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Evaluation of chemical composition and nutritive potential of oil palm slurry fermented with cassava peel as feed for livestock

ABIOLA-OLAGUNJU Oluwanike[1], MAKO Adejoke Adeneye[2]* and AKINSOYINU Akintunde Olaleye[3]

[1]Department of Home Economics and Hotel Management, College of Agricultural Science Olabisi Onabanjo University, Ayetoro Campus, Nigeria.
[2]Department of Agricultural Production and Management Sciences, Tai Solarin University of Education, Ijagun. Ijebu-Ode, P. M. B. 2118, Ijebu-Ode. Ogun State, Nigeria.
[3]Department of Animal Science, School of Agriculture and Industrial Technology, Babcock University Ilishan Remo, Ogun State.

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Cassava peels (CaP) and oil palm slurry (OPS) are agro-industrial by-products obtainable throughout the year. Utilization of CaP as feed can be enhanced through fermentation with OPS. The use of CaP fermented with OPS as feed for livestock was therefore investigated with three experiments. The nutrient composition of OPS collected from different locations was determined. Parameters varied significantly with Mamu samples recording the highest values of dry matter (DM) and crude protein (CP) (43.20 and 8.15 g/100 g DM) respectively. The chemical composition of fermented (CPF) and unfermented (CPU) cassava peel was assessed. Result revealed no significant variations with CPU recording the highest value of DM (73.63 g/100 g DM) while CPF recorded the highest (6.50 g/100 g DM) value of CP. The chemical composition of cassava peel fermented with a constant amount of OPS in the ratios, 1:1; 2:1; 3;1; 4;1; 5:1 and 6:1 of CaP and OPS, respectively was determined. The ratios vary significantly, with ratio 3:1 (CaP:OPS) recording the highest (14.15 g/100 g DM) value of CP and lowest (27 g/100 g DM) value of neutral detergent fiber (NDF). Conclusively fermentation improved the quality of the mixture by breaking down the fibre contents in each graded combination through microbial metabolic activities. The best result was obtained at the ratio 1:3 OPS to CaP.

Key words: Cassava peel, chemical composition, fermentation, oil palm slurry.

INTRODUCTION

Meeting the nutritional needs of ruminants throughout the year is a major challenge facing livestock farmers in the tropics due to the seasonality of forages. Grazing animals have adequate amount of lush pasture to feed on in the wet season, which is usually low in nutritive value. The latter (dry) six months of the year are characterized by

*Corresponding author: Jokemako2006@yahoo.com; Jokemako2006@gmail.com

scarcity and lignifications of available forage with low protein content (Babayemi et al., 2010). This various preponderances in livestock production, have made researchers sort out other alternative ways that could solve the problem of feed all year round like the browse plants, crop residues and agro industrial wastes and by products.

Agro-industrial by products and crop-residues account for 70% of the total feed intake during the dry season (Sallam, 2005). Oil palm slurry is an agro-industrial by product of oil palm industry obtained after the processing of the palm fruits (*Elaeis guineensis*). This by-product is a potential environmental pollutant (Davis and Briggs, 1998) and its utilisation as animal feed will minimize the environmental problem as well as provide energy for the animals (Webb et al., 1977). Oil palm slurry contains 4.6% crude protein (Abu et al., 1984). However, due to its high moisture content, Webb et al. (1978) suggested that oil palm slurry should be processed before its incorporation into feed. Cassava peel is a waste generated after the tuber (root crop) has been peeled. Various varieties of cassava exist but the one peculiar to Africa is *Manihot esculenta.* The limitation to the use of cassava for feeding livestock is in its low protein content. The flour for example contains about 3.0% crude protein and the peels about 1.66% crude protein (Okpako et al., 2008).

This study is aimed at determining the chemical composition of oil palm slurry (OPS) collected from four different locations. In addition, to access the suitability of combining mixtures of oil palm slurry and cassava peels (CaP) fermented as feed resource for farmers in the South-Western Nigeria.

MATERIALS AND METHODS

Collection and processing of samples

Oil palm slurry was collected from four different oil palm processing locations in South-Western Nigeria.

Oyo state ------- Badeku jako
Osun state ------ Ikoyi
Ogun state ------ Mamu
Edo state ------- Nifor

Cassava peels (Cap) was collected from a cassava processing unit at Eleyele Ibadan, Oyo state and it served as control for this experiment (Plates 1 and 2). Samples of oil palm slurry and cassava peels collected were then oven dried at 105°C until constant weight was recorded for dry matter determination. Each of the samples was thoroughly mixed and sub sampled. The dried samples were milled in a Thomas Willey laboratory mill fitted with 0.5 mm mesh. The milled samples were kept in airtight bottles until required for chemical analysis.

Chemical analysis

Crude protein, crude fibre, ether extract and ash content of the samples were determined using standard procedure of AOAC (1995). Cell wall components consisting of acid detergent fibre (ADF), neutral detergent fiber (NDF) and neutral detergent lignin (NDL) were determined using Van Soest (1994) method. Hemicellulose contents were estimated as the difference between NDF and ADF while cellulose was estimated as the difference between ADF and Hemicellulose.

Fermentation of the mixtures of oil palm slurry (OPS) and cassava peels (CaP)

Different ratios of fresh samples of cassava peel (CaP) were fermented with a constant amount of oil palm slurry (OPS) as follows:

Diet A -1 kg of cassava peel + 1 L of OPS
Diet B -2 kg of cassava peel + 1 L of OPS
Diet C - 3 kg of cassava peel + 1 L of OPS
Diet D - 4 kg of cassava peel +1 L of OPS
Diet E -5 kg of cassava peel + 1 L of OPS
Diet F -6 Kg of Cassava peel only (control)

Fermentation was carried out at these ratios in airtight cellophane bags for microbial action. Samples were fermented for five days and after which each diets were separately sun–cured. The proximate composition and the fibre fractions of the fermented mixtures were determined.

Statistical analysis

Data were analyzed using analysis of variance (SAS, 1999). Significant means were separated using the Duncan's multiple range test. Experimental model of the design was: $Y_{ij} = u + a_i + e_{ij}$
Where

Y_{ij}= Individual observation
U = General mean of population
a_i = treatment effect
e_{ij}= Composite error effect

RESULTS

The results of the dry matter and proximate composition of oil palm slurry and cassava peel are presented in Table 1. It was observed that effect of location on DM and proximate composition of oil palm slurry was significant ($p<0.05$). The values of DM ranged from 6.03 g/100 g DM for Edo samples to 43.20 g/100 g DM for Mamu samples. Same trend was observed for CP and ash, with highest values of 8.15 and 10.00 and lowest values of 5.15 and 7.10 g/100 g DM for CP and ash respectively. However the highest crude fibre (10.21 g/100g DM) and ether extract (39.20 g/100 g DM) were obtained for samples collected from Badeku and Ikoyi respectively, while the lowest values of 8.00 g/100 g DM and 32.01 g/100 g DM were obtained for Mamu and Edo samples, respectively.

The values of cell wall fractions are presented in Table 2, it was observed that the effect of location on these parameters were also significant ($p < 0.05$). The highest values of all cell wall fractions examined were obtained for Badeku samples and it ranged from 22.54 g/100 g DM to 53.54 g/100 g DM for Hemicellulose and Neutral

Table 1. Proximate composition (g/100gDM) of oil palm slurry from different locations in the South-West zone of Nigeria.

Variables	Mamu	Ikoyi	Badeku	Edo	SEM
Dry matter	43.20^{a}	16.61^{b}	8.20^{c}	6.03^{d}	0.06
Crude protein	8.15^{a}	7.00^{b}	7.31^{b}	5.15^{c}	0.08
Crude fibre	8.00^{c}	8.50^{c}	10.21^{a}	9.15^{b}	0.06
Ash	10.00^{a}	8.11^{b}	7.00^{c}	7.10^{c}	0.01
Ether extract	35.00^{b}	39.20^{a}	32.27^{c}	32.01^{c}	0.01

$^{a, b, c}$= means on the same row with different subscripts are significant (p<0.05).

Table 2. The fibre fractions of oil palm slurry collected from four locations in South-Western Nigeria.

Parameter	Mamu	Ikoyi	Badeku	Edo	SEM
Acid detergent lignin	25.80^{d}	28.21^{b}	31.00^{a}	26.45^{c}	0.02
Acid detergent fibre	43.25^{d}	46.26^{b}	50.41^{a}	45.00^{c}	0.01
Neutral detergent fibre	45.28^{c}	49.22^{b}	53.54^{a}	47.08^{b}	0.01
Cellulose	17.45^{d}	21.05^{a}	19.41^{b}	18.55^{c}	0.02
Hemicellulose	2.03^{c}	2.96^{b}	3.03^{a}	2.08^{c}	0.03

$^{a, b, c, d}$ =means on the same row with different superscripts are significant (p<0.05).

detergent fibre and respectively, while the lowest values were obtained for Mamu samples ranging from 19.48 g/100g DM and 45.28 g/100 g DM, respectively. The nutrients compositions of cassava peel unfermented and fermented are shown in Table 3. The result revealed that fermentation has no significant effect on cassava peels. The DM, CP, ash, ether extract (EE) and neutral detergent fiber (NDF) of cassava peel unfermented and fermented ranged as 73.63 and 68.42; 5.50 and 6.50; 8.50 and 6.90; 23.20 and 28.00; 59.00 and 58.52, respectively.

Proximate composition and cell wall fractions of graded fermented mixtures of oil palm slurry and cassava peel are represented in Figure 1. It was observed that all the graded mixtures varied significantly ($p < 0.05$) for crude protein with diet C recording the highest value of 14.15 g/100 g CP, while diet A recorded the lowest value of 9.10 g/100 g DM. Same trend was obtained for EE. For crude fibre and ash, diet C recorded the lowest value of 14.25 and 3.2 g/100 g DM, respectively, while diet B (19.2 g/100 g DM) and diet A (6.58 g/100 g DM) recorded the highest values for crude fibre and ash, respectively. The cell wall components also varied significantly ($p < 0.05$) among treatment means. Same trend was observed for diets A, B and C for ADF, NDF and ADL, with diet A recording the highest values of 22.0; 35.0 and 37.35 g/100g DM respectively, while diet C recorded the lowest values of 16.5; 27.0 and 31.25 g/100 g DM for ADF, NDF and ADL, respectively. The cellulose and hemicelluloses values did not follow a particular pattern, however, diet D and E recorded the highest values of 29.67 and 13.75 g/100 g DM for cellulose and hemicellulose respectively while diet C recorded the lowest values of 20.75 and 10.5 g/100 g DM for cellulose and hemicellulose respectively.

DISCUSSION

Analyses of samples of oil palm slurry from four different locations in the South-Western Nigeria revealed that samples from Mamu had the highest Crude protein and lowest crude fibre. Protein is required for normal body growth, repairs and maintenance (Okpako et al., 2008). The CaP and OPS fermented mixtures had CP values higher than OPS collected from Mamu. This increase could be attributed to the oil content which acted as a substrate for the possible secretion of some extracellular enzymes such as amylase and cellulase into the CaP by the OPS in an attempt to make use of the cassava starch as carbon source. Another reason could be the increased growth and proliferation of microorganisms in form of single cell protein, which accounted for the increase in the protein content of the CaP with OPS. This result is in accordance with the established results by other authors (Adebiyi, 2006; Okpako et al., 2008; Babayemi, 2010) that fermentation reduces the CF and increases the CP of a feed. Although there were significant variations, that could be attributed to the different levels of CaP inclusion ratios in each diet at a constant OPS. Jones and Porter (1998) observed that the inclusion rate of oil to a diet could affect microbial activity and the release of protein. This could be responsible for the low CP value of 9.10 g/100 g DM in other diets compared to diet C. Diet A had

Table 3. Proximate composition of unfermented and fermented cassava peel.

Parameter	Unfermented Cassava peel	Fermented Cassava peel
Dry matter	73.63	68.42
Crude protein	5.50	6.50
Crude fibre	21.02	20.36
Ash	8.50	6.90
Ether extract	23.20	28.00
Acid detergent fibre	43.21	40.45
Neutral detergent fibre	59.00	58.52
Acid detergent lignin	35.46	31.00
Cellulose	7.75	9.45
Hemicellulose	15.79	18.05

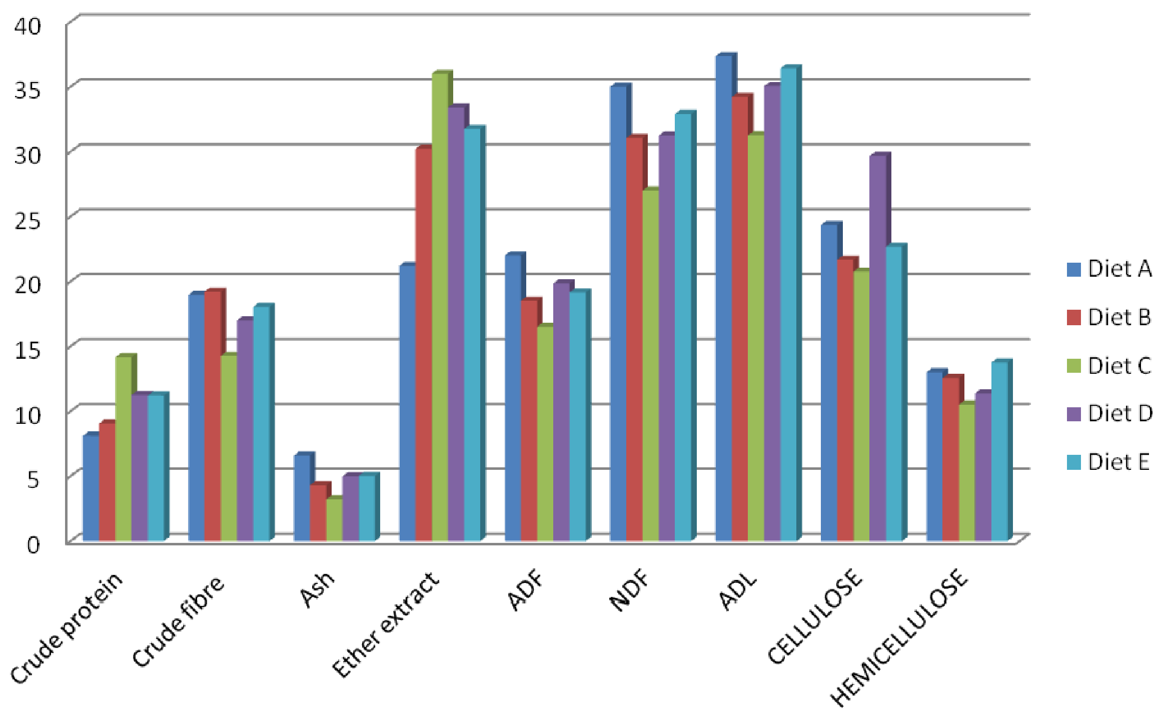

Figure 1. Chemical composition and fibre fraction of graded fermented mixture of Cassava peels (CaP) and oil palm slurry (OPS).

the highest concentration of oil, which might have suppressed microbial activity, while it is believed that diet C might have had adequate proportion of oil to CaP, which probably favoured microbial activities.

These changes may also be attributed to fermentation that occurred in the mixtures of OPS and CaP. Fermentation encourages the growth of anaerobic microorganisms and aids the conversion of nitrogen and carbon to true protein also it was reported that fermentation gives desirable biochemical changes and significant modification of food quality (Campbell and Laherrere, 1998).

Benefits of fermentation according to Steinkraus (1995) include fortification of diet and the removal of toxins. The residual oil contained in the slurry is also an added advantage to the rate of fermentation, since oils and lipids have been found essential components of many fermentation media (Adebiyi, 2006). This can best explain why protein production was highest (at 3%) after fermentation as the level of cassava peels increased. This result was close to the findings of Wanapat et al. (2007) that CP was significantly improved by supplementation at 4% oil inclusion only. There was also a reduced crude fibre content across the treatments due

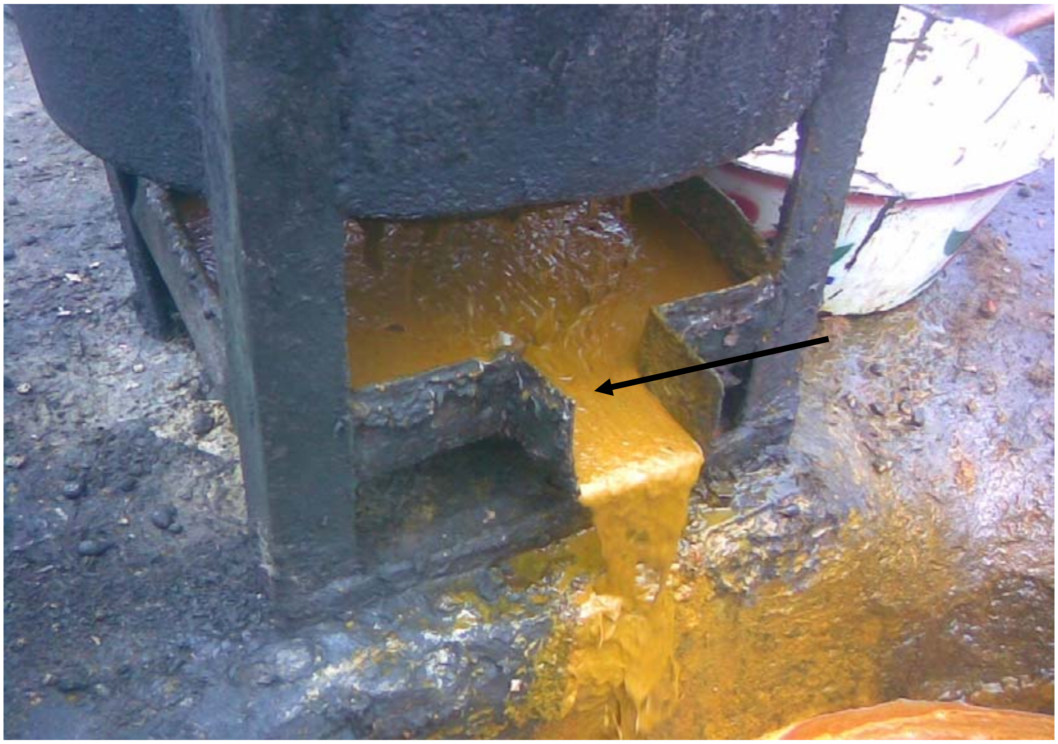

Plate 1. Clarified oil palm slurry from a palm oil processing site at mamu arrow is indicating slurry.

Plate 2. Relatively drained palm oil slurry in a basket.

to multiplication of microorganisms resulting in the breakdown of the polysaccharides to monosaccharides. Although the extent of break down varied significantly. The result conformed to the findings of Ma caskey and Anthony (1979) who reported that fermentation brings about improvement in nutrient composition, acceptability and convenience in the use of silage feeding equipments.

The ash content of a feed sample is an indication of mineral composition. In this study, reduced ash contents were recorded for diets B and E as shown in Figure 1. This suggests that oil in the mixtures aided microbial fermentation thereby reducing the ash contents. Reduced ash content recorded for diet A was statistically similar to that obtained for diet F which might have been an indication of a reduced microbial activity in both diets. This result disagreed with the findings of Okpako et al. (2008) and Babayemi (2010) that fermentation increased the ash content of cassava products.

High NDF could result in low intake while high ADF may hinder digestibility (Babayemi et al., 2010). Judging by the results in Tables 1, 2, 3 and that obtained, in Figure 1, it could be inferred that the features of fermentation and break down of the fibrous cell wall components of the Diets, reduced the ADF and NDF values. However, this effect of fermentation was least observed for Diet A which had recorded the highest values due to the highest concentration of oil (Jones and Porter, 1998). Diet C had the least values of NDF and ADF suggesting its high potential digestibility among other diets.

Conclusion

The chemical composition of oil palm slurry collected from different locations in this study, indicated a higher Crude Protein value than Cassava peel which had a positive influence on the Crude Protein fortification of the fermented combination of Oil palm slurry and Cassava peel. Fermentation also improved the quality of the mixture by breaking down the fibre contents in each graded combination through microbial metabolic activities. The best result was obtained at the ratio 1:3 Oil palm slurry to Cassava peel. This dilution ratio of oil palm slurry to cassava peel is an important factor to be considered.

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