal	24.00	28.00	25.00	24.00
Wheat bran	20.00	0.00	0.00	0.00
Corn bran	0.00	12.00	0.00	0.00
Watermelon peel	0.00	0.00	16.00	0.00
Groundnut shell	0.00	0.00	0.00	20.00
Palm oil	1.00	1.00	1.00	1.00
Oyster shell	2.00	2.00	2.00	2.00
Bone meal	1.00	1.00	1.00	1.00
Vitamin-mineral premix	0.25	0.25	0.25	0.25
Salt	0.50	0.50	0.50	0.50
Methionine	0.25	0.25	0.25	0.25
Energy, (Kcal/kg) *	2739.01	2750.37	2723.83	2719.01
Determined nutrients				
Protein	16.74	16.80	16.29	16.47
Fiber	4.51	4.90	4.75	5.01
Fat	3.82	3.75	3.87	3.79
Calcium	1.23	1.22	1.22	1.24
Phosphorus	0.35	0.30	0.33	0.31

**Calculated energy, based on compositional data (Dale, 1997)*

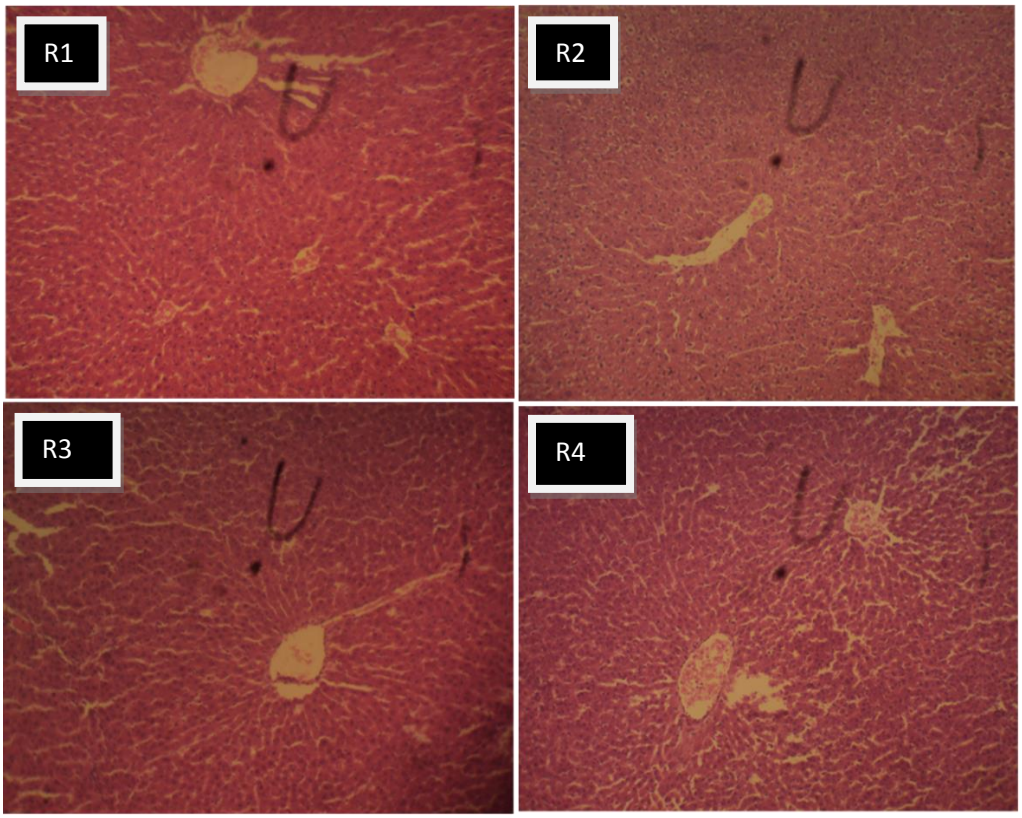

Figure 1. Liver micrographs of albino rats fed: Wheat bran (R1) showed a mildly infiltrated hepatic tissue; Corn bran, (R2) showed a mildly infiltrated and proliferated hepatic tissue; Water melon peel (R3) showed a grossly normal hepatic tissue; Groundnut shell (R4) showed an infiltrated and mildly proliferated hepatic tissue (Magnification: x 400)

DISCUSSION

Wheat bran was used as the control because of its use in livestock feeding as a source of fiber. Other selected agricultural solid wastes used in this study are not so popular as livestock feed ingredients, probably because little is known of their potentials as feed ingredients due to lack of information on their nutritional composition. Groundnut (*Arachis hypogeal*) shell is a by-product of groundnut processing industry. It is a waste product produced when the nut is being processed for consumption. In some villages in developing countries, the shells are usually discarded on the junction of the road where they are naturally further discarded by human feet. It has been reported to contain some nutrients and anti-nutrients (Abdulrazak et al., 2014). The reported anti-nutritional factors contained in these wastes can be overcome through heat treatments (Ologhobo and Adejumo, 2011; Adejumo and Ologhobo, 2012) as well as through other processing techniques. The values reported for ash, protein and lipid were higher in the present study; however, the crude fiber was lower in the present study than the value reported by Abdulrazak et al. (2014).

Watermelon (*Citrullus lanatus*) is mainly cultivated for its fruit. However, its peel can be a potential feedstuff owing to the reported nutrients in its fruit: 0.49% crude protein, 0.11% crude fat, 0.32% crude fiber, 0.27% ash, 126.00 mg/100g potassium and 5.60 mg/100g calcium (Naz et al., 2013). The poor performance of rats fed groundnut shell-based diet may be due to infestation with aflatoxin or presence of anti-nutritional factors that could be present in the feed ingredient. Groundnut cake or meal use in animal feeding and nutrition is limited by the presence of aflatoxin.

Table 2.
Chemical composition of selected agricultural wastes on dry matter basis

Treatment	Dry matter (g/100g)	Carbohyd-rate (g/100g)	Protein (g/100g)	Ash (g/100g)	NDF (g/100g)	ADF (g/100g)	Fiber (g/100g)	Fat (g/100g)	Ca (g/100g)	P (g/100g)
Wheat bran	88.04±0.05^{c}	58.83±0.07^{c}	10.88±0.02^{a}	4.93±0.04^{b}	27.84±0.15^{c}	11.97±0.10^{c}	10.36±0.02$_{c}$	3.05±0.02^{b}	0.27±0.10^{a}	1.33±0.52^{a}
Groundnut shell meal	89.57±0.31^{b}	35.28±0.08^{d}	9.53±0.13^{b}	4.61±0.08^{c}	46.44±0.04^{a}	25.58±0.03^{a}	37.26±0.64$_{a}$	2.90±0.04^{c}	0.30±0.01^{a}	0.12±0.01^{b}
Watermelon peel meal	91.93±0.03^{a}	61.96±0.04^{b}	6.53±0.06^{c}	5.43±0.00^{a}	31.750.14^{b}	16.10±0.12^{b}	14.94±0.04$_{b}$	3.08±0.05^{b}	0.20±0.01^{b}	0.27±0.10^{a}$_{b}$
Corn bran	87.02±0.09^{d}	65.19±0.13^{a}	10.86±0.01^{a}	3.96±0.04^{d}	18.47±0.12^{d}	4.49±0.09^{d}	2.43±0.01^{d}	4.59±0.01^{a}	0.28±0.01^{a}	0.31±0.01^{a}$_{b}$

Values are means ± standard deviation. Means with the same superscripts within a column are not significantly (p<0.05) different

Table 3.
Amino acid profile of selected agricultural wastes

Treatment	Arginine (g/100g)	Cysteine (g/100g)	Isoleucine (g/100g)	Leucine (g/100g)	Lysine (g/100g)	Methionine (g/100g)	Threonine (g/100g)	Tryptophan (g/100g)	Valine (g/100g)
Wheat bran	2.35±0.03^{c}	0.40±0.03^{c}	0.98±0.01^{c}	0.94±0.01^{c}	3.46±0.03^{b}	0.42±0.03^{a}	0.61±0.06^{c}	0.05±0.01^{b}	0.78±0.01^{b}
Groundnut shell meal	3.00±0.01^{a}	2.67±0.05^{a}	1.82±0.01^{a}	1.27±0.02^{b}	2.09±0.02^{d}	0.02±0.01^{b}	1.95±0.01^{a}	0.00±0.00^{d}	1.63±0.05^{a}
Watermelon peel meal	2.37±0.02^{c}	0.40±0.03^{c}	0.68±0.01^{d}	0.06±0.03^{d}	3.41±0.01^{c}	0.00±0.00^{b}	0.26±0.01^{d}	0.03±0.01^{c}	0.28±0.03^{c}
Corn bran	2.65±0.01^{b}	0.74±0.03^{b}	1.23±0.02^{b}	1.42±0.04^{a}	3.85±0.02^{a}	0.43±0.03^{a}	0.93±0.01^{b}	0.12±0.01^{a}	0.61±0.06^{bc}

Values are means ± standard deviation. Means with the same superscripts within a column are not significantly (p<0.05) different

Table 4.
Percentage liver-body ratio and biochemical parameters of albino rats fed selected agricultural wastes

Parameters	Wheat Bran	Corn Bran	Watermelon peel	Groundnut shell
% Liver-body wt.	4.144 ± 0.105^{a}	4.152 ± 0.175^{a}	3.750 ± 0.092^{a}	6.626 ± 0.383^{b}
Total protein (mg/ml)	0.221 ± 0.008^{ns}	0.228 ± 0.008^{ns}	0.213 ± 0.003^{ns}	0.217 ± 0.020^{ns}
AST (U/l)	0.018 ± 0.001^{ns}	0.018 ± 0.001^{ns}	0.017 ± 0.000^{ns}	0.017 ± 0.001^{ns}
ALT (U/l)	0.004 ± 0.002^{a}	0.011± 0.000^{b}	0.010 ± 0.000^{b}	0.011 ± 0.000^{b}
ALP(nM/min/mg protein)	59.091 ± 2.930^{ab}	34.849 ± 5.556^{a}	55.556 ± 12.555^{ab}	76.010 ± 11.940^{b}
ACP (nM/min/mg protein)	87.111 ± 4.001^{b}	75.975 ± 9.342^{ab}	50.237 ± 2.299^{a}	70.778 ± 10.260^{ab}

Values are means ± standard error. Means with different superscripts within the same row are significantly (p<0.05) different
AST = aspartate amino transferase, ALT = alanine amino transferase, ALP = alkaline phosphatase, ACP = acid phosphatase; ns = non-significant

The liver is the main site for protein synthesis therefore, the total protein concentration gives an idea of the functional status liver cells (Armin and Vishwanath, 2007). The experiment did not show any significant change in the total protein concentration which could be an indicative of a non-toxic effect of the compounded feed of the agricultural waste. Serum enzymes are commonly used as sensitive biochemical markers for the assessment of heaptocellular injury, as well as liver disease. Although AST and ALT have been reported to be found in high concentration in the cytoplasm and mitochondria of liver cells than in the blood (Aliyu et al., 2007), increased activities of the enzymes have been attributed to increased membrane permeability and leakage into the blood circulation when hepatocytes are injured (Benjamin 1978). The activity of these enzymes in this study showed that the feed did not have any toxic effect on the liver cell of the rats. When the serum level of ALP is elevated, frequently it indicates hepatic damage. Since it is located at the cell membrane, consequently compromise in the cell membrane could result in leakage into the blood. In this study, experimental rats fed with groundnut shell-based diet obtained numerical higher ALP values but the value obtained was statistically similar to the control. Acid phosphatase is a “marker” enzyme for lysosomal membranes (Yamamoto et al., 1980; Ohsumi et al., 1983). The decrease in the activity of the enzyme may be due inhibition by the anti-nutrients contained in the food. The histopathological result showed mild cell infiltration which is in tandem with some of the biochemical results.

CONCLUSION

Corn bran and watermelon peel could be included in animal feeding to replace wheat bran, thereby reducing the occurrences of environmental pollution arising from indiscriminate burning of these agricultural by products, affecting human and livestock health. Groundnut shell may require further processing in order to deliver the nutritional contents it contains. It is assumed that further processing of these agricultural by products may further enhance their nutritional composition; thereby providing alternative cheap animal feed for improved animal production and consequently improved animal protein consumption in developing countries.

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УТИЦАЈ ОДАБРАНИХ ЧВРСТИХ ПОЉОПРИВРЕДНИХ ОТПАДНИХ ОСТАТАКА НА БИОХЕМИЈСКИ ПРОФИЛ И ХИСТОЛОГИЈУ ЈЕТРЕ КОД АЛБИНО ПАЦОВА

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Сажетак: У раду је испитиван потенцијал пшеничних мекиња, љуске кикирикија, коре лубенице и кукурузних мекиња за примену у исхрани животиња. Одређен је хемијски састав и аминокиселински профил хранива и испитан је њихов утицај на биохемијски профил и хистологију јетре лабораторијских пацова. Највећи садржај суве материје је одређен у кори лубенице (91.93±0.03 г/100г) и љусци кикирикија а садржај угљених хидрата се кретао у опсегу 35.28±0.08 г/100г и 65.19±0.13 г/100г. Садржај сирових протеина се кретао између 6.53±0.06 г/100г (љуска кикирикија) и 10.88±0.02 г/100г (пшеничне мекиње). Испитивања су показала нормалну архитектуру јетре код храњених лабораторијских пацова. Резултати испитивања су показала да је нутритивни састав испитиваних одпадних материјала веома богат и да је оправдано даље испитивање њихове примене у исхрани животиња. Накнадна обрада ових материјала може да допринесе њиховом обогаћивању у нутритивном смислу. На овај начин би се могле обезбедити јефтине алтернативне сировине за исхрану животиња, унапредити њихов узгој и самим тим побољшати конзумацију протеина животињског порекла у земљама у развоју.

Кључне речи: *кукурузне мекиње, љуска кикирикија, кора лубенице, исхрана животиња, хистологија јетре, загађење околине*

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