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Dietary effect of *Pleurotus pulmonaris* treated cocoa bean shell meal on fibre fractions utilisation by the West African Dwarf goats

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Abstract

A 63-day study was conducted to evaluate the dietary effect of Pleurotus pulmonaris treated cocoa bean shell meal diets on fibre fraction utilization of West African Dwarf (WAD) goats (aged 9 -12 months) with an average live weight of 6.31±0.3 kg. Six diets were formulated such that wheat offal was replaced with ensiled Pleurotus pulmonaris treated cocoa bean shell meal at ratio 0 (A), 20% (B), 40% (C), 60% (D), 80% (E), 100% (F) in complete diets. The experimental diets were fed to 18 WAD goats in three replicates per treatment using completely randomized design. The determined parameters included; chemical composition of the diets, dry matter and fibre fractions intake, weight gains and feed to gain ratio. The dry matter of raw cocoa bean shells was 88.53% and dry matter of Pleurotus pulmonaris treated cocoa bean shells was 87.38%. The crude protein contents of raw bean shells and Pleurotus pulmonaris treated cocoa bean shells were 11.98 and 26.63% respectively. The dry matter of the diets ranged from 86.83 to 90.70%, diet B had the highest value while crude protein ranged between 19.73 (diet A) and 28.88% (diet F) and increased with increased inclusion of Pleurotus pulmonaris treated cocoa bean shell meal in the diets. The nutrients intake was significantly (P<0.05) influenced by the treatment except dry matter and cellulose. The crude fibre and fibre fractions were efficiently digested. Nitrogen balance, apparent digestibility and weight gain were significantly (P<0.05) influenced by the treatment. The goats fed diet A converted their feed to flesh better than other goats. However, goats fed diet F performed best compared to other goats fed diets B, C, D and E that contained Pleurotus pulmonaris treated cocoa bean shell meal. It can be concluded that Pleurotus pulmonaris treated cocoa bean shell meal incorporated in goat's diet could supply energy and protein to sustain the growth without adverse effect.

Keywords: Cocoa bean shell, fibre fractions, fermentation, *Pleurotus pulmonaris,* goats

Introduction

The inadequacy of quality feeds especially during the dry periods has necessitated the use of alternative feed resources. This development calls for means of achieving supply of browse forages, crop residues such as maize cob, maize husk, cassava peel, brewers grains, cocoa pod husk, cocoa bean shell and other supplements to the ruminants in the right quality and quantity. However, some of these feed resources contained anti – nutrients, have poor digestibility due to high fibre contents and unpalatable to animals (Olorunnisomo and Ibhaze, 2013). Cocoa bean shell is one of the by-products of processed cocoa beans, the dried CBS contained 13.12% crude protein; 13.00% crude fibre; 8.71% ether extract; 9.15% Ash and 2400 ME kcal/kg (Olupona *et al*., 2003). However; lignifications and theobromine concentration of this by-product render it underutilized by goats. Attempts have been made to detoxify/delignify cocoa by-products using physical, chemical and biological methods. A measure of success has been achieved using physico-chemical methods (Adamafio, 2013; Omotoso *et al.,* 2018a; 2018b) however; there is dearth of information on using biological method.

Pleurotus pulmonaris is filamentous fungus which can be used in biological method of detoxify/delignify cocoa bean shell. This treatment is a promising alternative to physico-chemical procedures, and circumvents the loss of soluble nutrients (Adamafio, 2013). This study was therefore, designed to evaluate the dietary effect of *Pleurotus pulmonaris* treated cocoa bean shell meal on fibre fraction utilisation by the WAD goats.

Materials and methods

Site of experiment and collection of materials

The experiment was conducted at the small ruminants unit of the Teaching and Research (T&R) Farm while the laboratory analyses were carried out at the Nutrition Laboratory of Animal Production and Health, Federal University of Technology, Akure (Latitude 7^0 18¨N and Longitude 5^0 10"E). The cocoa bean shell (CBS) was gotten from a cocoa processing company in Akure. The sun-dried and milled cassava peels were collected from a "garri" processing industry in Igbatoro, Akure while other ingredients were sourced from reputable feed miller's shop.

Ensiling procedure

The ensiling was carried out at the Teaching and Research Farm of Federal University of Technology, Akure. Adequate quantity of cocoa bean shells was divided into two equal parts, one part was subjected to aerobic fermentation using the method of Aro *et al.* (2008) thereby, one litre of water was added to one kilogram of dried cocoa bean shell, mixed thoroughly, packed into black polythene bag, sterilized at (100^oC) for 1 hour, and allowed to cool. The CBS was inoculated with 15 mL of cultured fungus (*Pleurotus pulmonaris*) and potato dextrose agar solution that contained 1.2×10^8 microbes/mL and fermented for five days under aerobic condition and air dry for two days before incorporated into the formulated diets.

Experimental diets preparation

Six experimental diets were formulated such that wheat offal (30.00%) was partially replaced with *Pleurotus pulmonaris* treated cocoa bean shell meal at ratio 0 (A), 20% (B), 40% (C), 60% (D), 80% (E), 100% (F) and the diets gross composition is shown in Table 1.

Animal procurement and management

Eighteen WAD goats aged 9-12 months and weighed 6.31±0.03 kg used for the feeding trial were selected from the flocks of goats unit of Teaching and Research Farm (TRF), Federal University of Technology, Akure. The goats were medicated against *Pesté-Petit dé Ruminanté* (PPR / kata) and other infections. The goats were randomly assigned (three per treatment) to the experimental diets in Completely Randomized Design and the experiment lasted for 63 days excluding twenty-one days adaptation. The last 14 days of the experimental period were used for collection of faeces and urine for laboratory analysis. The goats were fed the experimental diets daily early in the morning (7:00 am) and fresh water was given *ad libitum* throughout the experimental period. The goats were weighed before the commencement of the feeding trial and were repeatedly weighed weekly in the morning before feeding to determine weight changes using spring-balance (hanging scale). The goats were transferred to metabolic cages during the last fourteen days of the experimental period for the collection of faeces and urine. The urine samples were collected in containers that contained 1.0 mL each of 25% H_2SO_4 in order to trap ammonia. Faeces and urine samples were collected daily, measured and stored in refrigerator at -5^oC until they were required for chemical analysis. The parameters determined were

nutrients composition of untreated and ensiled microbial treated cocoa bean shell, chemical, feed intake, digestibility, daily weight gain, nitrogen balance and feed to gain ratio.

Laboratory analysis

The laboratory analysis was done in the Central Laboratory, Federal University of Technology, Akure, Ondo State Nigeria. The samples of untreated and ensiled treated cocoa bean shell meals, feed, faeces and urine were analysed using methods of AOAC (2000). Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined using the analytical procedures of Van Soest *et al.* (1991). Gross energy was determined by the method of Ekaneyake *et al.* (1999)

Experimental design and statistical analysis

The experimental design was of completely randomized design and all data generated were subjected to analysis of variance (ANOVA) as described by SAS (2008) and treatment means were compared by the methods of Duncan (1955).

Table 1: Gross composition of the untreated and *Pleurotus pulmonaris* treated cocoa bean shell diets fed to West African Dwarf goats

Ingredients	Diets					
	A	B	C	D	E	F
Cassava peels	50.00	50.00	50.00	50.00	50.00	50.00
Wheat offals	30.00	24.00	18.00	12,00	6.00	-
Microbial Treated Cocoa Bean Shell	-	6.00	12.00	18.00	24.00	30.00
Palm kernel cake	15.00	15.00	15.00	15.00	15.00	15.00
Bone meal	1.50	1.50	1.50	1.50	1.50	1.50
Salt	1.50	1.50	1.50	1.50	1.50	1.50
Urea	1.00	1.00	1.00	1.00	1.00	1.00
Premix	1.00	1.00	1.00	1.00	1.00	1.00

Results and discussion

The nutrients composition of the untreated and ensiled microbial treated cocoa bean shell meals is presented in Table 2. The dry matter content of untreated and microbial treated cocoa bean shell was 88.53 and 87.38% respectfully. The crude protein (23.63% CP) of microbial treated cocoa bean shell was improved better than the value obtained in the untreated CBS, this observation might be due to effect of fermentation on microbial treated cocoa bean shell. It was observed that fibre fraction contents decreased in the microbial treated cocoa bean shell with exception of cellulose, this observation could be attributed to the delignification of the fibre content by microbes during fermentation. The energy content of microbial treated cocoa bean shells was 20.80 KJ/100gDM and higher than the value obtained in untreated cocoa bean shells.

The chemical composition of the *Pleurotus pulmonaris* treated cocoa bean shells complete diets are shown in Table 3. The dry matter of the diets ranged from 86.83 to 90.70%, these values compared favourably to the values of 86% - 92% reported by Bamikole (2004). The crude protein ranged from 19.73% to 28.88%. The observed CP in the diets was above the critical 8% crude protein required by ruminants for optimum microbial activities in the rumen (Norton, 2003). The crude fibre ranged between 7.40

Table 2: Chemical composition of untreated and treated *Pleurotus pulmonaris* cocoa bean shell

Parameters	Untreated Cocoa bean shell	Treated Cocoa bean shell
Dry matter	88.53	87.38
Crude protein	18.98	23.63
Crude fibre	12.80	11.99
Ether extract	24.16	27.72
Ash	10.47	10.31
Nitrogen free extract	33.59	24.37
Neutral detergent fibre	47.06	46.15
Acid detergent fibre	38.46	37.25
Acid detergent lignin	23.13	21.51
Hemicelluloses	8.60	8.90
Cellulose	15.33	15.74
Gross energy (KJ/100gDM)	20.02	20.80

n = 3 Gross energy; Ekaneyake *et al.* (1999)

Table 3: Chemical composition of untreated and *Pleurotus pulmonaris* treated cocoa bean shell diets fed to West African Dwarf goats

Parameters	Diets					
	A	B	C	D	E	F
Dry matter	89.21	90.70	88.77	86.83	88.87	86.83
Crude protein	19.73	23.16	25.38	27.13	27.45	28.88
Crude fibre	12.23	10.79	10.34	9.03	8.79	7.40
Ether extract	16.04	13.31	11.63	11.88	10.01	9.39
Ash	11.80	11.77	11.66	10.59	10.04	9.78
Nitrogen free extract	40.10	40.97	40.99	41.37	43.71	44.55
Neutral detergent fibre	43.14	41.18	43.14	44.00	46.00	45.00
Acid detergent fibre	31.37	32.08	34.62	35.29	35.29	35.64
Acid detergent lignin	13.29	14.97	16.05	17.39	17.59	17.56
Hemicellulose	11.77	9.10	8.52	9.71	10.71	9.46
Cellulose	18.08	17.11	18.57	17.90	17.70	18.08
Gross energy (KJ/100gDM)	18.08	17.53	17.20	17.43	17.12	17.04

Table 4: Nutrient intake (g/day) of West African Dwarf goats fed untreated and *Pleurotus pulmonaris* treated cocoa bean shell diets

Parameters	Diets						
	A	B	C	D	E	F	SEM
Dry matter	344.60	324.36	267.61	302.51	279.15	349.00	12.04
Crude protein	59.96^{c}	75.13^{ab}	67.91^{bc}	82.05^{b}	76.63^{bc}	100.77^{a}	3.54
Crude fibre	42.14^{a}	35.00^{b}	27.67^{c}	27.32^{c}	24.54^{c}	25.83^{c}	1.58
Ether extract	55.27^{a}	43.17^{b}	31.12^{de}	35.94^{c}	27.94^{e}	32.77^{cd}	2.52
Ash	40.66^{a}	38.18^{a}	31.04^{bc}	32.04^{bc}	28.03^{c}	32.77^{b}	1.14
Nitrogen free extract	188.18^{a}	132.89^{c}	109.69^{e}	125.15^{d}	122.02^{d}	155.50^{b}	6.34
Neutral detergent fibre	148.66^{ab}	133.57^{ab}	115.45^{b}	133.10^{ab}	128.41^{ab}	157.40^{a}	5.26
Acid detergent fibre	108.10^{ab}	104.06^{ab}	92.67^{b}	106.75^{ab}	98.51^{ab}	127.52^{a}	4.08
Acid detergent lignin	45.80^{b}	48.56^{ab}	42.95^{b}	52.60^{ab}	49.10^{ab}	61.28^{a}	2.00
Hemicelluloses	40.52^{a}	29.52^{b}	22.80^{b}	26.35^{b}	29.93^{b}	29.87^{b}	1.65
Cellulose	62.30	58.96	49.70	54.15	49.41	62.75	2.42
Energy (kcal/g)	14.89^{a}	13.59^{ab}	11.00^{c}	12.60^{ab}	11.42^{bc}	14.21^{ab}	0.46

abcde = Means within the same row having different superscripts differ significantly ($P < 0.05$)

(diet F) and 12.23% (diet A), the CF decreased with increased inclusion of *Pleurotus pulmonaris* treated cocoa bean shell meal in the diets. The neutral detergent fibre ranged between 41.18 (diet B) and 46.00% (diet E), this might be due to the lignocellulose content of the diets. The gross energy (KJ/100gDM) ranged from 17.04 (diet F) to 18.08 (diet A), these values were higher compared to obtained energy values (15.46 – 16.99 KJ/100gDM) reported by Fajemisin and Adekunle (2017) when performance of pregnant WAD ewes fed corncobs fermented with *Neurospora crassa* and *Lactobacillus debrueckii* was evaluated.

The Table 4 presents the nutrients intake of the goats fed the experimental diets. The intake of nutrients by the goats was significantly (P<0.05) influenced by the inclusion of microbial treated cocoa bean shell meal in the diets except dry matter. The dry matter intake by the goats ranged from 267.61 to 349.00 g/day, the goats fed diet F had highest DM intake and this might be attributed to the protein quality of the diet. The DM intake values compared favourably to the findings of Adamafio (2013) who reported that the inclusion of cocoa bean shell in ruminant diets stimulated feed intake and growth of ruminant animals. The crude protein intake by goats fed diets B, C, D, E and F were high compared to other goats fed diets A, this CP intake might be influenced by the crude protein of the *Pleurotus pulmonari* treated cocoa bean shell meal included in the diets (Adamafio, 2013). The high crude fibre intake by the goats could be traced to the combination of delignification and improved protein quality of the diets.

The Table 5 presents the result of apparent digestibility of the goats. All parameters determined were significantly (P < 0.05) influenced by the treatment.. The apparent digestibility of dry matter, crude fibre and fibre fractions were above 50.00% in all diets, this observation might be due to microbial degradation of fibre, protein quality, acceptability and palatability of the diets. This observation was corroborated by the report of Fajemisin *et al.* (2012) that adequate protein content and fibre fraction in livestock diets enhanced nutrients intake and digestibility.

Table 5: Nutrient digestibility (%)of West Africa n Dwarf goats fed untreated and *Pleurotus pulmonaris* treated cocoa bean shell diets

Parameters	Diets						
	A	B	C	D	E	F	SEM
Dry matter	68.18^{ab}	68.79^{ab}	73.07^{a}	68.19^{ab}	60.53^{b}	66.11^{b}	0.90
Crude protein	61.73^{c}	67.05^{abc}	73.41^{a}	69.19^{ab}	65.76^{bc}	73.00^{a}	1.23
Crude fibre	66.04^{b}	78.24^{a}	75.28^{ab}	72.47^{ab}	71.56^{ab}	75.38^{ab}	1.43
Ether extract	70.80^{bc}	71.50^{bc}	81.78^{a}	67.84^{c}	79.22^{ab}	78.88^{ab}	1.54
Nitrogen free extract	65.01^{ab}	72.73^{a}	69.74^{a}	68.38^{ab}	55.74^{c}	59.41^{bc}	1.72
Neutral detergent fibre	54.33^{b}	67.27^{a}	57.28^{b}	52.47^{b}	52.98^{b}	58.27^{b}	1.43
Acid detergent fibre	63.22^{ab}	68.10^{a}	60.64^{bc}	54.57^{a}	55.39^{cd}	58.14^{bcd}	1.28
Acid detergent lignin	75.39^{a}	67.66^{b}	54.27^{c}	55.36^{c}	54.48^{c}	62.05^{b}	3.27
Hemicelluloses	50.77^{b}	60.72^{a}	54.23^{ab}	59.15^{ab}	56.69^{ab}	58.85^{ab}	1.29
Cellulose	65.99^{c}	76.84^{a}	71.16^{b}	58.68^{d}	56.40^{d}	57.49^{d}	1.92
Energy	67.18^{ab}	69.79^{ab}	72.07^{a}	68.20^{ab}	60.53^{b}	66.12^{b}	0.91

abcd = Means within the same row having different superscripts differ significantly (P < 0.05)

The results of nitrogen metabolism, weight gain and feed to gain ratio were presented in Table 6. The result revealed that nitrogen balance of the goats ranged from 5.55 to 11.46g/day; the goats fed diet F had the highest nitrogen balance. The daily weight gain ranged between 23.81 and 47.62 g/day, the goats fed diet A had the highest value however, the goats fed F had the best weight gain (42.38 g/day) compared to goats fed diets B, C, D and E. This observation might be attributed to feed intake and protein quality of the diet which was influenced by the inclusion of *Pleurotus pulmonari* treated cocoa bean shell meal in the diets. The obtained weight gain in this study agreed with the findings of Fajemisin *et al* (2012) that weight gain was dependent on dry matter, protein intake and digestibility of the nutrients. The best feed to gain ratio (7.24) was observed in goats fed diet A, indicating the ability of goats fed diet A to convert their feeds to flesh than goats fed other diets and this might be attributed to high dry matter intake. Considering the goats fed diets that contained *Pleurotus pulmonari* treated cocoa bean shell meal, the goats fed diet F utilized (8.24) their feed better than other goats fed *Pleurotus pulmonari* treated cocoa bean shell diets. It implied that diet F met the nutrient requirement of the goats thus; the diet supplied adequate energy and protein that sustained the growth of the goats without adverse effect.

Table 6: Nitrogen metabolism, weight gain and feed to gain ratio of West African Dwarf goats fed untreated and Pleurotus treated cocoa bean shell diets

Parameters	Diets						
	A	B	C	D	E	F	SEM
Initial weight	6.27	6.27	6.33	6.27	6.37	6.27	0.24
Final weight	9.27	83.7	7.83	8.37	8.33	8.94	0.29
Daily weight gain	47.62^{a}	33.33^{ab}	23.81^{b}	33.33^{ab}	31.75^{ab}	42.38^{ab}	2.82
Nitrogen intake	9.59^{a}	12.02^{bc}	10.87^{bc}	13.13^{bc}	12.26^{bc}	16.13^{a}	0.57
Faecal nitrogen	3.58^{ab}	4.23^{a}	2.96^{b}	4.11a	4.24^{a}	4.33^{a}	0.16
Urinary nitrogen	0.48^{ab}	0.61^{a}	0.35^{bc}	0.35^{bc}	0.23^{c}	0.34^{bc}	0.03
Nitrogen balance	5.53^{c}	7.19^{bc}	7.55^{bc}	8.67^{b}	7.82^{bc}	11.46^{a}	0.51
Feed to gain ratio	7.24	9.73	11.24	9.08	8.79	8.24	2.22

abc = Means within the same row having different superscripts differ significantly ($P < 0.05$)

Conclusion

The study revealed that inclusion of *Pleurotus pulmonari* treated cocoa bean shell meal in the diets improved the protein quality and feed intake. The goats fed diet A converted their feed to flesh better than other goats. Considering the goats fed diets that contained the *Pleurotus pulmonari* treated cocoa bean shell meal, the goats fed diet F utilized (8.24) their feed better than other goats fed *Pleurotus pulmonari* treated cocoa bean shell meal diets. It implied that diet F met the nutrients requirement of the goats. Hence, maize offal substituted with 100% *Pleurotus pulmonari* treated cocoa bean shell meal could be a good source of energy and protein to support goat production, purposeful use of cocoa bean shell and reducing high cost of feed.

References

Adamafio, A. N. 2013. Theobromine toxicity and remediation of cocoa by-products: An Over view. *Journal of biological sciences* volume 17: 4-10

AOAC, 2000. Association of Official Analytical Chemistry Official

Methods of Analysis, 17th Published by Association of Official Analytical Chemists Washington D.C.

Aro, S. O., Aletor V. A., Tewe, O. O., Fajemisin A. N., Usifo B., and Adesida J. A. 2008. Studies on nutritional potentials of cassava tuber wastes (CTW) collected from a factory. Proceedings of 4th Annual Conference School of Agriculture and Agricultural Technology (SAAT), Federal University of Technology Akure, Nigeria. 21st May, 2008: 86-92.

Bamikole, M. A. 2004. Macro mineral utilization in WAD goats fed combination of fertilized and unfertilized Red Guinea grass. *Journal of Livestock Research for Rural Development*. 21: (2), 3-8

Duncan, D. B. 1955. Multiple range and multiple F- tests. *Biometrics,* 11: 1 – 4.

Ekaneyake, S., Jansz E. R. and Nair, B. M. 1999. Proximate composition, mineral and amino acid content of mature *Canavalia gladiate* seeds. Food Chemistry, 66: 115-119

Fajemisin, A. N., Chineke, C. M., Fadiyimu, A. A., Fajemisin, A. J. and Alokan, J. A. 2012. Dietary effects of ensiled corncobs treated with or without water, lye and urea on performance characteristics of West African Dwarf sheep. *Proceedings of 17th Annual Conference, Animal Science Association of Nigeria* (ASAN) held at International Conference Centre,Opposite Radio House, Area 8, Abuja, (FCT), Nigeria, 9th - 13th September, 2012. Pp 575-578.

Fajemisin, A. N. and Adekunle, O. 2017. Performance of pregnant West African Dwarf ewes fed corncobs fermented with *Neurospora crassa* and *Lactobacillus debrueckii*. *Proceedings of the 61st Annual Conference, Association of Deans of Agriculture in Nigeria Universities (ADAN)* held at University of Benin, Benin City, Nigeria, 3rd - 6th July, 2017. Pp 193-196.

Norton, E. R. 2003. Nutritive value of rumen micro-organisms in ruminant. *British Journal of Nutrition.* 52: 613-620.

Olorunnisomo, O. A. and Ibhaze, G. A. 2013. Milk yield and feed conversion of Sokoto Gudali cows fed elephant grass ensiled with cassava peel. *Agricultura Tropical etsubtropica* 46 (4): 123 – 128.

Olupona, J. A., Abodunwa, J. A. and Fayoyin, F. K. 2003. Response of laying hens to graded levels of cocoa bean shells. In: Proceedings of the 23rd Annual Conference of Nigerian Society of Animal Production held at IAR&T, Moor-Platantion, Ibadan, Oyo State, Nigeria. 16th March, 2003. Pp 247 - 249

Omotoso, O. B., Fajemisin, A. N. and Alokan, J. A. 2018a. Nitrogen metabolism, digestibility and blood profile of West African Dwarf goats fed dietary level of *Cajanus cajan* as supplement to cassava peels. *Nigerian Journal of Rangeland Science* 8 (4): 298–303

Omotoso, O. B., Bello, I. A. and Fajemisin, A. N. 2018b. Effects of differently treated Theobroma cacao pod husk silage and cassava peel meals on nutrient utilization and weight gain of West African Dwarf goats. ***Animal Research International* 15(2): 3020 – 3033**.

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