Utilization of Urea Treated and Untreated Cocoa Pod Husk Based Diets by Growing Pigs: An On-farm Study

E.A. Iyayi[1]*, O. Olubamiwa[2], A. Ayuk[1], S. Orowvegodo[1] & E.F. Ogunaike[3]

Keywords: CPH – Urea – Treatment – Utilization – Pigs

Summary

An on-farm adaptation study of the utilization of urea treated and untreated cocoa pod husk (CPH) by growing pigs was carried out on a commercial pig farm. Thirty-two Landrace X Large White growing pigs (16 males + 16 females) were randomly assigned to 4 experimental diets. Diet 1 was a standard grower ration (control). In Diets 2 and 3 CPH meal was included at 250 g/kg, that used in Diet 3 being treated with a 5% urea solution. Diet 4 was the farmer's diet. There was no significant difference (P> 0.05) between diets 3 and the control in their effect on the performance of the animals. These two diets caused a better (P< 0.05) feed consumption, weight gain, feed efficiency and feed conversion ratio than diets 2 and 4. Backfat thickness, was significantly reduced (P< 0.05) by the CPH diets. Compared to the non treated CPH, treatment with urea increased daily weight gain while no significant (P> 0.05) influence on the backfat thickness. Carcass cuts were also not significantly (P> 0.05) influenced by inclusion of CPH meal. Results suggest (1) the possibility of formulating diets for growing pigs using CPH meals and (2) that further treatment of the CPH meal with urea improves its nutritive value resulting in better performance and economy of production.

Résumé

Utilisation des gousses de cacao traitées ou non-traitées à l'urée comme aliment pour porcs en croissance: étude au niveau d'une ferme

Une étude au niveau d'une ferme sur l'utilisation des gousses de cacao traitées ou non à l'urée comme aliment pour porcs en croissance a été menée dans une porcherie commerciale. Trente-deux porcs croisés Landrace X Large White en croissance (16 mâles + 16 femelles) ont été soumis à 4 rations expérimentales. La ration 1 était une ration standard de croissance (témoin). Dans les rations 2 et 3, les gousses de cacao étaient incorporées à hauteur de 250 g/kg, celles incorporées dans la ration 3 étant préalablement traitées avec une solution de 5% d'urée. La ration 4 était la ration habituelle de la ferme. Aucune différence significative entre la ration 3 et la ration témoin, en ce qui concerne leurs effets sur la performance des animaux, n'a été observée. Ces deux rations ont entraîné une ingestion, un gain pondéral, une efficacité et une conversion alimentaire significativement plus élevés (P< 0,05) que les rations 2 et 4. L'épaisseur du gras postérieur a diminué significativement (P< 0,05) pour les rations à base de gousses de cacao. Comparé aux gousses de cacao non traitées, le traitement à l'urée a augmenté le gain de poids quotidien alors qu'aucune influence significative (P> 0,05) sur l'épaisseur du gras postérieur n'a été obsevée. Les parties de la carcasse n'ont pas été significativement (P> 0,05) influencées par l'inclusion des gousses de cacao. Les résultats suggèrent (1) la possibilité de formuler des rations pour porcs en y incorporant de la farine des gousses de cacao (2), le traitement ultérieur avec l'urée augmente sa valeur nutritive et induit une meilleure performance et ainsi une productivité économique plus élevée.

Introduction

Cocoa pod husk (CPH) is a by-product of the cocoa crop, which is grown primarily for the bean. A thriving cocoa industry exists in the South Western part of Nigeria. The husk is the dried material, which is obtained after the removal of the bean and mucilaginous pulp from the cocoa fruit. It has been reported that CPH contains sufficient content of utilizable nutrients, with an energy content of 8.4 KJ/g ME and this could be used as livestock feed (3). The by-product has been extensively used for ruminant feeding (18) and to a limited extent for poultry (19, 20). Barnes *et al.* (8) and Fleischer *et al.* (13) have reported its very limited use in pig

[1] Department of Animal Science, University of Ibadan, Ibadan, Nigeria
[2] Cocoa Research Institute of Nigeria, (CRIN), P.M.B. 5240, Ibadan, Nigeria.
[3] Hope Farm, Ogunaike Agricultural Enterprises, Ibadan, Nigeria.
* Corresponding author (Email: eaiyayi@skannet.com.ng)
Received on 14.11.00. and accepted for publication on 20.04.01.

feeding. The crude fiber content (21.49 - 34.82%) (1, 20) discourages its high inclusion in non-ruminant diets. There is therefore a need to subject the CPH to further processing treatment to improve its digestibility. This on-farm study investigated the effect of diets containing treated or untreated CPH in comparison with a control and the farmer's diet on the performance of growing pigs.

Material and methods

Animals and location

The study was carried out in Hope Farms, one of the largest livestock farms in Ibadan municipality, South Western Nigeria. The farm is situated about 10 kilometers from the University of Ibadan. Thirty-two Large White and Landrace pigs (16 males and 16 females) with average initial weight of 15.98 ± 0.31kg were used. Each animal was numbered for easy identification.

Untreated CPH

Cocoa pod husk was collected after the beans have been extracted from the fruit. They were cut into pieces, sun dried on concrete floors for about seven days and then milled with a resultant characteristic brown colour.

Urea Treated Cocoa Husk

One kg of urea was dissolved in 25 litres of water. The resulting solution was mixed with CPH on v/w basis. Twenty-five litres of urea solution was mixed with 25 kg of CPH. The urea-mixed CPH was kept in thick polythene bags, tied firmly to eliminate air pockets and kept under shade for 2 weeks. After two weeks, the sheets were uncovered and the urea treated meal removed and sun dried for about two to four days. Properly dried urea treated meal had a brownish colour.

Experimental diets and design

Four diets were formulated on a dry matter basis as shown in Table 1. Control (Diet 1) had 250 g/kg maize, diet 2 had 250 g/kg urea untreated CPH and 100 g/kg maize. Diet 3 had 250 g/kg urea treated CPH with 100 g/kg maize. Diet 4 was the farmer's diet and had neither maize nor CPH. The diets were almost iso nitrogenous and iso-energetic. Each dietary treatment had eight growing pigs with four replicates of two animals (1 male + 1 female) per replicate. Thus, the animals were distributed to the treatment diets in a randomized complete block design. The pigs were fed *ad libitum* and they had unrestricted access to water.

Carcass analysis

At the end of twelve weeks, the animals were killed in a standard slaughter abattoir. They were starved of food for 24 hrs priors to slaughter but had access to drinking water. The internal organs were quickly excised and weighed, and the eviscerated carcass weights were recorded. The carcass was divided into two longitudinal halves thereafter. Carcass length was measured from the left half and cuts obtain from each half. Weights of lean cuts (ham, loin, picnic shoulder, and boston butt) were recorded in addition to belly and sparerib according to the technique of Aduku and Olukosi (4). All weights were expressed as percentages of carcass weight.

Table 1
Gross composition of experimental diets

	Diet			
g/kg	1	2	3	4
Untreated CPH*	-	250	-	-
Urea treated CPH*	-	-	250	-
Maize	250	100	100	100
Maize offal	220	220	220	220
Wheat offal	250	250	250	250
Wheat dust	-	-	-	-
Flour wheat/dust	-	-	-	-
Cotton seed meal	50	50	50	50
Groundnut cake	100	100	100	100
Palm kernel cake	100	-	-	-
Biscuit dust	-	-	-	-
Oyster shell	10	10	10	10
Bone meal	14	14	14	14
Premix	1	1	1	1
Methionine	-	-	-	-
Lysine	-	-	-	-
Antibiotics	-	-	-	-
Salt	5	5	5	5
Total	1000	1000	1000	1000
Analysed nutrient composition of diets				
Crude protein (g/kg)	167.2	168.2	166.7	176.0
Crude fiber (g/kg)	74.8	77.3	77.3	31.8
Energy (KJ/g)	9.55	9.66	9.66	9.88
Ether extract (g/kg)	41.5	32.0	32.0	34.1
Calcium (g/kg)	09.5	10.0	10.0	11.7
Phosphorus (g/kg)	03.8	04.0	04.0	04.5

* CPH : Cocoa Pod Husk

Chemical analysis and statistical treatment

Proximate composition of cocoa husk and diets was determined using analytical methods of AOAC (2). Statistical analysis was carried out using the ANOVA technique of Steel and Torrie (1960) and paired means were separated by the Duncan multiple range test (1955).

Results and discussion

Chemical composition of urea-treated and untreated CPH

The chemical composition of CPH (treated and untreated) is presented in Table 2. Moisture content and dry matter values were similar for urea-treated and untreated CPH. Values for moisture were low when compared to 86.30 - 88.53% reported in other studies (5, 19). However, results from this study were on a dry matter basis. Sun-drying led to a marked reduction in moisture content.

Table 2
Proximate chemical composition of cocoa husk (g/kg DM)

	Cocoa pod husk	
	Untreated	Urea treated
Moisture (g/kg)	80.0	80.0
Dry matter	920.0	920.0
Crude protein	60.2	90.8
Crude fibre	230.0	210.0
Ether extract	15.0	15.0
Ash	63.0	87.5
Nitrogen free extract	551.80	566.7

The crude protein of 6.02% for untreated CPH was close to 6.08% obtained by Sobamiwa (19), and is within range of 4.6 - 8.11% observed from other studies (6, 18). The value of crude protein for urea treated CPH (908 g/kg) was high. This value represents about a 51% increase in crude protein from the value obtained for untreated CPH. Our results agree with the observation of Sundstol *et al.* (21) who obtained an increase in the crude protein level of straw after being treated with urea. Ammonia as a gas or generated from urea (by bacterial and plant ureases in the ensiling process) hydrolyses the chemical/physical bonds between lignin and cellulose and hemicellulose in the plant cell walls. This also accounted for the reduction in crude fibre value of the urea treated CPH. However, it is pertinent to add that the reports of Chesnot and Kayouli (1997) showed that the additional proteins present in the urea treated diet do not supply amino acids to a monogastric. This nitrogen comes from the remaining urea and the ammonia trapped in the CPH fibres. Ruminants can utilize this protein for production of microbial protein and subsequently growth. But in monogastrics it is very little of this process that takes place in the hindgut with production of volatile fatty acids (VFA) which can increase supply in metabolisable energy.

Performance

Feed intake (FI), weight gain (WG), efficiency of feed utilization (EFU) and feed conversion ratio (FCR) results are shown in Table 3. There was no significant effect ($P > 0.05$) on the daily feed intake across the diets. But daily weight gain differed significantly ($P < 0.05$). Urea treatment of the CPH resulted in a significantly higher weight gain ($P < 0.05$) of animals on such diet over those on the untreated CPH and farmer's diet owing largely to better feed conversion ratio. Urea treatment has been shown to increase total nitrogen content of treated fibrous material while lowering lignin (15, 16). Increase in nitrogen and decrease in lignin contents may be viewed as an important development in enhancing the nutritive value of CPH when treated with urea because the formed N-compounds have a positive effect on the quality of the feed. Similar results have been reported by Sobamiwa and Longe (20) with growing pullets. The probable conversion of VFA from urea treated CPH, produced by microbial action in the hindgut, to metabolisable energy is a major advantage of treating CPH with urea. The physiological explanation for a positive effect of the remaining N (Chesnot and Kayouli, 1997) on monogastric performances is not evident. However, urea treatment confers improved digestibility on fibrous materials (20) and according to results of the present study, (Table 2) the carbohydrate fractions are also increased (551.8 to 566.7 g/kg) leading to an increase in supply of metabolisable energy as earlier explained.

Table 3
Performance of growing pigs on experimental diets

	Diet				
Parameters	1	2	3	4	SEm
Daily weight gain (kg)	0.45a	0.38b	0.42a	0.37b	+0.01
Daily feed intake (kg)	1.96	1.83	1.81	1.98	+0.08
Feed conversion ratio	4.36	4.79	4.30	5.39	+0.02
Efficiency of feed					
Utilization	0.23	0.21	0.19	0.19	+0.02

Note: Values without same superscript on same row are significantly different ($P < 0.05$).

Carcass measures

Slaughter weight, carcass weight, carcass length, dressing percentage, backfat thickness and cut parts are shown in Table 4. Warm dressing percentage and carcass length were not significantly influenced by dietary treatments. This agrees with previous findings of Babatunde *et al.* (7). Backfat thickness was significantly reduced ($P < 0.05$) by CPH diets. Treatment with urea had no significant ($P > 0.05$) influence on the backfat thickness. Carcass weight and backfat values have been shown to be significantly correlated to percentage carcass lean (17).

Carcass cuts

Carcass cuts as percentages of total carcass are shown in Table 4. There was no significant ($P > 0.05$) difference in the weight of the cut parts of animals due to dietary treatments. There was a tendency for pigs with lower slaughter weights to have lower percent loin, picnic shoulder and boston butt. This is contrary to findings that suggest an increase in lean content of carcass at a lower slaughter weight (14). However, in this study differences in slaughter weights were minimized. The lower voluntary feed intake of pigs on diet 3 and increased dietary crude protein accruing from urea-treatment suggests leanness. However, it must be noted that the high percentage of belly obtained for pigs on diet 3 suggests these pigs tended to be fatter than pigs on the other diets. The disparity between low backfat values and fatness could suggest that linear measurements of subcutaneous fat thickness may not accurately predict overall carcass fatness (12). In addition, deposition of internal fat and the development of subcutaneous fat in pigs are governed by different physiological and genetic factors (10).

Table 4
Carcass measures of experimental pigs

Parameters	Diet 1	2	3	4	SEm
Slaughter weight (kg)	60.75	58.50	57.00	52.00	±1.6
Carcass weight (kg)	43.8	40.75	39.00	36.50	±1.3
Dressing (%)	71.99	69.51	68.39	70.15	±0.65
Carcass length (cm)	70.80	69.00	65.00	63.00	±1.55
Backfat thickness (cm)	2.70[a]	2.10[b]	1.80[b]	2.30[a]	±0.18
Ham (cm)	25.12	27.12	25.12	26.48	±0.50
Lion (cm)	7.63	6.04	5.22	6.26	±0.43
Boston butt (cm)	10.11	10.68	9.80	11.95	±0.41
Picnic shoulder (cm)	14.99	11.68	12.42	12.99	±0.61
Fore lean cut (cm)	57.84	56.11	50.78	57.34	±1.40
Spare rib (cm)	10.75	11.04	9.52	9.98	±0.90
Belly (cm)	8.93	7.58	8.10	8.83	±0.26

[a, b] Treatment means with same letters on the same horizontal lines are not significantly different (P> 0.05).

Conclusion

Results of cocoa pod husk inclusion in growing pig rations showed favourable performance and good carcass quality in comparison with maize and wheat based rations. It is recommended that untreated CPH be included at 25 g/kg. Urea treated CPH can be included at levels higher than 250 g/kg diet because treatment of CPH may give lower feed cost per gain. In addition, urea treatment will change the cell wall architecture of the CPH enabling gut enzymes to reach the high amount of water carbohydrate compounds present in the CPH. It is predictable that fibres from CPH treated with urea will be more digested in the hindgut of pigs, supplying more VFA but nevertheless no increase in protein availability should be expected. Finally techniques for crude fibre breakdown in CPH need to be established leading possibly to increased inclusion level of the by-product.

Literature

1. Abiola S.S. & Tewe O.O., 1990. Chemical evaluation of cocoa by-products. Trop. Agric., Vol **68** (4): 335-336
2. A.O.A.C., 1990. Official Methods of Analysis (15th ed). Association of Official Analytical Chemistry (AOAC), Washington D.C.
3. Adeyanju S.A., Ogutuga D.B.A., Sonaiya E.B. & Eshiett N., 1977. Performance of chicks on diets containing graded levels of cocoa husk. Nutr. Rep Int., 15: 165-170.
4. Aduku A.O. & Olukosi J.O., 1991. Animal Products: Processing and Handling in the Tropics. Living Books Series, GU Publications, Abuja, 264p.
5. Alhasan W.S. & Naawu R.B., 1982. Studies on the use of cocoa by-products in animal feed. 1. Responses of weanling rats no various levels of cocoa pod husk. Turrialba, 32: 214-216.
6. Asonibare M.M., 1984. Replacement value of cocoa husk in grass silage in sheep and goat nutrition. M.Sc. Thesis. Dept. of Animal Science, University of Ibadan, Nigeria.
7. Babatunde G.M., Fetuga B.C., Oyenuga V.A. & Ayoade A.. 1975. The effects of brewers dried grains and maize cobs in the diets of pigs on their performance characteristics and carcass quality. Nig. Journal of Anim. Prod. **2** (1): 119-133.
8. Barnes A.R., Amega W.K., Manu M. & Rhule T., 1985. Utilization of cocoa husk meal by growing finishing pigs. 9th International Cocal Research Conference, Lome, Togo, 1984, pp 449-454, Cocoa Producers Alliance, Lagos.
9. Chandra S. & Fuller M.F., 1979. Pig Production in the Tropics. Oxford Tropical Handbooks, Oxford University Press.
10. Duniec H.I., Hielanowski J. & Osinska Z., 1961. Variability of chemical fat content in the loin muscle of baconers. Amin. Prod. 3: 195-201.
11. F.A.O. (1982). Production Year Book Vol **35**, Rome, Italy.
12. Fetuga B.L. Babatunde G.M. & Oyenuga V.A., 1976. Association among some carcass traits in three weight groups of pigs. Nigerian Journal of Amin. Production 2: 2-6.
13. Fleischer J.E., Barness A.R., & Adamako D., 1991. Determination of digestible crude protein, digestible energy and metabolisable energy of cocoa pod husk by pigs. Bulletin of Animal Health and Production in Africa. **39**. (1), 83-87.
14. Fowler V.R., 1976. Some aspect of energy utilization for the production of lean tissue in the pig proc. Nutr. Soc. 35: 75-90.
15. Khan M.F., Ali A. & Muller Z.O., 1992. Nutritional evaluation of sugarcane bagasse based rations treated with urea and cattle manure. Anim. Feed Sci. Technol. 38: 135-141.
16. Niazi A.H.K., Kausar T. Salariya A.M. & Hashmi, A.B., 1994. Effect of ammonia and urea treatment on *in viro* digestibility of mustard seed hulls. Pak. J. Sci. Ind. Res., 37: 43-45.
17. Pertricavic C.A., Krahk G., Gutymirth D., Meltar T., Layelhos J. & Ksapic, A., 1994. Evaluation of the meatiness of pig carcass and relationships between carcass quality traits. Zamost I Praska u polyoprioredi I Preparmbenoj technologiji **24** (1): 67-78, Paper presented at 2nd international Symposium (Animal Scientific day.) Rosipji, Croatia. 21-23 September, 1994.
18. Smith O.B. & Adegbola A.A.. 1995. Studies on the feeding value of agro-industrial by-products III. Digestibility of cocoa pod based diets by ruminants. Anim. Feed Science Technol. 13: 249-254.
19. Sobamiwa O. 1992. Utilization of cocoa pod husk as a broiler feedstuff. PhD. Thesis, University of Ibadan.
20. Sobamiwa O. & Longe O.G., 1994. Utilization of cocoa pod husk pericarp fractions in broiler chick diets. Anim. Feed Sci. Technol. 47: 237-244.
21. Sundstol F., Coxworth E. & Mowat D.N., 1978. Improving the nutritional quality of straw and other low quality roughages by treatment with ammonia. World Animal Review, 26: 13-21.

E.A. Iyayi: Nigerian, PhD, Senior Lecturer, Department of Animal Science, University of Ibadan, Ibadan, Nigeria.

O. Olubamiwa: Nigerian, PhD, Assistant Chief Research Officer. Crop Processing and Utilization Unit, Cocoa Research Institute, PMB 5244, Ibadan, Nigeria.

A. Ayuk: Nigerian, M.Sc. Department of Animal Science, University of Ibadan, Ibadan, Nigeria.

S. Orowvegodo: Nigerian, M.Sc., Department of Animal Science, University of Ibadan, Ibadan, Nigeria.

E.F. Ogunaike: Nigerian, Managing Director & Chief Executive, Hope Farm, Ogunaike Agricultural Enterprises, Ibadan, Nigeria.