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The Nutritive Value of African Oil Bean Seeds (*Pentaclethra macrophylla*)

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ABSTRACT

The nutritive quality of cooked, unfermented (UOB) and fermented (FOB) African oil bean seeds was evaluated by chemical analysis and animal assay.

The seeds were high in energy with a slight difference between the gross energy values of UOB and FOB. The estimated protein energy ratio (P^e%) and net dietary protein calorie percent (NDpCal %), showed that the two processed forms of the seed have the potential to satisfy human protein and energy requirements.

Rats fed diets containing UOB and FOB as the sole source of protein lost weight with a low feed intake resulting in negative PER values. These values were significantly ($P < 0.05$) inferior to the PER for the casein control.

The feed digestibility was 92·6% for UOB and 87·8% for FOB. The protein digestibilities of both test samples were low with that of UOB (80·0%) being significantly ($P < 0.05$) different from that of FOB (48·0%). Between the first and second week of the animal experiments, a 20% and 10% mortality was recorded for rats on diets containing UOB and FOB, respectively.

INTRODUCTION

Protein malnutrition, often coupled with caloric deficiency, is a critical and most prevalent form of malnutrition, especially in children in developing countries. In these parts of the world, which includes Nigeria, the available infant weaning foods are produced from such cereals as corn, sorghum and

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millet. The nutritive value of these cereals is limited because their protein is deficient in lysine and/or tryptophan. Adults also consume these cereals as their staple foods without any form of protein supplementation. Some workers (Okeiyi & Futnell, 1983) have proposed that the fight against malnutrition in developing countries should be based on the use of mixtures of cereals, legumes and oil seeds indigenous to that country. Fermentation processes have been used to upgrade the nutritive value of some protein foods including the oil seeds and some legumes.

This study was thus aimed at investigating the nutrient potentials, with special reference to the protein quality of fermented African oil bean seeds, for possible use as protein supplements, especially in cereal based foods.

MATERIALS AND METHODS

Materials

Mature freshly picked African oil bean seeds were purchased from the local markets in the Rivers State of Nigeria. Weanling albino rats, at 24-days old, were obtained from the University of Ife animal colony.

Methods

Preparation and fermentation of samples

The traditional method of fermentation, as practised in the Eastern States of Nigeria, was used. Undehulled seeds were boiled for 12 h. The boiled seeds were allowed to cool; the seed-coats were removed with a sharp knife and the seeds washed. Some of the boiled seeds were cut into thin slices (about 4 × 0·2 cm) and boiled for a further 30 min. The product was drained, cooled and washed again. The sliced seeds were wrapped in dry heat-blanched banana leaves and left to ferment at room temperature (29–32°C) for 3 days. The fermented seeds were oven dried (60°C for 48 h) and milled to pass through a 40 mesh sieve. This product was designated as the fermented oil bean seed sample (FOB). The other fractions of the boiled washed seeds were oven-dried at 60°C for 48 h, after which the dry sample was milled to pass through a 40 mesh sieve. Oil from the sample was extracted with petroleum ether (BP 40–60°C) under reflux for 8 h to obtain defatted meals.

Energy determination

The gross energy of the samples was determined with a Gallenkamp oxygen adiabatic bomb calorimeter.

Proximate analysis

All the chemicals used were of analytical grade.

Moisture, fat, crude protein, and ash contents of the samples were determined using the standard methods of the AOAC (1984).

Biological assay

Based on the proximate analysis of the samples, test diets were formulated in accordance with the AOAC (1984) procedure for protein efficiency ratio (PER) determination. Each test material was included in its corresponding diet at the 10% level as the sole source of protein.

Sixty 24-days old weanling albino male rats were used and the experimental arrangement was a completely randomized design involving three (3) treatments consisting of the three experimental diets (UOB, FOB and the casein control diet (Table 1). These diets were fed to three assay groups in duplicates of ten (10) replicate rats individually housed in galvanised steel cages.

The PER study lasted 28 days. The digestibility studies were started on the 14th day of the PER study and lasted for 7 days. From the data collected

TABLE 1
Composition of Basal Diet for PER

Ingredients	*Amount* (%)
Protein	10
Corn oil	8
Salt mixture[a]	5
Vitamin mixture[b]	1
Non-nutritive fibre (Cellulose)	1
Cassava starch	To make up 100

[a,b] Prepared by F. Hoffman-La Roche & Co. Ag., Basel, Switzerland based on formulation by Clarke *et al.* (1977) for laboratory animals.

[a] Salt mixture composition (content/kg): Calcium, 6 g; chloride, 5 g; copper, 10 mg; iodine, 0·2 mg; iron, 100 mg; magnesium, 2·0 g; manganese, 75 mg; phosphorus, 5 g; potassium, 5·0 g; sodium, 5 g; zinc, 18·0 mg.

[b] Vitamin mixture contained (International Units, IU, or mg or μg per kg of diet); Vitamin A 7000 (IU); Vitamin D 300 (IU); Vitamin E 60 (IU); Vitamin K 2·9 (mg); Thamine, HCl 4·00 (mg); Riboflavin 5 (mg); Pyridoxine HCl 6 (mg); Niacin 10 (mg); Pantothenic acid 12·0 mg; Cyanocobalamin (B_{12}), 5·0 (μg).

(AOAC, 1984) the PER, feed and protein digestibility and feed conversion efficiency were calculated.

RESULTS AND DISCUSSION

Energy studies

Table 2 shows the gross energy values, the protein-energy ratio (P^e%) and the net dietary protein calorie per cent (NDpCal %) of the test samples. They were calculated using the method of Miller & Payne (1961). There was not much difference between the values in P^e%. There was, however, an appreciable difference in the NDpCal % values.

The determined gross energy values in this study were similar to the values (6·26 kcal g^{-1}) obtained by Kamel *et al.* (1982) for pumpkin seeds. A gross energy value (5·0 kcal g^{-1}), obtained by Longe *et al.* (1983) for cooked defatted fluted pumpkin also compared favourably with those in this study.

The high energy content of the samples is noteworthy as protein utilization and energy intake are closely inter-related. If energy intake is seriously inadequate, it is unlikely that protein would be effectively utilized by the body.

Although the recommended 'safe' P^e% values are 11 and 12 for a protein utilization of about 60% (Beaton & Swiss, 1974) the values obtained in this study are higher. This demonstrates that the protein concentration in terms of energy of the samples is adequate.

The NDpCal % values were also above the recommended value of 8 (Araya, 1980) which is the equivalent of that of human breast milk and considered optimal for the human infant. Okeiyi & Futnell (1983) obtained NDpCal % values of 10 and above in their study of formulated cereal and legume mixtures for child-feeding.

NDpCal % is often adjusted upwards for lesser quality proteins, such as

TABLE 2
Energy Values of Fermented and Unfermented Oil Bean Seeds. (kcal g^{-1}) (Dry Matter)

Sample	*Gross energy (determimed)*	*Gross energy (calculated)*	P^e%	*NDpCal* (%)
UOB	6·67	5·44	29·3	10·5
FOB	6·48	5·54	29·4	15·0

P^e% = Concentration of protein in terms of energy.
NDpCal = Utilizable protein calories (Miller & Payne, 1961).

vegetable proteins. It has also been shown (Bodwell *et al.*, 1981) that individuals with high protein requirement and young children recovering from protein-energy malnutrition would benefit from levels significantly above the recommended NDpCal % level of 8.

Proximate analysis

Table 3 shows the proximate composition of the samples.

All the test samples contained high amounts of protein (UOB, 39·8%; FOB, 40·7%) and the fat content was 36·3% for UOB and 38·6% for FOB.

There was a slight decrease in carbohydrate content of the fermented samples.

Animal assay

Weight gain

Figure 1 shows the average body weights of rats during the 28-day feeding trial while Fig. 2 shows the weekly variation in the weight gain. A continuous

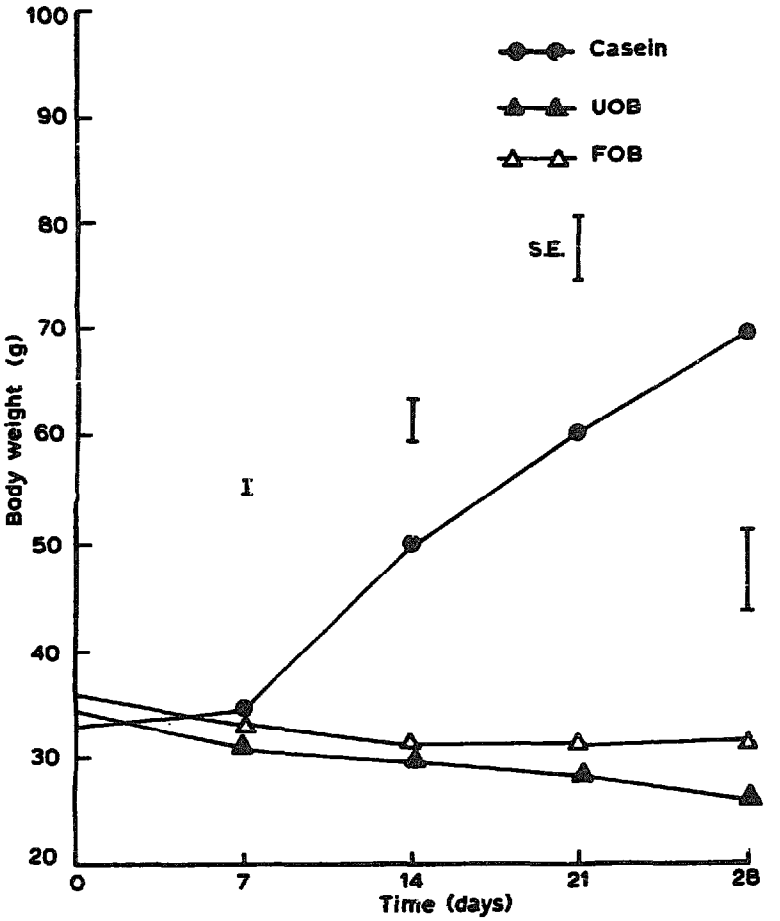

Fig. 1. Average body weight of weanling rats fed diets containing casein; unfermented oil bean (UOB) and fermented oil bean (FOB). (Vertical lines indicate ± SE between diets.)

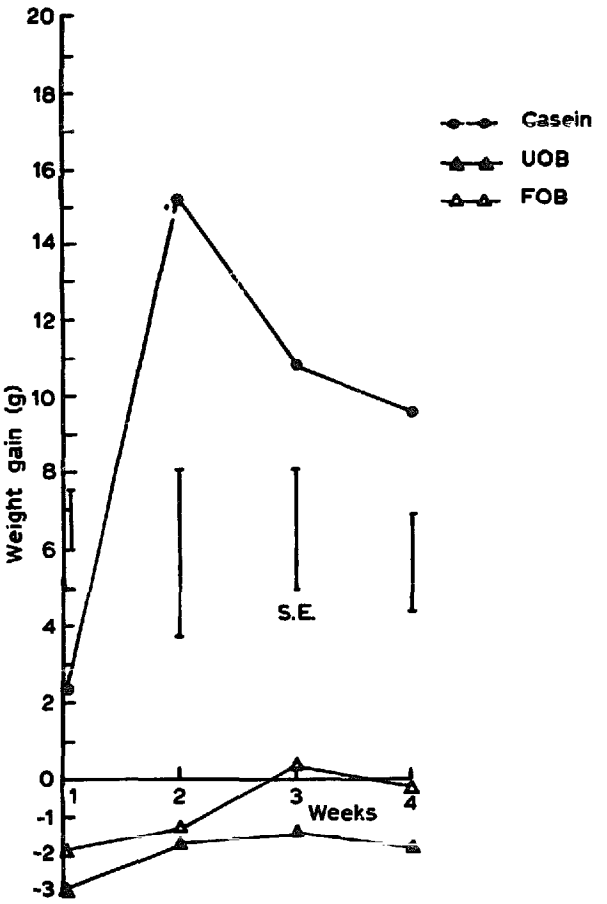

Fig. 2. Mean weekly weight gain of rats fed diets containing casein; unfermented oil bean (UOB) and fermented oil bean (FOB). (Vertical lines indicate ± SE between diets.)

depression in weight of rats fed UOB and FOB was observed from week 1 to the end of the experiments. The difference in the weights of rats fed the oil bean diets and those of rats fed the casein diet was highly significant ($P < 0{\cdot}05$).

Feed intake

The feed intake of rats fed the test diets decreased sharply between weeks 1 and 2 but the decrease was gradual after that (Fig. 3). There was a significant difference ($P < 0{\cdot}05$) between the feed intakes of rats on the casein diet and the two oil bean diets. The feed intake of rats fed the casein diet was the highest throughout the duration of the study. The observed low-feed intake of rats on UOB and FOB was probably due to unpalatability of the diets. The casein diet was probably more palatable; hence its high intake. Between the 1st and 2nd weeks of the animal assay, a 20% mortality of rats on diet UOB and 10% of those on FOB was recorded. No mortality was recorded for rats on the casein diet.

TABLE 3
Proximate Composition of Fermented and Unfermented Samples of African Oil Bean Seeds (% dry matter) ± SE[a]

Sample	*Moisture*	*Crude protein*	*Ether extract*	*Crude fibre*	*Total ash*	*Carbohydrate*[b]
UOB	2·42	39·9 ± 0·80	36·33 ± 0·50	3·56 ± 0·07	2·50 ± 0·80	15·3
FOB	3·90	40·7 ± 0·06	38·55 ± 1·47	2·51 ± 0·16	2·25 ± 0·2	12·1

[a] Mean of four determinations.
[b] By difference.

TABLE 4
Weight Gain, Feed Intake, PER, Feed Efficiency Ratio and Digestibility of Test Samples Fed to the Rats for 28 Days

Diets	*Average daily weight gain/loss (g)*	*Average daily feed intake (g)*	*P E R*	*Adjusted P E R*	*Feed efficiency ratio*	*Digestibility (%)*	
						Feed	*Protein*
Casein	1·35[a]	7·91[a]	1·76[a]	2·50	5·88	91·2[a]	82·7[a]
UOB	−0·82[b]	4·72[c]	−0·72[c]	−1·02	—	92·6[a]	79·9[a]
FOB	−0·11[b]	5·06[b]	−0·32[b]	−0·45	—	87·8[b]	48·0[b]

[a,b,c] Only means followed by different letters within columns differ significantly (Duncan's Multiple Range Test, $P < 0·05$).

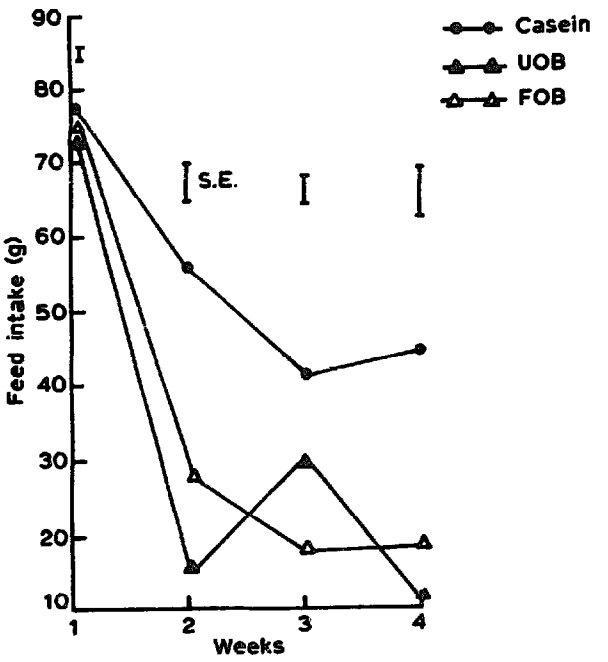

Fig. 3. Mean weekly feed intake of rats fed diets containing casein, unfermented oil bean (UOB) and fermented oil bean (FOB). (Vertical lines indicate ± SE between diets.)

PER, digestibility and feed efficiency ratio

The PER, digestibility and feed efficiency ratio of the test samples are given in Table 4. The difference between the PER values for UOB (−0·72) and FOB (−0·32) was significant ($P < 0·05$). The difference between UOB, FOB and the casein was also significant ($P < 0·05$). The trend observed in the weekly variation in the PER (Fig. 4) values is similar to that of the weight gain and feed intake. The continuous weight loss and low feed intake resulted in low protein intake, giving negative PER values for FOB and UOB.

The feed efficiency ratio (PER) was 5·88 for the casein diet, but this could not be calculated for UOB and FOB because their consumption by the rats resulted in weight loss rather than weight gain.

The apparent digestibility values were low for the test diets with those of FOB being significantly ($P < 0·05$) lower than those of UOB and casein. There was no difference in the values obtained for casein and UOB.

The results of this study demonstrate that, though the oil bean seeds are rich in protein (Achinewhu, 1982), they suffer some nutritional drawbacks. The seeds could not promote or maintain growth of rats. The poor performance of rats fed the test diets may not be due to inadequacies in amino acid composition or the overall poor digestibility but most probably the presence of toxic components in these seeds. The presence of toxic

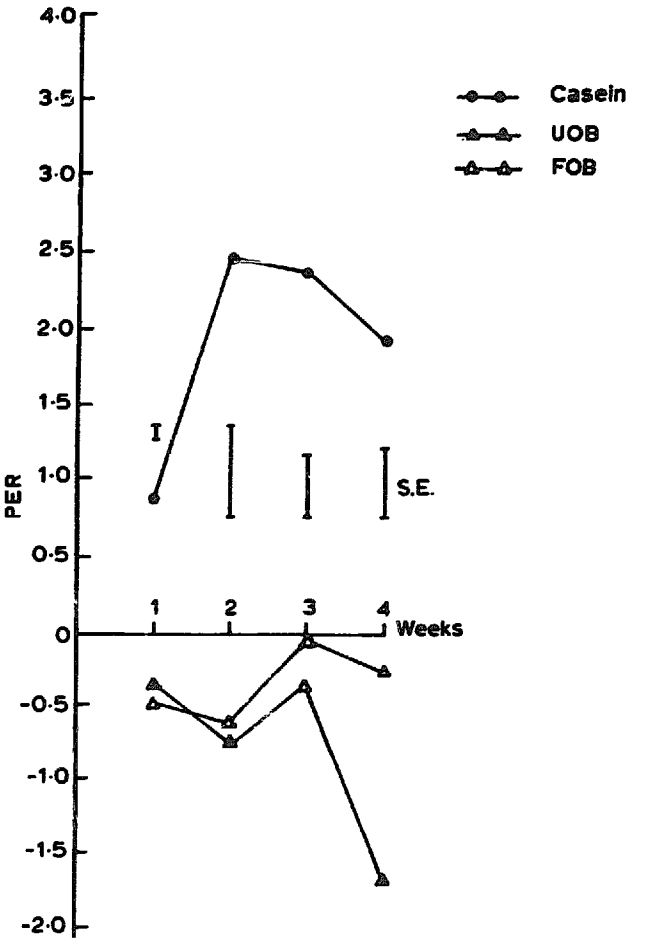

Fig. 4. Mean weekly PER of rats fed diets containing casein; unfermented oil bean (UOB) and fermented oil bean (FOB). (Vertical lines indicate ± SE between diets.)

components in seeds may affect their nutritive value by impairing protein utilization. Some toxic substances have been identified in some oil seeds and legumes. If some toxic substances occur in the oil bean seeds, the process of boiling and fermentation of the seeds probably did not detoxify them.

Achinewhu (1983*a*) shows the presence of saponins in African oil bean seed while Duke (1981) also reported the presence of a poisonous alkaloid, pancine. Other workers (Fetuga *et al.*, 1974; Achinewhu, 1983*b*, 1984; Osaniyi & Eka, 1978) have shown similar depression in weight and negative PER of rats given other Nigerian legume seeds. They attributed these to some heat-stable toxic components of the seeds.

These seeds are widely consumed as snacks or used as condiments in some parts of Nigeria and the adverse effects they may have on consumers are not known. Further investigation is necessary on the processing methods to inactivate these toxic components and improve the nutritive quality of the seeds.

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