IN VITRO NUTRITIVE VALUE ASSESSMENT IN GOATS OF OIL PALM PRESS FIBRE SUBJECTED TO SOLID STATE FERMENTATION

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ABSTRACT
Oil palm press fibre (PPF) is a lignocellulolistic material. Its usage as energy feed for ruminant is limited by high fiber. Delignifer such as white rot fungi e.g. *Pleurotus tuberregium* (Fr. Singer) has been found to successfully degrade lignocellulolistic wastes using solid-state fermentation (SSF) technique. The objective of the study was to determine the chemical composition (CP, ash, OM, NDF, ADF and hemicellulose) of raw and biodegraded PPF and in-vitro fermentation parameters of raw and biodegraded PPF as well as diets containing them. Biodegradation significantly increased in-vitro DMD ($P<0.05$) and OMD insignificantly ($P>0.05$). Optimum DMD was at 30 % and 40 % for untreated and treated PPF diets respectively. It is therefore concluded that untreated PPF may not be fed above 30 % level in WAD goats' diets while the treated can be included up to 40 %.
Keywords: PPF, in-vitro, chemical composition, DMD, OMD.

INTRODUCTION
Oil palm press fibre (PPF) is a residual mesocarp fibres of oil palm fruits after oil extraction (Ho *et al.*, 1996). Its use as ruminant feed is constrained by the low protein content and high fiber especially the component of lignin and cellulose (Bamikole and Babayemi, 2008). The PPF is often used as fuel for boilers, to generate electricity and steam in the palm oil mills (Ofori-Boateng and Teong Lee, 2013) while a large portion are discarded as waste (Obese *et al.*, 2001) which can be used as energy source in ruminant feeding (Bamikole and Ikhatua, 2009). About 608,700 tonnes of PPF are generated annually in Nigeria while Ofori-Boateng and Teong-lee (2013) stated 12.53 % for a 21.63 tonnes of biomass of oil palm plantation. High percentage digestive organic matter (OM) values which is indicative of good nutritive value of feed or feedstuff (Bamikole and Ikhatua, 2009) was discovered to be limited in PPF (Ho *et al.*, 1996; Bamikole and Babayemi, 2008; Bamikole and Ikhatua, 2009). Improving the nutritional value (NV) of PPF in terms of both crude protein (CP) and cell wall component degradation will make it an ideal ingredient in ruminant feed. Several studies on PPF with the aim of improving the NV have proven not significant (Wan Zahari *et al.*, 2013). In light of this, a white rot fungus (WRF) a delignifer was employed as a biodegrader of PPF. This study was designed to determine the chemical composition and in-vitro fermentation characteristics of raw and biodegraded PPF as well as diets containing them.

MATERIALS AND METHODS
Spawn preparation:
Pure culture of white rot fungi *Pleurotus tuberregium* (Fr) Singer was obtained from the Mushroom Biology Unit, Department of Plant Biology and Biotechnology, University of Benin, Benin City, Edo State and used in the preparation of spawn (planting material). The spawn was prepared using the test material (PPF) as substrate and terminated after full colonization (30 days).

PPF collection, preparation, inoculation and processing: Fresh PPF was collected from Nigeria Institute for Oil Palm Research (NIFOR), Amadi mill and Uselu mill in Benin City. The substrates were homogenized. The moisture content was adjusted to 70 – 75 % with sterile distilled water and then loaded into cellophane bags. The bags were then loaded into a steamer and steamed for 4 h. The bags were inoculated at 5 % of spawning for 30 days. Biodegraded and raw PPF were sundried and then milled to pass through 2 mm sieve and stored in an air tight container.

***In vitro* gas fermentation study**

Collection and preparation of rumen liquor, buffer and inoculums:

The rumen liquor was collected from West African Dwarf (WAD) goats reared at University of Benin farm project. Buffer was prepared according to Vavarro-Villa *et al.* (2011) and maintained at 39^{0}C before used. Inoculum was prepared using liquor and Buffer at ratio 2:1.

Incubation of samples: 200mg of milled samples of raw and biodegraded PPF and the diets containing their graded inclusion was weighed into nylon bag of known weight, sealed and put into 100 mL calibrated syringes to be used for incubation. Each syringe was dispensed 30 mL of inoculum and fitted with a silicon tube. Three syringes containing inoculum were used as blanks. *In vitro* incubation was for 24 hours and readings were taken at every 3 hours interval.

Determination and estimation of post *in vitro* parameters:

4 mL of 40 % NaOH was injected into the incubation syringes after 24th hour of incubation to leave CH_4. The syringes volume was read and recorded as CH_4 produced. The DMD was calculated as follows;

% DMD = [(Wt. of sample before incubation – Wt. of sample after incubation) / Wt. of sample before incubation] x 100

The SCFA and organic matter digestibility (OMD %) were estimated at 24-hour post gas production using the equation established by Menke and Steingass (1988) and ME by Getachew *et al.* (1999).

Chemical and Statistical analysis:

The analysis of crude protein and ash were estimated using the procedure of AOAC (1995) while the cell wall components were determined using the standard method of Van Soest *et al.* (1991). Data collected were analyzed using the general linear models procedure (PROC GLM) of SAS (2014) in a completely randomized design. Separation of means was done using Duncan New Multiple Range Test of the same SAS (2014) software.

RESULTS AND DISCUSSION

The CP content of treated PPF after 30 days' biodegradation with mushroom ranged from 8.38 % (untreated PPF) to 9.76 % (treated PPF). This change may be as a result of mycelia present. Mushroom mycelia are source of protein. Reduction in NDF and hemicellulose value of treated PPF was observed with no significant differences. This shows the utilization of NDF and hemicellulose as an energy source for growth by *P. tuberregium.* Tong *et al.* (1993) observed a negligible decrease in the hemicelluloses content of PPF incubated up to a period of ten different isolated of WRF using SSF with exception of *P. florida.* Reduction in ash content of biodegraded PPF was not significant in the course of research.

This was supported by Tong *et al.* (1993). Treated PPF recorded a higher gas production at 24 hours of incubation. This is in agreement with Okano *et al.* (2009) who reported an increase in net gas volume of fermented substrates. Gas volume has been observed to be a good parameter for measuring the degree of digestibility, fermentation end product and microbial protein synthesis of the substrates by rumen microbes in *in vitro* studies (Sommart *et al.*, 2000).

Larbi *et. al.* (1998) stated that there is a positive correlation between CP and the rate of gas production and negative correlation between cell wall fractions and the rate of gas production. In other word increased gas volume associated with 10, 20, 30 % untreated and 10, 20, 30 and 40 % treated PPF diets indicated higher digestibility. Forty (40 %) percent untreated PPF diet gave the least CH_4 production and digestibility indicating poor digestibility of feed. In this study Mushroom treatment improved the digestibility of PPF.

CONCLUSION

Fungus biodegradation increased the CP content of treated PPF. There was notable increase in DMD with no difference in OMD of biodegraded PPF. Among diets containing PPF, 40 % and 30 % inclusion gave the optimum DMD for treated and untreated PPF respectively. PPF can be successfully included in not more than 30 % level of ruminant diets as an energy source.

REFERENCES

AOAC (1995). Official Methods of Analysis. Association of Official Analytic Chemist, (16th, edition) Washington, DC.

Bamikole, M.A. and Babayemi, O.J. (2008). Chemical composition and in sacco dry matter degradability of residue and by-products of palm fruit processing in the

rumen of steers. *Animal Science Journal*, 79: 314-321.

Bamikole, M.A. and Ikhatua, U.J. (2009). Variety diversity effect on the chemical composition and dry matter characteristics of residue and by-products of oil palm fruits. *Animal Science Journal*, 80: 239-249.

Getachew, G., Makkar, H.P.S. and Becker, K. (1999). Stoichiometric relationship between short chain fatty acid and *in vitro* gas production in presence and absence of polyethylene glycol for tannin containing browse, EAAP satellite symposium, gas production; *Fermentation kinectics for feed evaluation and to assess microbial activity,* 18-19 August, Wageningen, the Netherlands.

Ho, Y.W., Abdullah, N. and Jalaludin (1996). Microbial colonization and degradation of some fibrous crop residues in the rumen of goats. *African Journal of Animal Science*, 9 (5): 519-524.

Larbi, A., Smith, J.W., Kurdi, I.O., Adehunle, I. O., Raji, A. M. and Ladipo, D.O. (1998). Chemical composition, rumen degradation and gas production characteristics of some multipurpose fodder trees and shrubs during wet and dry seasons in the humid tropics. *Animal Feed Science and Technology,* 72 (1): 81 – 96.

Menke, K.H. and Steingass, H. (1988). Estimation of the energetic feed value from chemical analysis and in vitro gas production using rumen fluid. *Animal Research Development*, 28: 7-55.

Navarro-Villa, A., O'Brien, M., Lopez S., Boland, T.M. and O'kiely, P. (2011). Modification technique for assessing in-vitro rumen methane production from feedstuffs. *Animal Feed Science and Technology*, 166-167; 163-174

Obese, F.Y., Osafo, E.L.K., and Okai D.B. (2001). Evaluation of the feeding value of palm press fibre using in vitro digestibility techniques. *Tropical Animal Health and Production*, 38(2):165-172.

Ofori-Boateng, C. and Teong Lee, K. (2013). Sustainable utilization of oil palm wastes for bioactive phytochemicals for the benefits of the oil palm and neutraceutical industries. *Phytochem. Rev.*

Okano, K., Ohkoshi, N., Nishiyama, A., Usagawa, T. and Kitagawa, M. (2009). Improving the nutritive value of madake bamboo, *Phyllostachys bambusoides*, for ruminants by culturing with the white-rot fungus

Sommart, K. Parker, D.S. Rowlinson, P. and Wanapat, M. (2000). Fermentation characteristics and microbial protein synthesis in an *in vitro* system using cassava, rice straw and dried grass as substrates. Asian-Australian Journal of Animal Science, 13:1084-1093.

Tong, C. C., Chew, S. L. and Wahab, M. N. (1993). Delignification of palm-press fibre fungi for enzymic saccharification of cellulose. *Pertanika Journal of Tropical Agricultural Science*, 16 (3): 193 – 199.

Wan Zahari, M., Alimon, A.R. and Wong, H.K.(2013). Utilization of oil palm co-products as feeds for livestock in Malaysia in "Biofuel co-products as livestock feed – opportunities and challenges. *wanzahari@umk.edu.my, unpublished.*

Table 1: Ingredient compositions (g/100gDM) of the proposed experimental supplement containing different levels of PPF

	Inclusion levels of fresh PPF (g/100gDM)				
Ingredients	0	10	20	30	40
Maize	40	30	20	10	0
PPF	0	10	20	30	40
DBG	24	24	24	24	24
PKC	23.5	23.5	23.5	23.5	23.5
GNC	5	5	5	5	5
MB	5	5	5	5	5
BM	2	2	2	2	2
CS	0.2	0.2	0.2	0.2	0.2
V&M premix	0.3	0.3	0.3	0.3	0.3
% CP of diets	15.18	15.01	14.83	14.65	14.47
ME (KCal/Kg)	2695.72	2616.3	2544.5	2457.43	2377.96

CP= Crude protein, DBG=Dried brewers' grain,PKC=Palm kernel cake, GNC=Groundnut cake, MB=Maize bran, BM=Bone meal, CS=Common salt, V&M =vitamin and mineral

Table 2: Chemical Composition (%) for treated (biodegraded) and untreated palm press fibre

	Palm press fibre			
Chemical composition (%)	**Treated**	**Untreated**	**SEM**	**Significance**
CP	9.76	8.38	0.26	+
Ash	2.76	3.36	0.38	NS
NDF	50.95	53.77	0.77	NS
ADF	31.75	31.43	0.4	NS
Hemi	19.2	22.33	1.11	NS
OM	97.24	96.64	0.38	NS

SEM=standard error of means, NS = not significant, P>0.05, + = tended to be significant =P>0.05 - 0.1,
CP= Crude protein,NDF=Neutral detergent fibre, Hemi=Hemicelluloses,OM=Organic matter

Table 3: Post in vitro gas production parameters of treated (biodegraded) and untreated palm press fibre

	PPF			
Parameter	Treated	Untreated	SEM	Significance
CH_4 (mL)	14.22	13.89	1.08	NS
CH_4 (%)	47.74	43.76	2.91	NS
DMD (%)	68.28a	58.50b	3.14	NS
OMD (%)	36.04	34.85	0.95	NS
SCFA (µmol)	0.28	0.27	0.03	NS
ME (MJ/Kg)	5.05	4.76	0.16	NS

ab = means on the same row with different subscript letters are significantly different ($P < 0.05$), SEM=standard error of means, PPF =Palm press fibre, NS = not significant, NS = P>0.05, CH4 (mL) = methane gas volume, CH4 (%) = methane gas percentage DMD= Dry matter digestibility, OMD=Organic matter digestibility, SCFA= Short chain fatty acid, ME= Short chain fatty acid

Table 4: Effect of treatments and inclusion levels on post in vitro fermentation parameters of palm press fibre based diets

		Inclusion Levels of PPF (%)				Significance		
Parameter	Treatments	10	20	30	40	L	T	LXT
CH_4	Untrt	17.33	14	13.33	8.671	+	NS	NS
(mL)	Trt	15.33	12.67	14	16.672			
	SEM	0.9	0.91	0.89	0.8			
CH_4	Untrt	58.86	48.65	39.86	53.25	NS	NS	NS
(%)	Trt	47.62	38.06	38.02	54.79			
	SEM	1.57	1.69	1.63	1.74			
DMD	Untrt	60.671	55.33	59	49.67	+	*	NS
(%)	Trt	81.332	63.67	60.67	65.67			
	SEM	1.25	0.98	1	1.86			
OMD	Untrt	41.37	32.06	36.49	32.98	*	NS	NS
(%)	Trt	39.83	38.31	36.07	37.27			
	SEM	1.02	0.93	0.9	0.95			
SCFA	Untrt	0.40	0.27	0.27	0.151	+	NS	NS
(µmol)	Trt	0.31	0.24	0.27	0.342			
	SEM	0.14	0.14	0.14	0.12			
ME	Untrt	5.59	4.67	4.96	3.691	*	NS	NS
(MJ/Kg)	Trt	5.24	4.89	5.07	5.432			
	SEM	0.34	0.39	0.33	0.29			

1,2 = means on the column with different superscript letters (1, 2)are significantly different (P<0.05), Untrt=Untreated, Trt=Treated, T = treatments (treated, untreated), L = PPF diets at different inclusion levels, L x T = Interaction between L and T, CH4 (mL) = methane gas volume, CH4 (%) = methane gas percentage, DMD = dry matter degradability, OMD = organic matter digestibility, SCFA= short chain fatty acid, ME = metabolisable energy, SEM = standard error of means PPF = Palm press fibre, NS = not significant, NS= P>0.05, * = P<0.05,+ = tended to be significant = P>0.05 - 0.1,