COMPARATIVE ENERGY VALUES OF SORGHUM DISTILLERS WASTE, MAIZE COB AND SHEA BUTTER WASTE FOR PIGS.

BOLU, S.A. AND BALOGUN, O.O.

Department of Animal Production, University of Ilorin, Nigeria.

Received 02 February 1998; Accepted 13 September 1998

ABSTRACT

A balance trial aimed at determining the energy values of Sorghum Distiller's Wastes (SDW), Maize cob (MC) and Shea butter Waste (SBW) for barrows was conducted using a 4 x 4 Latin square cross- over experimental design. While feed intake was influenced ($P<0.05$) by the test feed ingredients, the weight gained was not significantly affected ($P>0.05$). Digestibilities of dry matter and gross energy (GE) as well as metabolizability of digestible energy (DE) were not influenced ($P>0.05$) by the dietary treatment. The energy values (i.e. GE, DE, uncorrected metabolizable energy (ME), and metabolizable energy corrected for nitrogen retention (MEn) determined for the ingredients were different ($P<0.05$). DE values of 7.19, 6.73 and 15.54 MJ/kg DM; ME values of 5.90, 4.79 and 12.94 MJ/DM dm and MEn values of 5.72, 4.95 and 12.90 MJ/kg DM were established for SDW, MC and SBW respectively. These ingredients have potentials as alternative low-energy feedstuffs in pig feeds.

Keywords: Energy value, sorghum distillers waste, maize cob, shea butter waste, pigs.

INTRODUCTION

The keen competition existing between the agro-allied industries, general populace and livestock farmers in Nigeria for the much needed cereals has curtailed the availability of livestock products. Maize has formed the major energy source for sometime in rations for monogastric in Nigeria because other energy sources do not support similar performances of the animals when maize is totally eliminated. Sonaiya (1986) observed faster growth rate for cockerels fed 64% maize inclusion level. Longe (1986) also observed that broiler performance was negatively affected when biscuit waste was substituted for maize at 100% inclusion level.

Owing to the high cost of maize and other conventional feed ingredients, the need to source for locally available industrial "wastes" or by products to serve as cheaper substitutes for the cereals and other conventional feedstuffs can not be over-emphasized. Fetuga *et al.,* (1985) however, noted that before the use of these non-conventional feedstuffs can become effective, adequate research must be conducted to optimize their tolerable inclusion levels and allay all possible defects that might accrue in the course of feeding them to livestock.

This study aimed at determining the feeding and energy values of some common locally available and cheap agro-industrial by-products viz Sorghum Distillers' waste (SDW) (Burukutu), Maize Cob (MC) and shea butter waste SBW for pigs. Some of these ingredients had been the subject of nutritional studies in livestock species in the last two decades, (Dogari, 1978; Morgan and Trinder, 1981; Labiran 1985).

MATERIALS AND METHODS

The minerals used in this study were all collected from Ilorin, in Kwara State, Nigeria. Sorghum Distillers' waste was collected from a local distiller. The processes involved in the production of the local liquor include, soaking, grinding, cooking, saccharification, fermentation and distillation. This material was found to contain a mixture of fermentation residues, cracked and whole grains. This sample was air-dried and ground to appropriate particle size (1mm sieve) before use in feeding. The shea butter cake was collected from the store of the Presidential Task Force on alternative formulation for livestock (PTF) Niger River Basin, Ilorin in the dried form. It is a by-product of oil

TABLE 1: COMPOSITION OF EXPERIMENTAL DIETS (KG/100KG)

Item	Diets 1	2	3	4
SDW	97.70	-	-	-
MC	-	20	-	-
SBW	-	-	20	-
**Basal Diet	-	80	80	100
Salt	0.50	-	-	-
Bone meal	1.50	-	-	-
*Vit. Min. Premix	0.10	-	-	-
Total	100	100	100	100

*Contained (per Kg diet):

Retinol, 8000 I.U.; Cholecalciferol, 1,500,000 I.U.; Vit E 3,00g; Vit. K 3,000g; Riboflavin, 2.50g; Nicotinic acid. 8.00g; Ca- Pantothenate, 3.00g; Pyridoxine, 0.30g; Vit. B12, 8.00g; Manganese, 10.00g; Iron, 5.00g; Zinc, 4.50g; Copper, 0.20g; Iodine, 0.15g; Cobalt, 0.02g and Selenium, 0.01g.

** Analyzed nutrient content

Crude protein (%), 16; D.M (%), 89.6; Ash, (%) 3.95; crude fibre, 5.30; Ether extract, 2.51.

extraction from shea butter seeds. This material was further ground after acqusition (1mm sieve) and before incorporation into the test feed. Maize cob was collected from the threshing flour of Kwara Agricultural Development Project (KWADP), Ilorin. The cobs were air-dried and later ground (1mm sieve) before incorporation as feed ingredient. The basal diet was collected from the stores of the Presidential Task Force on Alternative Feed Formulation for livestock (PTF). It was also used as a control diet.

Experimental Design

Four (4) large white - Landrace cross-bred barrows weighing approximately 13.50±2.50kg at 5 weeks of age were used in this study. The pigs were allocated to a 4 x 4 Latin square "cross- over" design.

Feeding and Management

The pigs were placed separately in metabolism cages to aid easy and separate collection of urine and faeces. They were acclimatized to the cage and experimental conditions for 3 weeks during which standard commercial diets were given. Each experimental period consisted of five (5) days of adjustment to the new diet followed by a four-day collection period during which there was a total but separate collection of the urine and faeces. The diets were then "crossed over" and given to another pig until each had a taste of the four (4) diets. The barrows were fed twice daily (approx 0800 and 1600 hrs) at a controlled rate of 4% body weight (0.8 kg/day). The rations were gruel-fed for better consumption (0.8 kg in 250ml of water). Additional water (1.2 litres/day) was provided after each feeding. The composition of the experimental diets is as shown in Table 1.

Collections

Daily records of feed intake was recorded using chromic oxide as marker (Fraichney, 1980) as an indication of the onset and termination of each collection period. The faecal samples collected were oven-dried at 70°C for 24 hour; they were weighed and stored in a polythene bag and kept at -4°C in a deep freezer.

The urine was collected in vessels containing 5ml of 0.05M Hydrochloric acid as preservative. The total volume voided was recorded on a daily basis and 5% aliquot was accumulated and stored at 4°C in a deep

freezer pending analysis. Weight gained on each diet was recorded as the cumulative weight gained during each of the periods the diets were fed to the different pigs.

Analysis

The proximate compositions of the ingredients and diet were determined according to AOAC (1980) procedures. Gross energy was determined using the Ballistic Bomb calorimeter. The energy values of Sorghum Distillers' Waste was determined using the following equations employed by NRC (1979):

DE = GE (feed) - GE (faeces)

ME = DE - GE (urine)

where GE = Gross energy, MJ/KG

DE = Digestible energy, MJ/kg

ME = Metabolizable, MJ/kg

While the energy values of maize cob and shea Butter waste were determined according to the indirect method described by Crampton and Harris (1969):

$$S = \frac{10\,(T - B) + B}{C}$$

S = Energy value of test ingredient

T = Energy value of Basal + Test ingredient

B = Energy value of Basal diet

C = Level of supplementation of test ingredient in the diet

The data for each response criterion were subjected to analysis for indirect digestibility as outlined by Crampton and Harris (1969). The differences in the analysis was informed by the inclusion levels. Sorghum Distillers Waste can be fed at about 70% without detrimental effect on the health and well being of the animal, whereas, shea butter waste and maize cob can not be fed at such levels. The difference between treatment means for each response criterion was determined using Duncan New Multiple Range test according to Steel and Torrie (1980).

Routine Operation

Metabolism Cages, piggery unit and animals were washed every other four (4) days with water containing calculated concentration of IZAL, a disinfectant to reduce the incidence of flies, vector insects and pathogens invasion. Since there was no allowance for wallowing, pigs were occasionally sprinkled with water and the floor of the pen covered with water to produce indirect evaporative cooling effect on the pigs.

RESULTS AND DISCUSSION

The proximate composition of the test ingredients and diets are presented in Tables 2 and 3 respectively. The results observed differed from previously reported values for these ingredients. The crude protein determined for SDW was higher than 22.01% reported by Dogari (1978) but the gross

TABLE 2: ANALYSED NUTRIENT CONTENT OF THE TEST INGREDIENTS (DM BASIS)

Item	SDW	MC	SBW
Dry matter (%)	91.50	93.80	96.83
Crude Protein (%)	24.63	2.02	16.47
Crude fibre (%)	7.87	28.61	10.60
NFE (%)	45.19	57.87	60.13
Ash (%)	8.48	4.54	1.55
Ether Extract (%)	5.33	0.80	15.45
GE, MJ/kg	16.56	14.05	18.03

TABLE 3: ANALYSED NUTRIENT CONTENT OF THE EXPERIMENTAL DIETS DM BASIS

	Diets			
Item	1	2	3	4
Dry Matter (%)	93.43	93.53	94.50	94.00
Crude Protein (%)	17.88	12.47	24.94	19.68
Ether Extract (%)	6.20	8.10	14.40	10.57
Crude fibre (%)	9.26	36.40	8.10	3.56
Ash (%)	10.30	6.20	2.40	1.78
NFE (%)	49.79	30.36	43.66	56.39
GE (MJ/kg)	16.53	16.21	17.87	15.27
Sample size	4	4	4	4

TABLE 4: DIGESTIBILITIES OF DRY MATTER AND ENERGY (%) AVERAGE LIVE WEIGHT GAINED AND ENERGY VALUE OF THE BY-PRODUCTS

Item	Ingredients		
	SDW	MC	SBW
DM Digestibility (%)	81.34	78.18	73.61
Daily DM intake (g)	575a	606a	670b
Average weight gain (g)	3.24	3.20	3.25
G.E. Digestibility (%)	65.33	62.79	62.97
Daily Absorbed Energy (MJ/kg DM)	7.49a	7.93a	9.43b
Daily Retain Energy (MJ/kg DM)	6.06a	6.14a	7.51b
Digestible Energy (MJ/kg DM)	7.19a	6.73a	15.54b
Metabolizable Energy (MJ/kg DM)	5.90a	4.79a	12.94b
Metabolizable Energy corrected for Nitrogen Retention (MJ/kg DM)	5.72a	4.75a	12.90b
Metabolizability of DE (%)	82.13	71.18	83.37
Sample size	4	4	4

a,b,c = Means having different superscripts within each row differ significantly ($P < 0.05$)

energy values were comparable. Generally, the crude fibre content of these ingredients was high. This tend to support earlier reports that a militating factor in the use of agro-industrial by-products in livestock feeds is the high fibre content which tends to reduce their feeding value through impaired nutrient digestibility (Fetuga, *et al.*, 1985).

The daily dry matter intake (Table 4) was influenced ($P < 0.05$) by the diets fed. This seems to imply differential acceptability of the various diets by the animals. Diets containing SBW was preferred ($P < 0.05$) to the other diets. This observation agrees with earlier reports by Babatunde *et al.*, (1975) that pig combats low digestibility of crude fibre by increasing their feed intake to compensate the low energy values of the diets especially when fed *ad libitum*. Expectedly, the dry matter intakes for SDW and MC with correspondingly higher crude fibre content was higher than for SBW. The consequence of this high dry matter intake as it relates to fibre is that it results in good carcass quality, (Babatunde *et al.*, 1974) and also increases stool weight, consistency and shortened feed transit time in the gut (Pond, 1981).

The energy values (Table 4) were significantly influenced ($P < 0.05$) by the various dietary treatments. The high GE value (although not a response criterion) reported for SBW (18.30 MJ/Kg) could be explained in accordance with the observation made by Fetuga *et al.*, (1985) that variability in batch chemical composition and efficiency of extraction method employed, will affect the energy value of most seed cakes, because the level of residual oil resulting from inefficient oil extraction of the various methods. The shea butter seed (45 - 60% EE) was hand pressed to extract the oil leaving an appreciable amount of oil in the cake. The ME (MJ/kg) was found to be positively related to DE (MJ/kg) (x) for the ingredients by the following established equations:

SDW

ME (MJ/kg) = 0.4556 + 0.760 DE (MJ/kg), r = 0.74

MC

ME (MJ/kg) = 0.198 + 0.961 DE (MJ/kg), r = 0.99

SBC

ME (MJ/kg) = -0.1136 + 0.84 DE (MJ/KG), r = 0.99

The energy values obtained were at

variance with earlier report for the ingredients. Fetuga *et al.*, (1985) reported a GE of 16.74 MJ/kg for maize cob. The ME values of 5.92 MJ/kg determined for SDW is lower than values earlier reported by Ewan, (1976). Dogari (1976) reported ME value of 7.4 MJ/kg for broiler chicks fed diets containing SDW while Ewan, (1976) reported ME value of 2.96 MJ/kg for the same material using pigs, this tends to further buttress the fact that different animals exhibit variable digestibilities for the same ration (Crampton and Harris, 1969).

The feeding values (nutrient digestibilities) observed were not influenced ($P>0.05$) by the various dietary treatments (Table 4). The apparent digestibilities of dry matter and GE was higher for SDW than for the other ingredients. This observation is in agreement with earlier reports of Ewan (1976) that incomplete hydrolysis of the sorghum or distiller's grains highly improved feeding values owing to residues of whole, cracked grains and fermentation residues. The least digestibility of GE of 62% for MC can be associated with its high crude fibre level reported to depress average daily gain consequent to reduction of digestibility and availability of nutrients (NRC, 1979). However, Pond (1981) and NRC (1979) reported that pig can tolerate wide levels of crude fibre in their diets if the digestible energy is sustained or held constant by the inclusion of high energy feedstuff. Under such condition, it was observed that fibre inclusion level exerts little effect on the rate or efficiency of gain or leanness of carcass.

The inclusion levels (Table 1) of the ingredient seem to be realistic for this class of animal. The inclusion of sorghum distillers' waste at 20% was reported optimum for growing- finishing pigs and that higher inclusion level will not depress growth if sulphur containing amino acid e.g. methionine is added to improve the amino acid profile. Pond *et al.*, (1981) also demonstrated that dietary inclusion of sorghum or distiller's dried grains 44.7% as a substitute for soybean and maize in gestating swine (Sorghum distiller's waste contributed 44% of the total metabolizable energy) did not affect weight gain or reproductive performance. Morgan *et al.*, (1981) recommended that shea butter cake (SBW) be included at an optimum level of 25% in pig ration. Babatunde *et al.*, (1975) recommended 10% as the best dietary inclusion level of maize cob for fatteners.

Conclusively, SBW and SDW would qualify as potential low-energy feed stuffs in compounded feeds for pigs. This is supporting the recommendation of Fetuga *et al.*, (1984) that the ability of pigs to utilize fibrous feeds be re-appraised since it has been long underestimated. Consequently, a balance should be reached between the economies of cost reduction by employing the use of cheaper by-products and growth depression resulting from such by- products when incorporated into livestock feeds.

ACKNOWLEDGEMENT

This research was funded by the Presidential Task Force on Alternative Feed Formulation for livestock.

REFERENCES

ASSOCIATION OF OFFICIAL ANALYTICAL CHEMIST, (1980). Official Methods of the AOAC, 13th ed. Assoc. of Anal. Chem. Washington D.C. pg 447.

BABATUNDE, G.M., FETUGA, B.L. OYENUGA, V.A. AND I.A.O. (1974). Effect of varying levels of fibre on performance characteristic, organ weights and carcass quality of pig in the tropic. *Nig. Agric. J.* Vol. II No. 3.

BABATUNDE, G.M. FETUGA, B.L. OYENUGA, V.A. AYOADE, A. (1975). Effects of graded level dried brewer's grain and maize cob in the diets of pigs on their performance characteristics and carcass quality. *Nig. J. Anim. Prod.* (2) 1: 119 - 133.

CRAMPTON, E.W. AND HARRIS, L.E. (1969). Applied Animal Nutrition, 2nd ed. W.H. Freeman and Co. San Francisco.

DQGARI, M. (1978). Evaluation of local sorghum beer residue in broiler chicks. M.Sc. Thesis. Animal Science department.

Ahmadu Bello University, Zaria, Nigeria.

ERICKSON, J.P., MILLER, E.R., BERGEN, W.G. AND ELLIOT, F.C. (1978). An evaluation of several winter selections of triticale as a source of protein and energy for weanling pig. *J. Anim. Sci.* 46: 417 - 424.

EWAN, R.C. (1976). Utilization of Energy feed ingredients by young pig. Proceedings of Distillers' feed Research Council Conference, 31, Pg. 16 - 21. Cincinati, Ohio.

FETUGA, B.L. AND TEWE, O.O. (1985). Potentials of Agro- Industrial by-products and crop residues as livestock feed components. *Nig. Food Journal 2:* 136 - 142.

FRAICHNEY, G.I. (1980). The use of marker to measure digesta flow from stomach of sheep fed once daily. *J. Agric. Sci.* Camb. 94: 313 - 318.

LABIRAN, A.A. (1985). The effect of maize cob on nutrient retention in broilers. B.Sc. Thesis. Dept. of Anim. Sci., Univ. of Ibadan, Nigeria.

LONGE, O. (1986). Replacement value of biscuit waste for maize in broiler diets. *N. J. Anim. Prod.* 13: 70 - 78.

MORGAN, D.J. AND TRINDER, H. (1981). The composition and nutritive values of some tropical and subtropical by-products. Occasional Publi. No. 3 *Bri. J. of Anim. Prod.*

NATIONAL ACADEMY OF SCIENCE/NATIONAL RESEARCH COUNCIL (1979) Nutrient requirements of domestic animals No. 2. Nutrient requirement of swine. Pg. 1599, Washington, DC. 1978. 8th Rev. ed.

SONAIYA, E.B. (1986). Live and carcass performance of cockerels raised to 16 weeks on two (2) caloric - protein rations. *J. Anim. Prod.* Res. 6 (1), 73 - 79.

STEEL, R.G.D. and TORRIE, J.H. (1980). Principles and Procedures of Statistics. A Biometrical Approach MC Graw-Hill Book Company. Kogakusha, Ltd. Japan 2nd ed P. 401 - 417.