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Full Length Research Paper

Comparative utilization of two sources of expeller-extruded soybean meal as a replacement for on-farm processed soybean in diets of growing-finishing pigs

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Thirty pigs averaging 30 ± 1.1 kg were randomly assigned by origin and weight to one of three dietary treatments in a randomized complete block to determine the comparative utilization of two sources of expeller-extruded soybean meal as a replacement for on-farm processed soybean in diets of growing-finishing pigs. The result revealed that pigs fed diets containing the expelled soybean meal (ESM) had decreased (P<0.05) average daily gain (ADG) compared to pigs fed the on-farm processed soybean resulting in between 13-17% reduction in the ADG. The expelled soybean meal samples resulted in comparable (P>0.05) gains even though slight numerical differences were observed. Feed efficiency was 18 to 24% significantly (P<0.05) poorer for pigs fed the expelled soybean meal diets compared to the improvement observed in the feed conversion of pigs when fed the on-farm processed soybean. Conclusively, the gains as well as the efficiency of feed utilization obtained with the on-farm processed soybean were significantly (P<0.05) superior compared to the expeller- extruded soybean but the serum metabolites of the pigs were observed to be unaffected by the different processing methods.

Key word: Expeller-extruded soybean, On-farm processed soybean, pigs, soybean processing, performance, serum metabolites

INTRODUCTION

Fish meal (FM) is presently the most expensive animal protein source in animal feeds (Tacon, 1993). The increasing costs and unpredictable availability of FM necessitates the search for its replacement with cheaply and abundantly available plant protein feed stuffs (Robinson and Menghe, 2007). Recent research trends indicate that there is an increased interest towards the search for alternative/additional protein source to meet the increasing requirements for protein source for the expanding livestock industry, especially in the developing countries (Janardhanan et al., 2003). Even though soybean and other common legume grains play a key role as protein source for human beings and animals alike, their production is not sufficient to meet the protein requirements of the increasing population and expanding livestock industries (Vijayakumari et al., 2007). The heavy demand for these common legumes has given rise to a disproportionate increase in their prices, and consequently, the cost of the food and feedstuffs into which it is incorporated.

Use of raw soybean is limited due to the presence of endogenous and heat-labile anti-nutritional factors (ANFs) that is, lectin, phyto-haemoglutinin, anti vitamins and protease (trypsin) inhibitors (Liener, 1980). The most important of which are trypsin inhibitors, which seriously impair protein digestibility (Balloun, 1980). There are both heat stable (saponins, tannins, estrogens, phytate) and heat-labile (protease inhibitors) in soy. Protease inhibitors in soy are destroyed by heating but other factors also play a role, such as duration of heating, particle size and moisture conditions. Thus, how soy products are processed will dictate how much of the protease inhibitor (also known as trypsin inhibitor) remains. The nutritive value of the protein in soybean actually increases with heating which destroy trypsin inhibitors (Weingartner, 2008). Roasting or cooking of raw soybean to a temperature of 240-260 degrees Fahrenheit for 3 to 5 min destroys this inhibitor and ensures the utilization of soy-

Table 1. Diet Composition.

Ingredient %	On-Farm Processed Soybean	Expelled Soybean meal [a](43%)	Expelled Soybean meal [b](41%)
Maize	30.00	29.30	28.54
Maize Offal	12.00	12.00	12.00
Soybean meal (45%)	15.00	-	-
Expelled soybean meal	-	15.70	16.46
Palm kernel Cake	20.00	20.00	20.00
Wheat Bran	20.00	20.00	20.00
Bone meal	2.25	2.25	2.25
Vit-Min. premix	0.25	0.25	0.25
Salt	0.50	0.50	0.50
Total	**100.00**	**100.00**	**100.00**
Calculated: Crude Protein	17.95	17.95	17.95
ME Kcal/Kg	2773	2738	2735

bean as a protein supplement (Vijayakumari et al., 2007). Development of new processing technologies for the removal of ANFs has facilitated its increased use as protein source in feeds (Garg et al., 2002) . Therefore, for the elimination of ANFs, soybean seeds (*Glycine max*) could be hydrothermically processed before incorporating in diets. Soybean meal (SBM) can be produced either by solvent extraction or expeller-extrusion. Expeller-extruded SBM (EE-SBM) contains more oil but less crude protein than solvent extracted SBM (SE-SBM) (Powell et al., 2007). However, results of experiments indicate that EE-SBM had similar feeding value to SE-SBM when the differences in nutrient values are considered in diet formulation.

Presently, solvent extraction is the most common method of extracting soybean oil today; leaving less than 1% fat, but, the expeller process is still the most commonly used industrial method in Nigeria (Fashina, 1991). This experiment was therefore conducted to determine the replacement value of expeller-extruded soybean meal for on-farm processed soybean in diets of growing-finishing pigs.

MATERIALS AND METHODS

Expeller-extruded soybean meal was purchased at two local industrial sales outlets in Ibadan, Nigeria. The two samples of expelled soybean meal and the on-farm processed soybean were analyzed for percentage protein (AOAC, 1990) and diets formulated to be isonitrogenous and isocaloric (Table 1). In the expeller process, the soybean are cracked, dried, and transported to a tempting device, which stirs them for uniform heat processing. The soybeans are then fed into an expeller barrel, which presses the oil from the beans. The soybeans leave the barrel and are ground. The expeller process leaves the beans with approximately 5% fat. However, boiling of soybean is the most conventionally and commonly used farm-adaptable processing method in Nigeria (Awosanmi, 1988). Raw soybean packed in jute bags is lowered into half-drum of boiling water and allowed to boil for a time-period. The boiled seeds are then drained of water and sun-dried to less than 10% moisture content before being ground and stored (Fanimo, 1996).

The metabolisable energies were also determined with the equation predicted by Morgan et al. (1975). ME = 0.416CP + 0.605EE + 0.367NFE – 20.06 (R^2 = 0.94) where ME is the metabolizable energy, CP is the crude protein, EE is the ether extract and NFE is the nitrogen free extract. Lysine was assumed to be a fixed percentage of total protein in both soybean meals. The arrangement of treatments allowed for a direct comparison of the protein quality of the two expelled-soybean meal sources to the on-farm processed soybean, as well as assessing the effect of the potential variation in protein on pig performance. Thirty pigs averaging 30 ± 1.1kg were assigned randomly by origin and weight to one of three dietary treatments in a randomized complete block. In each of the treatment groups, there were five replicates of two pigs per replicate. The pigs were allowed assess to feed and water *ad libitum* for a 42-day period.

Five of the ten experimental grower pigs in each of the three dietary treatments were randomly selected and bled at the end of the feeding trial. The bleeding was done in the morning before feeding and 10ml of the blood was obtained from the jugular vein into a sample bottle using a sterilized needle and syringe as described by Adesehinwa (2007). The samples were allowed to clot before centrifuging to obtain the serum used in the determina-tion of some serum metabolites (Total protein, Albumin, Globulin, Urea nitrogen, Creatinine, Cholesterol and Glucose) using methods described by Toro and Ackermann (1975) and Kaneko (1989).

All the data obtained were subjected to analysis of variance and where statistical significance were observed, the means were compared using the Duncan's Multiple Range (DMR) test. The SAS Computer software package (1988) was used for all statistical analyses.

RESULT AND DISCUSSION

Pigs fed diets containing the expelled soybean meal (ESM) had decreased ($P<0.05$) average daily gain (ADG) compared to pigs fed the on-farm processed soybean (Table 2) resulting in between 13 - 17% reduction in the ADG. This could be attributed to a suspected higher fat content of the on-farm-processed soybean, which may have resulted in the higher caloric density of the diet, since, it was not defatted. The expelled soybean meal

Table 2. Effect of expelled soybean meal on pig performance.

Ingredient, %	On-Farm Processed Soybean	Expelled Soybean meal a(43%CP)	Expelled Soybean meal b(41% CP)	CV
Daily gain, kg	0.76[a]	0.66[b]	0.63[b]	6.7
Daily feed intake, kg	2.43	2.48	2.51	8.7
Feed efficiency	3.27[b]	3.59[a]	3.73[a]	9.0

a,b: Means along the same row having different subscripts differ significantly at P<0.05

Table 3. Serum Metabolites of growing Pigs fed two sources of expeller-extruded soybean.

Metabolites	On-Farm Processed Soybean	Expelled Soybean meal a (43%CP)	Expelled Soybean meal b (41%)	±SEM
Total Protein (g/dl)	6.49	6.30	6.36	0.05
Albumin (g/dl)	3.75	3.99	3.68	0.02
Globulin (g/dl)	3.35	3.31	3.29	0.03
Urea N (mg/dl)	44.13	41.25	43.38	1.84
Creatinine (mg/dl)	1.49	1.57	1.44	0.05
Cholesterol (mg/dl)	277.00	266.62	263.5	6.06
Glucose (mg/dl)	85.13	84.46	90.13	2.75

samples resulted in comparable (P>0.05) gains which was significantly inferior to gains obtained with the on-farm soybean. The average daily fed intake was not significantly influenced by the different soybean samples, in accordance with the findings of Awosanmi (1988) and Bamgbose (1988), that processing of soybean may not affect the feed intake. Hayward et al. (1953) had earlier reported inability of processed oilseed meals to promote good growth as not due to a lack of feed intake but difference in the nutritional value of their protein as a result of methionine deficiency. Hence, it could be inferred that the nutritional value of the resultant protein contained in the on- farm processed soybean used in this study was superior to the expelled soybean taking into consideration the superior gains observed. Balogun (1979) reported methionine deficiency in the rations of pigs to cause amino acid imbalance with consequent adverse effect on performance. Feed efficiency was 18 to 24% significantly (P<0.05) poorer for pigs fed the expelled soybean meal diets compared to the improvement observed in the feed conversion of pigs when fed the on-farm processed soybean. However, the replacement of the on-farm processed soybean with the expeller-extruded soybean resulted in neither beneficial nor adverse effect on the serum parameters. These results indicated that the expelled soybean meal used in this experiment was an inferior protein source compared to the on-farm-processed soybean due to the comparative adverse animal performance in terms of feed efficiency and weight gains.

The effect of expeller-extruded soybean protein sources on the serum metabolites of the pigs is shown in Table 3.

The serum total protein, albumin and globulin of the pigs were observed to be unaffected by the different processing methods. These parameters are indications of protein reserves in animals (Adesehinwa, 2007) and can be specifically influenced by protein shortage indicated by alterations in albumin content (Gouache et al., 1991). The result of this study showed that the protein levels and the amino acid profiles of the isonitrogenous diets were able to support normal protein reserves in the experimental pigs. The influence of diets on haematological and serum biochemical variables have been established (Ologhobo et al., 1993; Otesile et al., 1991).

The observed values were within the range reported by Kaneko (1989) for this class of pigs. This could have been brought about by the efficient utilization of the soybean proteins contained in the diets thereby resulting in comparable (P>0.05) values. However, the gains as well as the efficiency of feed utilization obtained with the on-farm processed soybean were significantly (P<0.05) superior compared to the expeller-extruded soybean. It should be noted that the crude protein content of cakes have been reported to be dependent on the extent of dehulling and the efficiency of the oil extraction process (Villamide and San Juan, 1998). The efficiency of utilization of any protein source is affected by the level of protein in the diet, the digestibility of the protein, and the levels of essential amino acids, particularly the first limiting amino acid - lysine (Maina et al. 2002).

The economic feasibility of feeding extruded soybeans to swine is affected by the differences in nutrient content compared to soybean meal, the need to increase the protein in diets containing whole soybeans, the value of

extra fat and the cost of processing (Hollis, 2008).

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