COMPARATIVE UTILIZATION OF COOKED SOYBEANS AND FISHMEAL-GROUNDNUT CAKE MIXTURE IN DIETS

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ABSTRACT

A 4-week experiment involving 45 growing albino rats was carried out to assess the nutritional utilization of cooked full-fat soybean (CFFS) as a major source of dietary protein relative to that of the protein concentrates - fishmeal-groundnut cake mixture and the response to supplementation of the cooked soybeans with 2g DL-methionine/kg diet and/or 2g L-lysine/kg diet. Feed intake (FI), average daily weight gain (DLG), feed conversion ratio (FCR), protein efficiency ratio (PER) and feed cost (FC) per unit live-weight gain, (FC/WG) were measured. No significant effect of the various dietary treatments was observed on PER and FC/WG. However, the incorporation of CFFS either alone or in conjunction with either of both lysine and methionine significantly improved FI and FCR ($P < 0.05$) and also DLG ($P < 0.01$) over the control fish-groundnut meal ration. Supplementation of CFFS with lysine either alone or along with methionine appeared unwarranted as methionine supplementation alone resulted in similar or slightly better efficiency of protein (0.247) and overall feed (0.596) utilization. From the results obtained, it appears that maize-based CFFS diet supplemented with 2 g/kg DL-methionine may be applicable for non-ruminant feeding. However, since this level of methionine supplementation only provides for 67% of rat requirement, it is suggested that further studies with higher methionine levels be conducted.

Key Words: Soybeans, Fishmeal, Groundnut Cake, Diets, Rats

INTRODUCTION

Presently, the production of soybeans is on the increase in the country. It has been the practice world wide to feed soybeans to livestock only after the extraction of its

constituent oil and the heat treatment of the residual meal to remove the effect of the anti-nutritional factors (principally, anti-trypsin and anti-chymotrypsin) which interfere with protein utilization. There are, at present, very limited number of soybeans processing plants in the country and an attempt to simulate through local improvisation will only result in gross reduction of efficiency with the attendant high and uneconomic cost of the final products.

In the light of the above, the use of soybeans in our present condition calls for the adoption of simple techniques that could lend themselves to easy and quick applicability by the majority of Nigerian livestock farmers. One such technique is the use of the whole soybeans with appropriate heat treatment through cooking. Besides, the proximate composition of full-fat soybeans (FFSB) indicates that they are potentially useful sources of both protein and apparent metabolizable energy (AME). Soybean is known to be deficient in methionine and its use in livestock feeding requires its supplementation with synthetic amino acids or animal protein source (Balloun, 1980). It is also known that part of its lysine content (the most heat labile amino acid) may be rendered unavailable following heat treatment (Taira, Sugimurak and Sakurai, 1965; Iriartre and Barnes, 1966).

It was therefore the aim of this study to compare fishmeal-groundnut meal supplement and cooked whole soybeans as major sources of protein in a maize-based ration for rats. It was also the interest of this investigation to assess the need or otherwise for amino acid supplementation when soybean is used as a major protein source in diets.

MATERIALS AND METHOD

Origin and processing of feed ingredients

The soybean sample evaluated in this study was a TGX 1025- 32 E variety obtained from the Institute of Agricultural Research and Training (I.A.R.&T.) Ibadan. Heat treatment was accomplished by autoclaving soybeans in shallow metal containers covered with aluminium foil at 110°C and 15 p.s.i. for 30 minutes. This was followed by sun-drying achieved by spreading cooked soybeans thinly on concrete platforms laid with polythene sheets for 6 hours each day for 7 days. The soybeans were then ground to pass through a 2.5 - mm screen and stored under a cool condition until ready for incorporation into the experimental diets. The groundnut and fish meals used in the experiment were of commercial grade in which the oil had been removed. These, along with the remaining feed ingredients, were obtained locally from reputable farms around Ibadan and Ijebu-ode.

Diets

Five iso-nitrogenous experimental diets were formulated to contain approximately 16 percent crude protein in the five dietary treatments with varying levels of synthetic amino acids. The composition of the Experimental diets is shown on Table 1

Experimental procedure

Forty-five albino rats of the sprague-dawley strain, housed individually in shoe-box type cages furnished with wire lids, feed and water containers, were used in this experiment which lasted four weeks. The rats were weighed at the beginning of the study and were randomly distributed into five treatments of nine rats each in such a way that the initial body weights of the rats in any treatments were as nearly same as those of the rats in all the other treatments. Each of the experimental diets was fed *ad libitum* to triplicate groups of the three rats for four weeks. Water was also provided to each rat without restriction.

The data collected included average daily weight gain, (DWG) average daily feed intake (FI), food conversion ratio (FCR), protein

efficiency ratio (PER) and feed cost per unit of live-weight gained (FC/WG). From records of individual body weights measured at the beginning, at seven days interval and at the end of the trial, average daily weight gain of rats in each treatment over the 4 - week period was derived. Daily record of average feed consumption per rat for each treatment was obtained in a way similar to weight gain.

Data analysis

A total number of 15 observations were made on each of the measurements taken. A complete randomised design was employed and all experimental data were subjected to analysis of variance procedure as described by Steel and Torrie (1980) and differences among means were compared statistically using the Duncan's multiple range test (Duncan, 1955).

RESULTS

Mean squares of analysis of variance of FI DWG, FCR, PER, and FC/WG of rats fed the various diets used in this study are shown in Table 2. The results indicated significant ($P < 0.05$) effects of dietary treatments on feed intake and feed conversion ratio and a highly significant ($P < 0.01$) effect on daily weight gain. However, both protein efficiency ratio and feed cost per unit of live weight gain of the rat were not significantly ($P > 0.05$) affected by the different dietary treatments. Table 3 shows the means and standard errors for the measurements recorded in this study. Feed intake by rats fed soybean-lysine diets was significantly more than the intake by those rats on soybean methionine diets and those fed fishmeal-groundnut meal diets (between which the difference was not significant). This highest intake was, however, not significantly different from those of rats fed other test diets.

All the cooked soybean-containing diets significantly improved live weight gain above that of fishmeal-groundnut meal diets. There were no significant differences, among the soybean diets, in their effects at promoting gains. However, soybean supplementation with lysine either alone (2.66g/day) or in combination with methionine (2.46/day) produced slightly better weight gain than

COOKED FULLFAT SOYBEAN IN DIETS

TABLE 1. COMPOSITION (g/KG) OF THE EXPERIMENTAL DIETS FED TO THE GROWING RATS DURING THE 4-WEEK STUDY.

Ingredients	1	2	Diets 3	4	5
Maize	709.4	707.7	707.7	704.3	760.0
Full-fat soybean	198.1	198.5	198.5	199.2	-
Fish meal	-	-	-	-	50.8
Groundnut meal	-	-	-	-	101.7
Wheat offals	55.0	55.0	55.0	55.0	55.0
Bone meal	25.0	25.0	25.0	25.0	25.0
Oyster shell	1.0	1.0	1.0	1.0	1.0
Salt	2.5	2.5	2.5	2.5	2.5
Vitamin/mineral premix	9.0	9.0	9.0	9.0	9.0
Synthetic L-lysine	-	2.0	-	2.0	-
Synthetic DL-methionine	-	-	2.0	2.0	-
Calculated nutrient composition					
ME (MJ/kg)	13.19	13.17	13.17	13.13	13.08
Crude protein (g/kg)	163.4	163.5	163.5	163.4	164.12
Calcium (g/kg)	10.12	10.13	10.13	10.12	13.02
Phosphorus (g/kg)	5.74	5.54	5.54	5.54	6.32

TABLE 2. MEAN SQUARES OF ANALYSIS OF VARIANCE FOR AVERAGE DAILY WEIGHT GAIN (DLG), DAILY FEED INTAKE (FI), FEED CONVERSION RATIO (FCR), PROTEIN EFFICIENCY RATIO (PER) AND FEED COST PER UNIT LIVE WEIGHT GAIN (FC/WG) OF RATS FED THE EXPERIMENTAL DIETS.

Source of variation	d.f.	DLG	FI	FCR	PER	FC/WG
Dietary treatment	4	0.404**	3.166*	0.720*	0.074	0.163
Residual	10	0.055	0.639	0.201	0.031	0.271

* (P < 0.05); ** (P < 0.01).

TABLE 3. GROWTH PERFORMANCE DATA OF RATS FED THE CONTROL DIET AND WHOLE SOYBEANS WITH OR WITHOUT AMINO ACID SUPPLEMENTATION.

Performance criterion	Diets					SE
	1	2	3	4	5	
Average daily weight gain (g/day)	2.44 ^b	2.66 ^b	2.35 ^b	2.46 ^b	1.70 ^a	0.136**
Average daily feed intake (g/rat/day)	11.00 ^{bc}	11.40 ^c	9.45 ^{ab}	10.32 ^{abc}	8.95 ^a	0.462*
Feed conversion ratio (g feed/g gain)	4.56 ^{ab}	4.30 ^a	4.05 ^a	4.19 ^a	5.29 ^b	0.259*
Protein efficiency ratio (g gain/g protein intake)	1.48	1.55	1.68	1.59	1.26	0.102NS
Feed cost (k)/g weight gain	5.20	5.21	4.86	5.38	5.47	0.301NS

Means in each row common superscript are not significantly different, * (P < 0.05); ** (P < 0.01).
NS, No significant difference between means.

TABLE 4. AMINO ACID CONCENTRATIONS OF EXPERIMENTAL DIETS IN RELATION TO THE REQUIREMENTS FOR THE RAT

Amino acid Requirement ¹		Dietary concentration as% of requirement				
		1	2	3	4	5
Arginine	0.67	143	143	143	143	175
Histidine	0.33	103	103	103	145	103
Isoleucine	0.61	113	113	113	113	110
Leucine	0.83	167	166	166	166	166
Lysine	1.00	68	88	68	71	63
Methionine	0.67	37	37	67	67	46
Phenylalanine						
/Tyrosine	0.89	146	146	146	146	160
Threonine	0.56	107	107	107	107	107
Tryptophan	0.17	112	112	112	112	100
Valine	0.67	115	115	115	115	127

¹ Nutrient requirements of the rat (NRC, 1972).

soybean alone or soybean with methionine supplementation (2.35g/day). Soybeans alone also gave slightly higher gains than when it was supplemented with methionine. Maize-soybean protein supplemented with methionine was slightly, though not significantly, more efficient than the other soybean containing diets in promoting gain. This diet, along with those supplemented either with lysine alone or with both lysine and methionine, was significantly more efficient in promoting weight gain than fishmeal-groundnut meal diet. There was, however, no significant difference between the latter and the sole soybean diet in efficiency of feed conversion.

DISCUSSION

Based on the observed performance of rats on soybean diets compared with those fed the control fish-groundnut meal diet in terms of live weight gain, feed intake, efficiency of feed and protein utilization and economy of live weight gain, it would appear that cooked soybeans offer a better alternative to the Nigerian conventional fish-groundnut protein source in non-ruminant feeding. The superior efficiency of soybean diets over the control fish-groundnut meal diet at promoting weight gain observed in this study should not be surprising since Krider *et al.* (1950) had indicated that fish meal was not better than good quality soybeans in promoting gains in pigs. The slightly superior protein efficiency ratio of soybean diets (although not significant) over the control diet may be indicative of a more favourable amino acid balance of the cooked soybean diets.

The comparative poor efficiency of fish-groundnut meal diet could be due to the worsening effect of groundnut cake which has been reported to be deficient in methionine and lysine (Combs and Wallace, 1962; Combs *et al.*, 1963 and Olomu, 1971) and perhaps to its high risk of aflatoxin toxicity (Oyenuga, 1968). Another probable reason for the poor performance of rats given diet 5 is the 5% level of fish meal inclusion which may be regarded as being inadequate. A close look at

the cost analysis will, however, reveal that increasing the level of fish meal in the diet beyond 5% may not be economically justifiable as this may further increase the feed cost per unit of live weight gain.

Of all the soybean diets, diet 3 containing methionine supplement was slightly better in terms of efficiencies of protein and overall feed utilization. This diet was also slightly more economical than the others at producing a unit of live weight gain. This may be a confirmation of the earlier reports that methionine is the limiting amino acid in soybeans (Osborne and Mendel, 1917; Berry *et al.*, 1966).

The possible adverse effects of excessive heat treatment on soyabean lysine as reported by Liener (1958) and Iriarte and Barnes (1966) which might necessitate lysine supplementation for effective use of soyabean seemed not to have occurred in the present study. This is because lysine supplementation either alone or in addition with methionine appeared not to have brought about any significantly additional benefits on the animals performance. This observation indicates that the method of processing adopted in the present study appeared to be compatible with the preservation of soybean protein quality and desirable for soybean processing for better animal performance.

From the findings of this study, it can be inferred, therefore, that there was no adverse effect of heat treatment adopted in this study on soybean lysine or the loss of lysine resulting from heat treatment, if any, could only have been marginal as it was not evident to have lowered the nutritive value of the soybean diets. This would then mean that lysine supplementation is unnecessary when cooked, fullfat soybean is being fed to non-ruminants provided suitable heat treatment is applied. A similar observation has been reported by Pelura *et al.* (1980) who found no significant difference in feed efficiency of growing pigs when soybean diet was supplemented with 2.2 glysine/kg diet, a level similar to the one used in this study. It can be seen from Table 4 (amino acid concentration of experimental

diets in relation to the requirement for rat growth) that, except for methionine and lysine, all other amino acids adequately cover requirement for the rat according to NRC recommendation. With the 2g/kg level of methionine supplementation used in the current trial, diet 3 only covers 67% of NRC requirement for that amino acid and only 68% for lysine.

It may well be that further improvements in performance can be obtained if methionine supplementation is such as to fully cover rat requirement. Given the combination of feed ingredients used in this trial, methionine supplementation at a level of approximately 3g/kg would be needed for this purpose, the practical manifestation or otherwise of which would require further investigations.

The general conclusion from the results of this study are that: Well cooked fullfat soybeans, particularly when supplemented with 2 g methionine/kg diet offer a better alternative to fish-groundnut protein concentrate. Also, on account of the very little additional benefit arising therefrom, supplementation of soybean diets with lysine either alone or in conjunction with methionine for the purpose of rat feeding appears unwarranted.

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