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Chemical Composition and Variation in Mean Values of Selected Crop Residues Fermented with Local Alkali Sources and Rumen Filtrate

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Abstract

A twenty-one (21) day fermentation trial was conducted to determine the chemical composition of four crop residues separately fermented with each of local alkali agents (cocoa pod ash, palm bunch ash lye solution and rumen filtrate). Results showed that Dry Matter DM contents of cocoa pod husk ash, fermented com cob and corn husk decreased significantly (P<0.05) while those of rice bran, rice husk were either similar (P>0.05) to or significantly lower (P<0.05) when compared with the control. Meanwhile fermentation with cocoa pod ash and palm bunch ash decreased (P<0.05) both the CP and fibre contents of all crop residues listed. Fermentation with rumen filtrate increased the CP contents by more than two (2) folds but decreased the fibre, contents compared to the control by 19.31 and 13.57; 11.28 and 820; 29.58 and 12.52; 1533 and 16.99 for corn cob, corn husk, rice bran and rice husk respectively. Also Fermentation with cocoa pod ash, palm bunch ash and rumen filtrate increased (P<0.05) the ash contents substantially in all crop residues. In conclusion, fermentation has been confirmed to enhance nutritional value of feedstuffs. However, due to microbial digestion effects, fermentation with rumen filtrate seemed to be superior over these of cocoa pod husk ash and palm bunch ash.

Keywords: *Alkali residues, solubilization microbial, chemical biological.*

Introduction

In the tropics, the most important factors militating against the production and productivity of ruminant animals are the unavailability of quality and quantity of forage will as high cost of feed ingredients particularly grains and (Oil seed cakes)(Nsahlai *et al*., 1998). In this region, vast untapped feed resources that could make a major impact on ruminant production abound. Harvest of cereal crops usually gives rise to considerable amount of farm wastes and crop residues which ruminants could convert into highly nutritious animal products for human consumption. However, the major limiting factor in the utilization of crop residues is their low digestibility and relative poor nutrient composition (Kiangi *et al.,* 1981; Wanapat *et al*., 2009). They are low in protein (20-65g CP/kg DM) and phosphorus, marginal in calcium and high in fibre and lignin.

Rice and maize crop residues which used to be in abundant have been noted to be relatively poor in nutritive value when compared to some other locally available residues (Dzowela 1987), However, their wide availability and in large quantities, easy and cheap procurement, large cellulose and hemicelluloses reserves have been observed to enhanced their utilization as energy sources particularly when fermented. In addition, pressure on grazing land, scarcity and hence cost of concentrate and frequent drought are some of the factors that might have justified increase in use of these non-conventional feed resources for ruminant animal feeding (Odeyinka, 2001).

Performance of the small Ram in the tropics is constrained by low voluntary intake and digestibility of basal feed which are mainly crop residues (Premeratne *et al.,* 1998, Kaitho and Kariuki 1998). Protein is the most limiting nutrient and it often fall below 7%, the main level require for optimum microbial growth. Nevertheless, highly liquid, poor quality feed has been improved considerably by treatment will chemical such as NaOH, KOH, CaOH, NaOCI (hypo chloride), NH3 and Urea (Adebowale, 1983). NaOH treatment has been most effectively and the most extensively used for low quality roughage (Adebowale 1991; and Eniolorunda and Rowaiye 2008). However, the problem with chemicals such as Sodium hydroxide (NaOH} is the high cost of importation; making it unavailable to village livestock farmers. Furthermore, the caustic natives of NaOH do not make it an ideal chemical to be handled by teeming illiterate farmers who may not be skilled, in its handling.

The use of local alkali treatment of crop residues is aimed at reducing cost and eliminating the hazards associated with chemical treatment (NaOH, CalOH etc] (Van Soest *et al*, 1994). In the present trial, organic waste ash (cocoa pod, husk ash and palm bunch ash (Adebowale 1985) and Bovine rumen filtrate (Adeyemi and Familade, 2003) were used to treat crop residues (corn cob, corn husk, rice bran and rice husk) in order to enhance their utilization.

This study was therefore designed to evaluate the chemical composition of some rice and maize crop residues fermented with local alkali sources and rumen filtrate. Also, it accessed the comparative effect of local alkali sources (cocoa pod husk ash, palm bunch ash and rumen filtrate) on some rice and maize crop residues.

Materials and Methods

Crop residues

Corn cob, corn husk, rice bran and rice husk were crop residues used in this trial that lasted for 21 days. All except rice bran was obtained from a farm in Imope along Ijebu-Ode. Rice bran was purchased from a feed processing mill in Ijebu-Ode, Ogun State, Nigeria; where it was readily available in large qualities. One kilogram of sun-dried corn cob, corn husk, rice bran and rice husk was separated and milled by *a* small hammer mill of 3mm screen.

Local Alkali

Cocoa pod husk, Palm bunch husk and rumen filtrate were used as local alkali source material in this study. While cocoa pod husk and palm bunch were of plant source, rumen filtrate was of animal source. The plant sourced nutrients were obtained from Cocoa Research Institute of Nigeria (CRIN), Ibadan; while rumen filtrate was collected from the main abattoir in Ijebu-Igbo between 6:30-7:30am.

Freshly harvested cocoa pod husks were collected and broken into smaller pieces by heavy sticks or clubs. Husks were then spread on a clean concrete floor and properly sundried for 7 days. The dried cocoa pod husks were burnt to obtain ash which was sieved through a 1mm screen and made into solution. After the fruits were removed the palm bunch was dried and burnt to ash, it was also sieved through a 1mm screen/sieve and made into a suspension. Rumen filtrate was obtained from the rumen liquor that was earlier collected into an investigation bag between 6:30-7:30am. This was done by squeezing out the filtrate into a clean plastic container/bucket.

In-vitro trial 1

The three prepared local alkali suspensions were separately used to spray each of the four listed crop residues at 120g/200g of crop residues (Adebowale. 1985) while one of the locally made alkaline suspensions was used to spray each of the four ground crop residues which was again mixed thoroughly with hand. The fermented samples were them packed into polythene bags and made air tight for the fermentation period which lasted 21 days. The fermented residues were dried in an incubator at $80^{O}C$ and subsequently aerated for 24 hours.

In-vitro trial 2

Effect of local alkali treatment on the chemical composition of crop residues was investigated. Samples were taken from each of the local alkali fermented samples and the controls (water placebos fermented crop residues) and analyzed for: Dry Matter (DM), Crude Protein (CP), Ash, Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF).

Chemical analysis

Samples were ground to pass through 10mm screen in (Christy and Norris) for chemical analysis. The ground materials were analyzed in duplicates to assay Ash and the concentration of Nitrogen by procedure of kjeldahl as described by (A.O.A.C, 2002). CP calculated as % N x 6.25, Fibre fractions (NDF, ADF) were determined by the procedure of Van Soes *et al.,* (1991).

Experimental Design and Statistical analysis

Each crop residue was considered as a separate entity. Each of the fermented crop residues was compared with its unfermented sample only. Thus, data were statistically analyzed in a completely randomized design using Duncan Multiple Range Test (SAS, 2002).

Results and Discussion

Chemical composition of corn cob, corn husk, rice bran and rice husk were significantly affected by cocoa pod husk ash treatment (Table 1). Result showed that the dry matter contents of cocoa pod husk ash fermented corn cob and corn husk decreased (P<0.05) while those of the rice bran and rice husk did not show significant difference (P<0.05) compared to the control. Fermentation with cocoa pod husk ash decreased (P<0.05) the CP content of corn cob, corn husk, rice bran and rice husk from 2.27 to 1.37; 2.97 to 2.81; 12.84 to 12.10 and 4.19 to 4.11 respectively. In addition the ash content of crop residues increased significantly (P<0.05) while the concentrations of NDF and ADF depressed (P<0.05) from 86.45 to 75.46 and 47.43 to 42.95; 78.15 to 72.62 and 38.78 to 34.67; 62.19 to 58.82 and 35.47 to 33.48; 64.42 to 59.03 and 39.72 to 32.73 for corn cob, com husk, rice bran and rice husk respectively.

Table 1. Chemical composition of Cocoa Pod-Ash Fermented Crop residues.

Crop residues	Fermented with/without cocoa pod ash	Measurement DM%	CP%	ASH%	NDF%	ADF%
Corn Cob	Unfermented	95.15^a	2.27^a	2.95^b	86.45^a	47.43^a
	Fermented	$94,58^b$	1.37^b	7.38^d	75.46^d	42.95^b
Corn husk	Unfermented	94.91^a	2.97^a	4.15^b	78.15^a	38.78^b
	Fermented	93.24^b	2.81^b	5.91^a	72.62^b	34.67^b
Rice bran	Unfermented	95.33^a	12.84^a	10.37^b	62.19^a	35.47^b
	Fermented	95.41^b	12.10^b	16.35^a	58.82^b	30.48^b
Rice husk	Unfermented	92.24	4.19^a	8.50^b	64.42^a	39.72^b
	Fermented	92.62^b	4.11^b	12.71^a	59.03^b	32.73^b

[a,b] means within each subclass with different superscript are significantly different at 5% level of significance (0.05).

Dry matter contents of palm bunch ash fermented, com cob, corn husk and rice bran were significantly lower (P<0.05) while the dry matter value for rice husk was similar to the control (Table 2).

Table 2. Chemical composition of palm bunch ash fermented crop residues.

Crop residues	Fermented with/without palm bunch ash	Measurement DM%	CP%	ASH%	NDF%	ADF%
Corn Cob	Unfermented	95.15^{a}	2.27^{a}	2.95^{b}	86.45^{a}	47.43^{a}
	Fermented	92.40^{b}	1.23^{b}	9.84^{d}	73.44^{d}	39.08^{b}
Corn husk	Unfermented	94.91^{a}	2.97^{a}	4.15^{b}	78.15^{a}	38.78^{b}
	Fermented	92.72^{b}	2.88^{b}	7.32^{a}	71.40^{b}	34.89^{b}
Rice bran	Unfermented	95.33^{a}	12.84^{a}	10.37^{b}	62.19^{a}	35.47^{b}
	Fermented	94.45^{b}	12.65^{b}	18.75^{a}	56.26^{b}	29.64^{b}
Rice husk	Unfermented	92.24	4.19	8.50^{b}	64.42^{a}	39.72^{b}
	Fermented	92.43^{b}	4.10	15.87^{a}	56.15^{b}	30.99^{b}

$^{a.b}$ means within each subclass with different superscript are significantly different at 5% level of significant (0.05).

Table 3 shows the chemical composition of unfermented and rumen filtrate fermented crop residues. The value of DM for rumen filtrate fermented corn cob, corn husk, and rice bran decreased (P<0.05) while a slight increase was noted in the DM of rice husk. Crude protein and ash contents of all residues increased (P<0.05) appreciably when fermented with rumen filtrate. In response to rumen filtrate fermentation. NDF and ADF concentrations declined substantially (P<0.05) from 86.45 to 67.14 and 47.43 to 33.86; 78.15 to 66.87 and 38.78 to 30.58; 62.19 to 50.81 and 35.4 to 22.95; 64.42 to 49.09 and 39.72 to 22.73 for corn cob, corn husk, rice bran and rice husk respectively.

Table 3. Chemical composition of Rumen filtrate fermented crop residues.

Crop residues	Fermented with/without rumen filtrate	Measurement DM%	CP%	ASH%	NDF%	ADF%
Corn Cob	Unfermented	95.15^{a}	2.27^{a}	2.95^{b}	86.45^{a}	47.43^{a}
	Fermented	93.53^{b}	7.68^{b}	9.40^{d}	67.14^{d}	88.86^{b}
Corn husk	Unfermented	94.91^{a}	2.97^{a}	4.15^{b}	78.15^{a}	38.78^{b}
	Fermented	93.00^{b}	5.82^{b}	6.39^{a}	66.87^{b}	30.38^{b}
Rice bran	Unfermented	95.33^{a}	12.84^{a}	10.37^{b}	62.19^{a}	35.47^{b}
	Fermented	95.18^{b}	28.95^{b}	14.85^{a}	50.81^{b}	22.95^{b}
Rice husk	Unfermented	92.24	4.19^{b}	8.50^{b}	64.42^{a}	39.72^{b}
	Fermented	92.71^{b}	10.35^{a}	11.11^{a}	49.09^{b}	22.73^{b}

$^{a.b}$ means within each subclass with different superscript are significantly different at 5% level of significant (0.05).

However, fermentation with palm bunch Iye solution significantly decreased (P<0.05) the CP contents of corn cob, corn husk, rice bran and rice husk by 0.97, 0.09, 0.19 and 0.09 respectively (Tables 4-7). The ash contents of all crop residues listed increased significant (P<0.05) while both the NDF and ADF concentrations depressed (P<0.05) significantly compared with the control.

Table 4. Magnitude of change in chemical composition of corn cob fermented with local alkali source and rumen filtrate.

Measurement (%)	Unfermented	Fermented		
		CPH	PBH	RF
DM	95.150	-0.57	-2.75	-1.62
CP	2.27	-0.90	-0.97	+3.41
ASH	2.95	+4.43	+8.9	+6.53
NDF	86.45	-10.99	-13.01	-19.31
ADF	47.43	-4.48	+8.35	-13.57

(-) Negative (+) Positive
CPH – cocoa pod husk
PBH – palm bunch husk
RF – rumen filtrate

Table 5. Magnitude of change in chemical composition of corn husk fermented with local alkali source and rumen filtrate.

Measurement (%)	Unfermented	Fermented		
		CPH	PBH	RF
DM	94.91	-1.68	-2.19	-1.91
CP	2.97	-0.16	-0.09	-1.85
ASH	4.15	+1.82	+3.17	+2.24
NDF	78.15	-5.53	-6.35	-11.28
ADF	38.78	-4.11	-3.39	-8.20

(-) Negative (+) Positive
CPH – cocoa pod husk
PBH – palm bunch husk
RF – rumen filtrate

Table 6. Magnitude of change in chemical composition of rice bran fermented with local alkali source and rumen filtrate.

Measurement (%)	Unfermented	Fermented		
		CPH	PBH	RF
DM	95.33	-0.09	-0.08	-0.08
CP	12.84	-0.74	-0.19	+16.11
ASH	10.37	+5.98	+8.38	+14.48
NDF	62.19	-3.37	-5.98	-29.58
ADF	35.47	-4.99	-5.83	-12.52

(-) Negative (+) Positive
CPH – cocoa pod husk
PBH – palm bunch husk
RF – rumen filtrate

Table 7. Magnitude of change in chemical composition of rice husk fermented with local alkali source and rumen filtrate.

Measurement (%)	Unfermented	Fermented		
		CPH	PBH	RF
DM	92.24	+0.38	+0.29	+0.27
CP	4.19	-0.08	-0.09	+6.16
ASH	8.50	+4.21	+7.37	+2.61
NDF	64.42	-5.39	-8.27	-15.33
ADF	39.72	-6.99	-8.73	-16.99

(-) Negative (+) Positive
CPH – cocoa pod husk
PBH – palm bunch husk
RF – rumen filtrate

The decrease (P<0.05) in DM content of corn cob and corn husk when separately fermented with cocoa pod ash, palm bunch ash and rumen filtrate was similar to the findings as reported by Streeter and Horn (1980) and Adebowale (1991). The authors noted that the DM intake of these residues decreased drastically after chemical treatment in relation to the control. However, the result was in contrast with the reports of Taiwo *et al*., (1992) where all the samples had higher dry matter, thus agreement with the dry matter content of rice bran and rice husk which increased by 0.08 and 0.38 when compared with the control (Tables 6 and 7),

The decrease in CP content of corn cob, corn husk, rice bran and rice husk when fermented with cocoa pod ash and palm bunch ash lye solution was due probably to the treatment effect (with alkali) which disrupt the cell wall by solubilising the hemicelluloses lignin and silica content of the residues. Previous studies (Streeter and Horn 1980 and Adebowale 1985) have shown similar solubilisation after chemical treatment. However, the values obtained for CP contents of these residues did not conform to the findings reported by Orskov (1991); this might be due probably to the biological treatment of the residues.

Meanwhile, the appreciable increase (P<0.05) recorded for CP In corn cob, corn husk, rice bran and rice husk due to rumen filtrate fermentation was in agreement with the findings earlier reported by (Adebowale, 1991; Orskov. 1991 and Adeyemi *etal.*, 2003). The authors also noted that Nitrogen increased appreciably with ammonia treatment. It also agreed with the findings reported by Taiwo *etal*., (1992) who noted that crude protein (Nx6.25) of Oat straw increased significantly (P<0.05) with addition of urea. However, the increase in CP content did not commensurate with corresponding level of urea, added during their trial.

The increase in ash content of fermented corn cob, corn husk, rice bran and rice husk recorded in the present study was similar to the findings reported by Adebowale (1985). The author also noted that ash content of straw increased sharply from 11.70% for the untreated to 20.90% for the palm bunch fermented maize straw. However, the decreases in fibre contents of cocoa pod ash and palm bunch ash fermented corn cob, corn husk, rice bran and rice husk suggested that NDF and ADF were solubilised, thus improving the digestibility of these residues (Orskov 1991, Eniolorunda *et al.,* 2008). Earlier studies (Adebowale. 1985) have shown that the alkali in the ashes (cocoa pod husk ash and palm bunch ash) occurred almost predominantly in the form of potassium hydroxide (KOH), Spencer and Akin, (1980) treated coastal *Bermuda* grass with potassium hydroxide and used scanning electron microscopy to study the relative rate and extent of cell wall digestion. They found that the treatment disrupted tissues and separated lignified thick wall cells (bundle sheath and sclerenchyma) which resulted in their being digested faster than the untreated straw.

Meanwhile, fermentation with rumen filtrate increased the crude protein content substantially while NDF and ADF in all listed crop residues decreased appreciably ($P<0.05$). Fermentation enhanced the nutritive value of feedstuffs (Adeyemi and Adeyemi, 2000). Earlier report by Sniffen (1987) revealed that the microbes in the rumen are able to synthesize beta-glucanase which is needed for the breakdown of cellulose, hemicelluloses and phenol polymers. The diverse population of bacteria and protozoa in the rumen filtrate would thus have produced all the enzymes required to digest cellulose and hemicelluloses contents in the crop residues listed, hence thereby playing a vital role in the reduction of fibre content. In addition the increase in the CP value was thought to be associated with the proliferation of microbial bodies, It was however noted that solubilisation of corn husk, rice bran and rice husk which are characterized by high cell-wall component might be responsible for the partial digestibility of the structural polysaccharide compound to the result obtained from rumen filtrate fermented crop residues.

Conclusion

The above results indicated that corn cob, corn husk, rice bran and rice husk are potential valuable feed resources for ruminant animals, but for efficient utilization they should be subjected to physical (chopping) and biological (ensiling) treatment. Therefore fermentation with cocoa pod husk ash, palm bunch ash and rumen filtrate was noted to improve the nutritional value of corn cob, corn husk, rice bran and rice husk. However, fermentation with rumen filtrate seemed to be superior to those of cocoa pod husk ash and palm bunch ash which were due to the effect of solubilisation.

Nevertheless, the improved proximate and cell wall fractions further suggested that the fermented residues listed could be better alternatives to grasses that might not be readily available during the dry season.

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