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APPARENT NUTRIENT DIGESTIBILITY AND NITROGEN UTILIZATION BY WEST AFRICAN DWARF SHEEP FED MIXTURE OF OIL PALM SLURRY AND CASSAVA PEEL IN VARIED PROPORTIONS

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Abstract

The objective of this study was to evaluate the apparent digestibility, nitrogen utilization and digestible nutrients by West African Dwarf (WAD)sheep fed mixtures of fermented Oil Palm Slurry (OPS) and Cassava Peel (CaP) based diets. A total of twenty-four (24) female WAD sheep between the ages of 5-6 months, weighing 9.18 – 11.8 kg were allotted to 6 experimental diets in a completely randomized design as follows; one litre of OPS mixed with 1Kg 2Kg; 3Kg; 4Kg and 5Kg (Diets A – E) of CaP, respectively while 6Kg (Diet F) of CaP only, served as the control. The experiment lasted fourteen (14) days with feed and water served ad-libitum. Data collected were analyzed to determine apparent nutrient digestibility; nitrogen utilization and total digestible nutrients by WAD sheep. Parameters measured included: Nitrogen intake (N-intake g/d), Feacal Nitrogen g/d (Feacal N), Urinary Nitrogen g/d (Urinary-N), Total Nitrogen excreted g/d (T-N excreted), Nitrogen balance g/d (N-balance) and Nitrogen retention % (N-retention). Digestibility (%) of dry matter, crude protein, crude fiber, ether extract, nitrogen free extracts and total digestible nutrients (TDN) were also determined. Results revealed significant variations (p<0.05) in all parameters measured. Sheep on Diet C (One litre of OPS mixed with 3kg CaP) had the highest values (16.01, 14.0 and 75.05%) for N-intake; N-balance and N-retention respectively, while least values (10.00g/d, 1.45 g/dand 45.60%) respectively, were obtained for sheep on Diet A (One litre of OPS mixed with 1Kg of CaP). The highest value (5.44 g/d) of T-N excreted was recorded for animals on diets C, while the lowest value (2.05 g/d) was recorded for animals on diet A. Significant reduction in values (1.45g/d and 0.60g/d) were observed for feacal and urinary-N respectively in sheep fed diet C as compared to the increased values of (4.24g/d, 2.50g/d and 1.20g/d, 1.00g/d) for animals placed on diet A and diet B respectively, (One litre of OPS mixed with 2Kg of CaP). Significant observations were obtained for digestible CP, CF, EE, NFE and TDN, where sheep placed on diet C record highest value of 73.04% and a decreasing value of 58.06% and 53.90% were recorded for animals on diets B and A respectively. Based on these results. It could be concluded that sheep fed Diet C (1 litre Oil Palm Slurry: 3kg Cassava Peel), gave best results for all the parameters measured compared to other diets fed to sheep.

Key words: Cassava Peel, Digestible nutrients, Nitrogen retention, Oil Palm Slurry, Sheep

Introduction

The search for alternative feedstuffs has brought agro industrial by products in focus. These unconventional feedstuffs are readily available, economical and are abundant at various processing sites thereby, making them very acceptable particularly, to ruminant husbandmen (Abiola-Olagunju, 2011). A very important reason for the wide acceptability of these agro-industrial by products by ruminants, is their innate ability to synthesis high quality protein from non-protein nitrogenous (NPN) compounds, through the action of microorganisms present in their digestive tract (Cott, 2009). Protein available for digestion in the small intestine thus consists of microbial protein and feed protein that have escaped microbial breakdown in the rumen (Preston and Leng, 1987). Cassava peels (CaP) and Oil palm slurry (OPS) are agro-industrial by-products that possess same attributes earlier ascribed to these wastes. A unique characteristic, which they both bear, is that both are by products of cash cropping, and are both harvested frequently within a year, thereby making their wastes abundantly available throughout the year (Abiola-Olagunju, 2011). However, while research have been conducted on the use of cassava peels as feed for ruminants, there is dearth of information on the use of oil palm slurry as feed for ruminants. In addition, the use of a combination of Oil palm slurry and Cassava peel as feed for ruminants requires investigation. Therefore this research was conducted to evaluate the nitrogen utilization and total digestible nutrients by WAD sheep fed combination of oil palm slurry and Cassava peel in varied proportions.

Material and Methods

Twenty-four (24) post weaned female West African dwarf sheep aged 5-6 months weighing 9.18 –11.8kg were used for the experiment. On arrival, the sheep were given prophylactic intramuscular treatment of oxytetracycline and vitamin B complex, at the dosage of 1m/10kg body weight. They were also drenched with albendazole to control endoparasites and treated for mange and other ectoparasites using i vermectin. The experiment lasted 14 days, in which the first seven days was to adjust the sheep and their ruminal micro-flora to the new test diets and the latter was for data collection. The animals were fed at 09.00 hours in the morning and at 15.00 hours in the afternoon daily. Feed was served at 3% of the body weight of the animals. Water and salt lick were accessible to the animals throughout the metabolic period. The left over feed (ort) was weighed at 08.00 hours every morning and deducted from the total offered for intake determination prior to serving new feed daily. Fresh water was also served *adlibtum*. During seven days of collection, total faeces was collected, weighed and 10% aliquot was taken and stored in the freezer at -4^{0}C. After the 7-day collection period, total faeces from daily collection were bulked, mixed and dried in the oven and kept till required for chemical analysis. Urine samples were collected and measured daily for each animal in the morning using measuring cylinder and kept in separately labeled containers. Two drops of concentrated Sulphuric acid was added to each container daily after collection of each sample to prevent microbial growth and loss of nitrogen. Approximately 10% of total urine was sampled daily and stored at -4^{0}C till required for nitrogen analysis. Nutrient retention was determined for crude protein, ether extract, crude fibre, ash and nitrogen free extract using the formula as follows:

Nitrogen retention =

$$\frac{\textit{Nutrient in feed} - \textit{nutrient in feaces} \times 100}{\textit{Nutrient in feed}}$$

Nitrogen utilization was also determined by analyzing the nitrogen content of the urine

Experimental Diets

Diet A = 1 litre Oil palm slurry + 1kg cassava peel
Diet B = 1 litre Oil palm slurry+ 2kg cassava peel
Diet C = 1 litre Oil palm slurry+ 3kg cassava peel
Diet D = 1 litre Oil palm slurry+ 4kg cassava peel
Diet E = 1 litre Oil palm slurry+ 5kg cassava peel
Diet F = (control) 6kg cassava peel only

Chemical Analysis

Crude protein, crude fibre, ether extract and total ash of the experimental diets were analyzed in triplicates using standard procedure of A.O.A.C (2012). The crude protein was determined with the micro kjeldahl distillation apparatus. Neutral detergent fibre (NDF), Acid detergent fibre (ADF) and Acid detergent lignin (ADL) were determined as reported by Van Soest,1995.

Statistical Analysis

Data obtained were analyzed and subjected to analysis of variance procedure (ANOVA) of SAS (2012). Significant means were separated by Duncan's Multiple Range Test of the same statistical package.

Results

The proximate (g/kg DM) composition of the experimental diets fed to West African Dwarf Sheep is presented in Table 1. The dry matter composition of all the diets revealed significant differences only among diets A (52.27) and C (71.04) while values obtained for diets B (68.47) and F (68.42) were similar. Same trend was observed for Diets D and E. The highest CP value (14.15) was obtained for diet C while the least value (5.50) was recorded for diet F. Ash values of 3.20 and 5.01 were significant for diets C and D only, while diets A and B were similar. Diets E and F were also similar. Significant differences (p<0.05) were observed for the CF and EE. The least CF value (14.25) was obtained for diet C and the highest (20.36) was recorded for diet F. EE values were highest (36.00) for diet C while diet A recorded the least value (21.20).

Table 1:Dry matter and proximate composition (g/kgDM) of experimental diet fed to WAD Sheep

Parameter	Diet A	Diet B	Diet C	Diet D	Diet E	Diet F	SEM
Dry matter%	52.27^{d}	68.47^{b}	71.04^{a}	63.29^{c}	63.00^{c}	68.42^{b}	0.05
Crude protein	8.10^{d}	9.05^{c}	14.15^{a}	11.25^{b}	11.21^{b}	6.50^{e}	0.08
Crude fibre	18.96^{c}	19.20^{b}	14.25^{e}	17.00^{d}	18.04^{ab}	20.36^{a}	0.03
Ash	6.58^{d}	4.29^{b}	3.20^{e}	4.98^{b}	5.01^{c}	6.90^{d}	0.01
Ether extract	21.20^{e}	30.21^{c}	36.00^{a}	33.40^{b}	31.75^{ab}	28.00^{d}	0.05

a ,b, c, d, e= Means on the same row but with different superscripts are significant (p<0.05)
Diet A-1 litre Oil palm slurry + 1kg cassava peel; Diet B -1 litre Oil palm slurry + 2kg Cassava peel
Diet C- 1litre Oil palm slurry + 3kg Cassava peel; Diet D- 1litre Oil palm slurry + 4kg Cassava peel
Diet E-1litre Oil palm slurry + 5kg Cassava peel; Diet F- 6kg Cassava peel
WAD – West African Dwarf; SEM-Standard Error of Means

The apparent nutrient digestibility by West African dwarf sheep fed graded mixtures of OPS and CaP is shown in Table 2. The results revealed significant (p<0.05) variations in DM digestibility of animals placed on diets A and C alone, ranging between 58.41 and 89.43 % respectively. Animals on diet C had the highest CP digestibility (92.70%) while the least (80.I6 %) was recorded for sheep on diet A. The CF digestibility was highest (p<0.05) at (87.39 %) in Diet C followed by Diet B (86.88 %) while the least value (56.02 %) was obtained in Diet A. The values obtained for EE, ADF, ADL, NDF and hemicellulose contents were similar.

The nitrogen utilization of sheep fed graded mixtures of Oil palm slurry and Cassava peel is shown in Table: 3. The N-intake, fecal-N, Urinary-N, N-balance and N-retention, ranged from 10.00-16.01; 1.45-4.24; 0.60-1.20;4.56-12.62 g/d and 45.60-75.05 % respectively. Significant variations ($p<0.05$) were observed in the fecal-N and N-retention, with sheep on Diet C recording the highest values (4.24 and 75.05%) for both parameters while least values (1.45 and 45.60%) were obtained for sheep on Diet A. N-Intake varied significantly ($p<0.05$) for sheep fed Diets, A, B, C and F. The highest value was obtained for sheep on Diet C (16.01g/d) and lowest for sheep on Diet A (10.00 g/d). Statistical similar variations in values were obtained for sheep on diet D and E. Same trend was observed for the Urinary-N and N-balance for animals on Diets A,B,C and F. The value of (0.6g/d) was the least for animals on Diet C for Urinary-N, while the highest value of (1.20g/d) was recorded for animals on Diet A. Treatment effect was not significant ($p>0.05$) for animals on diets D and E. Nitrogen retention varied significantly ($p<0.05$) ranging from 45.60 – 75.05% in diet A and C respectively.

Table 2: Apparent Nutrient Digestibility (%) by WAD Sheep Fed Fermented Graded Mixtures of Oil Palm Slurry and Cassava Peel.

Parameters	Diet A	Diet B	Diet C	Diet D	Diet E	Diet F	SEM
Dry matter	58.41^{e}	76.08^{b}	89.43^{a}	70.21^{d}	70.64^{c}	74.52^{ab}	2.05
Crude protein	88.16^{d}	89.48^{c}	92.70^{a}	90.00^{b}	80.26^{e}	90.32^{b}	1.02
Crude fibre	56.02^{e}	78.48^{c}	87.39^{a}	85.88^{b}	80.00^{ab}	64.05^{d}	2.23
Ether extract	90.90	95.00	91.35	83.17	93.24	92.04	3.12
Neutral detergent Fibre	83.42	88.45	90.05	84.96	88.55	85.66	11.07
Acid detergent fibre	54.29	72.86	76.84	64.25	73.51	66.76	12.88
Acid detergent Lignin	50.52	67.42	70.32	59.51	68.28	60.18	10.12
Cellulose	17.59	28.74	36.63	23.29	17.08	15.60	5.05
Hemicellulose	13.82	15.59	17.93	20.71	15.04	18.90	4.45

^{a,ab,b,c,d,e}= Means on the same row but with different superscripts are significantly different ($p<0.05$)
Diet A-1 litre Oil palm slurry + 1kg cassava peel; Diet B -1 litre Oil palm slurry + 2kg Cassava peel
Diet C- 1litre Oil palm slurry + 3kg Cassava peel; Diet D- 1litre Oil palm slurry + 4kg Cassava peel
Diet E-1litre Oil palm slurry + 5kg Cassava peel; Diet F- 6kg Cassava peel
WAD – West African Dwarf; SEM-Standard Error of Means

Table 3: Nitrogen Utilization by West African dwarf Sheep Fed Fermented Graded Mixtures (%) of Oil Palm Slurry and Cassava Peel

Parameters	Diets						
	A	B	C	D	E	F	SEM
N-Intake (g/d)	10.00^{e}	14.21^{c}	16.01^{a}	13.45^{d}	13.89^{d}	15.00^{b}	0.02
Feacal-N (g/d)	4.24^{a}	2.51^{b}	1.45^{e}	1.70^{c}	1.82^{ab}	1.63^{d}	0.04
Urinary-N (g/d)	1.20^{a}	1.00^{b}	0.60^{e}	0.84^{c}	0.80^{c}	0.75^{d}	0.04
Total-N excreted (g/d)	5.44^{a}	3.51^{b}	2.05^{f}	2.54^{d}	2.62^{c}	2.38^{e}	0.02
N-Balance (g/d)	4.56^{e}	10.7 ^{d}	14.0 ^{a}	10.91b^{c}	11.27^{c}	12.62 ^{b}	0.02
N-Retention(%)	45.60^{e}	56.00^{d}	75.05^{a}	60.01^{c}	65.35^{ab}	70.25^{b}	0.01

$^{a, b, c, d, e}$ means on the same row with different superscripts are significantly different ($p<0.05$) SEM=Standard Error of Means
Diet A-1 litre Oil palm slurry + 1kg cassava peel ; Diet B -1 litre Oil palm slurry + 2kg Cassava peel
Diet C- 1litre Oil palm slurry + 3kg Cassava peel ; Diet D- 1litre Oil palm slurry + 4kg Cassava peel
Diet E-1litre Oil palm slurry + 5kg Cassava peel ; Diet F- 6kg Cassava peel
WAD – West African Dwarf;

In the digestible nutrients (Table 4) the CP, CF, EE, NFE and TDN were all significantly ($p<0.05$) higher for sheep on diet C with the values of 11.51, 20.22, 15.09, 34.18, 73.04% respectively. Sheep on diet F followed with values of 13.05, 18.79, 13.10, 32.06 and 69.24% respectively. The least values ($p<0.05$) in all the parameters were recorded for sheep on diet A.

Table 4: Digestible Nutrients intake (%) by West African Dwarf sheep Fed Fermented Mixtures of Oil Palm Slurry and CassavaPeel

	Diet composition						
Parameters	A	B	C	D	E	F	SEM
Crude Protein	5.27^{d}	7.75^{c}	11.51^{a}	9.45^{b}	8.90^{ab}	4.05^{e}	1.21
Crude Fibre	9.03^{e}	13.45^{d}	20.22^{a}	17.67^{c}	17.32^{c}	18.79^{b}	0.89
Ether Extract	12.00^{e}	13.78^{c}	15.09^{a}	13.23^{c}	12.40^{d}	13.10^{b}	0.21
Nitrogen Free Extract	23.70^{e}	30.11^{d}	34.18^{a}	32.65^{b}	31.88^{dc}	32.06^{c}	1.10
Total Digestible Nutrients	53.90^{e}	58.06^{d}	73.04^{a}	60.57^{c}	62.00^{ab}	69.24^{b}	0.09

a ,b, c, d, e= Means on the same row but with different superscripts are significant ($p<0.05$)
Diet A-1 litre Oil palm slurry + 1kg cassava peel; Diet B -1 litre Oil palm slurry + 2kg Cassava peel
Diet C- 1litre Oil palm slurry + 3kg Cassava peel; Diet D- 1litre Oil palm slurry + 4kg Cassava peel
Diet E-1litre Oil palm slurry + 5kg Cassava peel; Diet F- 6kg Cassava peel
WAD – West African Dwarf; SEM-Standard Error of Means

Discussion

High protein feeds have been found to be acceptable and with the ability to stimulate appetite and digestive activity (Cott, 2009). In this experiment diet C (Table 1) had the highest DM (Dry matter) and CP (Crude Protein), compared to other Diets and the control. This indicated that maximum microbial activity at this ratio of OPS to CaP was probably attained. This may be linked to its high CP of 14.15% obtained from the proximate composition. Sheep on control (Diet F) recorded lower values of DM and CP compared to those on Diet C. This may be attributed to the residual anti-nutritional factor (glucocyanide) present even after fermentation. Adebowale and Ademosun (1981) observed that about 80% of the anti-nutritional factors could be removed from cassava peel through fermentation.

Treatment effect of OPS to CaP ratio was poorly observed on the DM and CP digestibility parameters in sheep fed Diet A, which might be due to a higher concentration of oil to cassava ratio that could have hinderd the effect of rumen microbes (Jones and Porter, 1998). However, there is the dearth of information on any particular level of oil palm slurry to cassava peel inclusion in the DM and CP digestibility of nutrients in sheep or small ruminants. The residual oil present in the slurry represents a percentage of palm oil in feed. Conversely, Gonzalez *et al.* (1999) reported no treatment effect on DMI digestibility in the use of 0.5 and 10% palm oil with diets based on cassava foliage meal for growing pigs. The DMI values of animals on diets B, D, E and F, in this study, compared with the range of values obtained elsewhere for WAD goats fed sun-cured water hyacinth based diets (Mako, 2009). The lower values observed for animals on diet A could be attributed to low activity of the micro flora in the rumen, hence low by-pass protein from the rumen, subsequently, low digestion as well as absorption in the omasun and abomasum (Mako, 2009) due to high concentration of oil in the diet. However, reduced feed intake has been established to have a direct relationship with feed retention time in the rumen. (Van Soest, 1995).

Mariana and Ivanor (2017) reported that as the strength of OPS decreased due to increased inclusion of cassava peels, DM digestibility in this study increased. Nguyen *et al.*, (2007) reported similar results that groundnut oil at 5ml/kg live-weight could improve feed intake, growth rate and profitability. The highest DM value (89.43 %) recorded, for sheep on diet C in this work was higher than 71.2 and 83.3% reported by Chhay *et al*. (2003) for diets in which levels of palm oil were added to basal diet of ensiled cassava leaves. These values were similar to values of 76.08 and 74.52 % obtained for Diets B and F (control). The reported high DM digestibility value for animals on diet C compared to those on diets B and F might be traced to the higher CP content in the diet (Akinwande *et al.,* 2018).

The high CP digestibility in animals fed diet C compared with other diets in this study might be related to the high CP content of the mixture as earlier stated and the favourable mixture of the diet which aided microbial breakdown. However, this CP value of the diet C is higher than the 8-12% recommended ammonia levels required for optimal rumen functioning of small ruminants (ARC 2000). The excess ammonia produced could be a useful source of protein build up by the rumen micro flora for microbial activities.

An inference drawn from the reports of Shahid *et al.,* (2000) was that, excess ammonia not utilized by the microbes is absorbed in the blood circulation and converted to urea in the liver, with a consequence of metabolic burden on liver of the animal. The CP digestibility (90.26 %) obtained for animals on diet F (control), was higher than those of animals on other diets except diet C. This could be connected to the residual anti- nutritional factor present after fermentation that aided in protecting the protein from fermentation in the rumen. Ffoulkes and Preston (1978);Wanapat*et al*., (1997), indicated that cassava hay was a good source of rumen by-pass protein due to the condensed tannins acting to protect the protein from fermentation in the rumen, which may increase the supply of amino acids to the small intestine.

Animals on diet E recorded the least CP digestibility value; this was not expected because the animals on diet A recorded the least values in other parameters, hence the lowest microbial activity than animals on diet E and other diets.

Therefore, reason for the low CP digestibility in animals on diet E could not be ascertained. The CP digestibility values of 80.2 to 6-92.70% obtained in this study were higher than those reported for WAD goats fed sun-cured water hyacinth based diets 67.89 - 80.13 % (Mako. 2009) probably due to fermentation which influenced high microbial activity in the rumen of the animals. It has been reported that fermentation brings about high microbial activity hence high protein synthesis (Erasmus *et al.,* 1994).

Digestibility value of crude fibre (CF) 87.39% obtained for animals on diet C, was the highest. This could be due to the favourable OPS to CaP ratio, which facilitated the high microbial breakdown of the cellulose cell wall in the diet. It could then be traced to the residual CP available to the microbes in the rumen of the animals as discussed earlier, which aided the diet in staying longer in the rumen. This caused a gang up of microbes in the breakdown of the CF contents in this diet for single cell formation (Mako, 2009). Oil has also been discovered as an adjunct to fermentation (Jones and Porter, 1998). Phengvilay souk and Wanapat (2008) opined that the influence of oil at 3% inclusion level, in sheep diet significantly $p<0.05$ increased fibre digestibility. Sheep on diet A had the least value of CF compared to the animals on other diets and the control. The reduction in the buildup of rumen microorganisms responsible for the breakdown of CF (Kane *et al.*, 1979) might be the reason for this observation. This connotes that the ratio 1:1 of OPS to CaP mixture was unfavourable to the ruminal micro flora of the animals for this diet thereby suppressing CF digestibility. Patra (2013) did not report any effect of fat on CF digestibility. Jorge *et al.,* (2008) also noted that, CF digestibility was not significantly different at all the levels of oil to broken rice inclusion, which has been established to have a direct relationship with feed retention time in the rumen (Van Soest, 1995).

Observations from the present study, showed that ether extract (EE), neutal detergent fibre (NDF), acid detergent fibre (ADF), cellulose and hemicelluloses contents were not significantly influenced ($p>0.05$) by dietary treatments. However, Gonzalez *et al.* (1999) indicated that in diets based on cassava foliage meal for growing pigs. NDF digestibility decreased while ether extract digestibility was enhanced with increasing levels of dietary palm oil. Further reports by Phengvilaysouk and Wanapat (2008) revealed that supplementation of cassava hay with coconut oil significantly ($p<0.05$) improved digestion of NDF and ADF.

Results of the N-balance (Table 3) showed that animals on diet C had the highest N-balance, which might be because of the relatively higher nitrogen intake and the high micro floral gang up towards the feed ingested. It could be deduced that the ratio of the feed mixture, i.e. OPS to CaP was favorable to the microbes in the rumen of the animals on this diet. The reduction in the microbial utilization by the animals fed diet A, may be connected to the low intake of the feed, due high CF and low CP composition of the mixture. Mako (2009) deduced that dry matter intake (DMI) was a limiting factor in feed utilization since it will affect the overall performance of the animal which may result in a low microbial utilization of the feed. Cheng *et al*. (1984) reported that microbial colonization of highly lignified particles was limited. Though the crude protein content of animals fed diet F was low compared to other diets, the value of N-retention obtained (70.25) was higher than that of sheep on the other diets except for animals on diet C. This observation could be due to the residual anti nutrient which might be present in the feed that aided in trapping down the bypass protein, hence a high N-retention as reported (Wanapat*et al*., 1997).

The high total digestible nutrients (TDN) and apparent digestibility of dry matter, crude protein, positive N-balance and N-retention of animals on diet C may be indicative of proper utilization of the feed by the animals placed on this diet as compared to other diets.

Conclusion

It can be concluded from the results of the apparent digestibility of nutrients, total digestible nutrients, N-Balance and N-Retention that optimum performance in West African Dwarf sheep was best at 3K CaP to 1litre Oil palm slurry. At the ratio of 1:3 (OPS to CaP), minimum cassava peel with little quantity of oil palm slurry will be required thereby controlling the economy of alternative feed resources. Control diet (6 kg of cassava peel) was expected to give optimum performance, but oil inclusion enhanced best performance in diet C. This confirms that oil was as an antidote to anti nutritional factors contained in unprocessed cassava peel.

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