The Replacement Value of Brewers Yeast Slurry-Maize Offal Mixture for Full fat Soybeans and Maize in the Diets of Pigs

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Abstract

Sixteen crossbred pigs (Large White x Landrace x Hampshire) were used in two feeding trials to evaluate the replacement value of brewers yeast slurry-maize offal mixture (BYS-MO) for full fat soybean (FFSB) and maize in the diets of pigs, and in addition to determine carcass characteristics in experiment 2. In experiment 1 four isocaloric (3250 Kcal/Kg) and isonitrogenous (18 % crude protein) maize – full- fat soybean based diets containing 0, 22.75, 40 and 59.15% of a 1.5: 1 (weight/weight) mixture of BYS-MO were fed ad libitum for 56 days. In the second experiment four isocaloric (3250 Kcal/kg) and isonitrogenous (16 % crude protein) maize – full- fat soybean basal diets containing 0, 15, 28 and 43% of a 1.5 :1 weight/weight mixture of BYS-MO were fed ad libitum for 30 days. Parameters computed included daily feed intake, daily weight gain, feed to gain ratio, protein efficiency ratio, cost per kg weight gain, linear and jointed carcass parameters and weights of internal organs. Due to the high protein content (44.3% CP) of BYS, the BYS-MO mixture gave a product whose protein content of 34.3% was close to that of FFSB (36.4% CP). There were no significant differences ($P > 0.05$) among treatments in all the parameters measured. However, the cost of feed was lower for the diets containing BYS-MO than the control diets in both experiments, thereby reducing the cost per kg weight gain from ₦129.20 to ₦96.20, ₦84.00 and ₦43.50 respectively for diets I, II, III and IV in experiment 1 and from ₦133.37 to ₦116.38, ₦109.77 and ₦108.06 respectively for diets I, II, III and IV in experiment 2. The 1.5:1 (weight/weight) brewers yeast slurry-maize offal mixture can replace up to 40 to 59% of maize and full fat soybeans in diets for weaner-grower pigs and finishing pigs without any adverse effects on performance and carcass quality.

Keywords: Brewers yeast slurry, maize offal, full fat soybeans, pigs.

Introduction

The problem of feed supply and availability on a sustainable basis has been the major concern of the livestock industry in Nigeria. This problem has been made more critical by the prevailing high competition between man and his animals for the existing grains and oilseeds, which form the bulk of food for both. One of the suggested means of increasing animal protein production in developing countries is through the use of cheap and readily available agro-industrial by-products in the diets of livestock (Tegbe *et al.*, 1995). One of such by-products is brewers yeast slurry (BYS) which is a spent product of yeast, which has been used in the fermentation of malt in beer brewing. It is normally run off through gutters as a waste product by most breweries in Nigeria. It is a single cell protein containing high amounts of protein (over 44% DM basis), amino acids, vitamins, minerals, carbohydrates and fats (Brandis, 1984 and Avila *et al.*, 1985). However, the use of BYS in livestock feeds is limited by its short shelf life, low dry matter content and difficulties in drying the slurry, which has compelled most breweries to discard it. But following the work of Ikurior and Achadu (1995), it is now possible to preserve BYS by using a less proteinous but higher energy feed stuff like cassava root meal, ground maize and maize offal as carrier before drying. The objective of this study therefore was to determine the replacement value of a mixture of brewers yeast slurry and maize offal (1.5: 1 weight/weight) for toasted full fat soybeans (FFSB) and maize in pig diets.

Materials and Methods

Prior to the beginning of the feeding trial, brewers yeast slurry, maize offal, brewers yeast slurry-maize offal mixture and full fat soybean samples were analyzed for proximate contents using the A.O.A.C. (1984) methods. Maize offal a by-product of maize dehulling was procured from local feed millers in Makurdi metropolis. Raw full fat soybeans were purchased from the open market and sand toasted over fire until it became crispy and brown. Brewer's yeast of *Sacharomyces carlsbergensis* was collected in batches in 50 litre screw-top plastic containers from Benue Breweries PLC, Makurdi. It was immediately sampled for proximate analysis. Within approximately one hour of its collection, the BYS was mixed with MO in a ratio of 1.5 parts BYS to 1 part MO (weight/weight) and sun dried for 3 days on concrete slabs to a moisture content of about 10%, with frequent manual turning to ensure quick drying without the formation of clods. The BYS-MO mixture was dried, stored in polythene bags and samples obtained for analysis.

Dietary Treatments

In experiment 1, four isocaloric (3250 Kcal ME/kg) and isonitrogenous (18%CP) diets were formulated to contain 0% (control diet I), 22.75% (diet II), 40% (Diet III) and 59.15% (diet IV) levels of brewers yeast slurry-maize offal mixture replacing 25% (diet I), 18.75% (diet II), 12.50% (diet III) and 6.25% (diet IV) (Table 1) levels of full-fat soybeans and maize.

Experimental pigs and their management

Sixteen crossbred weaner pigs (Large White x Landrace x Hampshire) weighing on the average 9kg were used in the study. They were dewormed with Levamisole at the rate of 1 ml per 20kg body weight. Four pigs (2 males and 2 females) were randomly allotted to pens and treatments randomly allotted to each of the pens. The animals were individually housed in 1.8m x 0.75m concrete floored pens and fed their respective diets twice daily (08.00 and 14.00 hours) in mash form and given clean drinking water *ad libitum* for 56 days.

There were four replicates per treatment. The pigs were weighed at the beginning of the experiment and weekly thereafter. Performance characteristics were monitored in terms of daily feed intake (ADF), daily weight gain, feed to gain ratio. The protein efficiency ratio (PER) and cost per kg weight gain were also computed.

In experiment 2 there were also four isocaloric (3250Kcal/kg) and isonitrogenous (16% CP) diets (Table 2). The same pigs used in Experiment 1 were used in this trial. The pigs which had an initial average weight of 41.40kg were randomly assigned to pens and treatments randomly allotted to pens containing the pigs and fed for 30 days as in experiment 1. Performance criteria computed were feed intake, average daily weight gain, feed to gain ratio and economic performance. When the pigs attained an average weight of 60kg body weight, three pigs from each treatment were selected on the basis of average treatment weight for slaughter. The pigs were weighed then starved for 24 hours before they were slaughtered for carcass evaluation

according to Ikurior and Fetuga (1988) procedures. All data were subjected to Analysis of Variance (Snedecor and Cochran, 1967) and significant differences were separated using Duncan's Multiple Range Test (Steele and Torrie, 1980).

Results

The results of the effects of feeding diets containing different levels of BYS-MO mixture on the performance and carcass characteristics of weaners and finisher pigs are presented in Tables 1 – 7. The proximate chemical composition of brewers yeast slurry (BYS), brewers yeast slurry-maize offal (BYS-MO) mixture, maize offal (MO) and full fat soybean (FFSB) are summarized in Table 3; while the diets used in the weaner and finisher trials and their analyzed chemical composition are shown in Tables 1 and 2 respectively.

The performance characteristics of the weaner and finisher pigs comprising average daily feed intake, average daily weight gain, feed to gain ratio, protein efficiency ratio (PER) cost per 100kg feed and the cost (N) per kg gain are presented in Table 4. There were no significant differences ($P > 0.05$) in all parameters determined. There was a tendency for daily feed intake to increase as the level of brewers yeast slurry – maize offal mixture increased. This increase in feed intake was however not reflected in average daily weight gain which tended to decrease marginally instead. Pigs on the control diet were also superior to those on the brewers yeast slurry-maize offal mixture diets in feed conversion efficiency, and protein efficiency ratio. The feed cost per kg gain was higher for

Feeding value of brewers yeast slurry and maize offal mixture for pigs.

Table 1. Composition of diets of weaner pigs containing brewers yeast slurry-maize offal mixture.

Ingredients	Experimental diets			
	I	II	III	IV
Maize	52.54	35.90	24.90	12.00
Full fat Soybean	25.00	16.75	12.50	6.25
BYS-MO mixture	-	22.75	40.00	59.15
Brewers dried grain	20.00	20.00	20.00	20.00
Bone meal	2.00	2.00	2.00	2.00
Salt	0.40	0.40	0.40	0.40
Vitamin/mineral premix ^a	0.20	0.20	0.20	0.20
ZnO ^b	+	+	+	+
Total	100.00	100.00	100.00	100.00
Analyzed composition:				
Crude protein (%DM)	18.20	18.20	18.88	18.90
Crude fibre (%DM)	4.50	5.80	6.78	7.88
Ash (%DM)	4.46	5.10	5.24	5.81
Calcium	0.90	0.80	0.77	0.79
Phosphorus	0.75	0.75	0.73	0.79

^aVitamin/ mineral premix (Ad - Vit Super), supplied the following per kg of the product: Vit. A, 10,000,000 IU; Vit. B1, 0.75g; Vit. B2, 2.50g; Vit. D3, 2,00,000 IU; Nicotinic Acid, 25g; Cal. Pantothenate 12.50g; Vit. B12, 0.015g; Vit. K3, 2.5g; Vit. E, 25.00g; Biotin, 0.05g; Folic acid, 1.00g; Choline Chloride, 250g; Co., 0.40g; Cu., 8.00g; Fe, 32.00g; I., 8.00g; Mn., 64.00g; Zn., 40.00g

^bZinc Oxide added at the rate of 12.48g/100Kg ration to supply 100ppm elemental zinc.

Table 2. Composition of diets of grower pigs containing brewers yeast slurry-maize offal mixture.

Ingredients	Experimental diets			
	I	II	III	IV
Maize	59.58	49.00	40.49	29.94
Full fat Soybean	17.82	13.39	8.91	4.46
BYS-MO mixture	-	15.03	28.00	43.00
Brewers dried grain	20.00	20.00	20.00	20.00
Bone meal	2.00	2.00	2.00	2.00
Salt	0.40	0.40	0.40	0.40
Vitamin/mineral premix ^a	0.20	0.20	0.20	0.20
ZnO ^b	+	+	+	+
Total	100.00	100.00	100.00	100.00
Analyzed composition:				
Crude protein (%DM)	16.88	16.84	16.12	16.66
Crude fibre (%DM)	4.41	4.64	4.98	5.08
Ash (%DM)	3.80	3.50	2.95	4.20
Calcium	0.78	0.78	0.78	0.78
Phosphorus	0.72	0.73	0.73	0.74

^aVitamin/ mineral premix (Ad - Vit Super), supplied the following per kg of the product: Vit. A, 10,000,000 IU; Vit. B1, 0.75g; Vit. B2, 2.50g; Vit. D3, 2,00,000 IU; Nicotinic Acid, 25g; Cal. Pantothenate 12.50g; Vit. B12, 0.015g; Vit. K3, 2.5g; Vit. E, 25.00g; Biotin, 0.05g; Folic acid, 1.00g; Choline Chloride, 250g; Co., 0.40g; Cu., 8.00g; Fe, 32.00g; I., 8.00g; Mn., 64.00g; Zn., 40.00g

^bZinc Oxide added at the rate of 12.48g/100Kg ration to supply 100ppm elemental zinc.

Table 3. Analyzed proximate composition of brewers yeast slurry, maize offal, brewers yeast slurry-maize offal mixture and full fat soybeans on dry matter basis.

Nutrients	Brewers yeast slurry	Brewers yeast slurry/maize offal	Maize offal	Full fat soybeans
Dry matter	15.40	90.00	89.60	90.24
Crude protein	44.27	34.20	10.40	36.40
Crude fibre	2.88	18.80	12.15	4.25
Ether extract	0.92	12.60	3.90	17.85
Ash	4.68	10.40	2.00	4.20
Nitrogen free extract	49.25	23.90	71.55	37.30

Values are means from 3 determinations.

Table 4. Performance characteristics of weaner pigs fed brewers yeast slurry - maize offal mixture supplemented diets (Experiment 1)

Parameters	Dietary treatments				SEM ^{1,2}
	I	II	III	IV	
Initial body weights (kg)	8.38	8.33	8.35	8.13	-
Final body weights (Kg)	38.02	32.41	32.43	31.65	0.63
Daily feed intake (Kg/pig/day)	0.92	0.99	1.01	1.01	0.04
Daily weight gain (kg/pig/day)	0.44	0.43	0.43	0.42	0.01
Feed/gain ratio	2.10	2.31	2.35	2.40	0.13
Protein efficiency ratio (PER)	2.66	2.36	2.34	2.30	0.17
Cost N/100Kg feed	34.36	25.11	18.25	10.27	10.12
Cost N/Kg gain	129.20	96.18	83.96	43.53	35.39

¹Standard error of means.

²Differences between treatment means were not statistically significant ($P > 0.05$)

the control diet and was increasingly lower as the level of brewers yeast slurry-maize offal mixture increased in the diets.

Table 5 shows the performance characteristics of finisher pigs fed on diets containing brewers yeast slurry-maize offal mixtures. There were no significant differences in average daily feed intake, average daily gain, feed to gain ratio and protein efficiency ratio as was the case in the weaner trial. However, the pigs fed the brewers yeast slurry-maize offal diets consumed slightly less feed but were superior to the control animals in average daily gain, feed to gain ratio and protein efficiency ratio, although the differences were not significant. As in the weaner trial the cost per kg gain was progressively less as the level of brewers yeast slurry-maize offal mixture in the diet increased.

Tables 6 and 7 show the effects of brewers yeast slurry-maize offal mixture based diets on linear carcass measurements and weights of internal organs and jointed carcasses respectively of pigs slaughtered at about 60kg body weight. Linear carcass measurements (carcass length, back fat thickness and loin eye area) were not significantly affected by dietary treatments neither were the weights of internal organs (liver, heart, lungs and trachea, kidney, spleen or empty stomach). The jointed carcass portions were also not significantly influenced by dietary treatments. The control animals dressed slightly higher but were not superior in jointed portions like ham, loin, picnic, Boston butt, jowl and belly to pigs fed the BYS-MO based diets. Here also, specific trends were not noticed suggestive of treatment influences.

Table 5. Performance characteristics of finisher pigs fed brewers yeast slurry-maize offal mixture supplemented diets (Experiment 2)

Parameters	Dietary treatments				SEM ^{1,2}
	I	II	III	IV	
Initial body weights (kg)	42.26	41.44	41.46	40.42	-
Final body weights (Kg)	61.16	61.24	59.76	59.32	0.43
Daily feed intake (Kg/pig/day)	2.08	2.06	2.02	2.07	0.03
Daily weight gain (kg/pig/day)	0.63	0.66	0.61	0.63	0.02
Feed/gain ratio	3.31	3.32	3.31	3.29	0.09
Protein efficiency ratio (PER)	1.80	1.90	1.83	1.83	0.04
Cost N/100Kg feed	24.38	20.38	16.65	12.97	4.86
Cost N/Kg gain	133.37	116.38	109.77	108.06	11.55

¹Standard error of means

²Differences between treatment means were not statistically significant ($P > 0.05$)

Table 6. The effects of replacing full – fat soybean with brewers yeast slurry-maize offal mixture on linear measurements and organ weights of pig slaughtered at approximately 63kg live weight.

Parameter	Dietary treatments				SEM ^{1,2}
	I	II	III	IV	
Carcass length (cm)	58.00	55.00	57.50	56.40	-
Back fat thickness (cm)	2.47	2.75	2.15	2.12	0.30
Loin eye area (cm ²)	29.55	28.24	29.25	28.75	0.58
Kidney fat (kg)	0.35	0.40	0.36	0.34	0.03
Liver (kg)	1.18	1.14	1.17	1.16	0.02
Heart (kg)	0.33	0.28	0.30	0.29	0.02
Lungs and trachea (kg)	0.68	0.68	0.69	0.68	0.01
Kidney (kg)	0.14	0.14	0.14	0.13	0.01
Spleen (kg)	0.14	0.13	0.13	0.13	0.01
Empty stomach (kg)	0.58	0.59	0.59	0.59	0.01

¹Standard error of means

²Differences between treatment means were not statistically significant ($P > 0.05$)

Table 7. The effects of replacing full – fat soybean with brewers yeast slurry-maize Offal mixture on jointed carcass proportion of pigs slaughtered at approximately 60kg live weight

Parameter	Dietary treatments				SEM ^{1,2}
	I	II	III	IV	
Dressing % (warm)	79.06	78.64	78.29	78.42	0.34
Ham (%)	26.56	26.74	26.72	26.48	0.13
Loin (%)	19.34	18.94	19.26	19.37	0.19
Picnic shoulder (%)	16.90	16.74	16.86	16.58	0.14
Boston Butt (%)	13.26	13.92	13.04	13.62	0.39
Jowl (%)	7.03	7.12	6.96	6.98	0.07
Belly (%)	15.85	16.28	15.88	16.14	0.21
Four lean cuts (%)	76.06	76.43	75.88	76.05	0.18
Two fat cuts (%)	22.87	23.40	22.84	23.12	0.26

¹Standard error of means

²Differences between treatment means were not statistically significant ($P > 0.05$)

Discussion

From the results of the preliminary study, it was found that brewers yeast slurry (BYS) had a low dry matter (DM) of 15.4% and a high crude protein (CP) value of 44.27%, but when mixed or carried by a less proteinous stuff like maize offal (MO) with a moderate CP of 10.4% and a high DM of 89.6%, the CP of the mixture was enhanced to a value of 34.3% and the DM value of 90.0%. This enhancement in CP value of the BYS-MO mixture was due to the high protein content of BYS. These proximate values of the BYS were close to those reported by Krider and Carrol (1971 and Peterson and Johnson (1978) who reported CP values of 45 and 45 – 59% respectively. The quantitative enhancement of the protein and DM content of the mixture was one of the highlights of the study. Ikurior and Achadu (1995) and Ikurior (1995) had reported similar enhancements using cassava root meal and ground maize. The full-fat soybeans (FFSB) had a CP value of 36.4% and a DM of 90.24%, which shows that the BYS-MO mixture (34.3% CP) was close to FFSB (36.4% CP). This means that BYS-MO mixture is potentially useful as a substitute for FFSB which has always been the conventional protein source in pig diets (Eusebio, 1980).

In experiment 1, after 56 days, the pigs on diet I had slightly higher weight gains (33.02Kg) than those on diets II, III and IV, though these were not significantly different ($P > 0.05$). As the inclusion level of the BYS-MO mixture increased from diet I to diet IV, the average daily feed intake also slightly increased. The crude fibre value of the diets increased with consequent dilution of the energy content of the diets with

increasing BYS-MO mixture as shown on Table 1. This meant that the pigs had to eat slightly more to meet their energy requirements (NRC, 1988). The pigs on diet I (control) also gained slightly but not significantly ($P > 0.05$) more weight than those on diets II, III and IV. Feed to gain ratio and protein efficiency ratio were better for pigs on the control diet though differences were also not significant.

The cost per kilogram gain favoured the BYS-MO diets. It cost N33.03, N45.24, N45.24 and N85.67 less respectively to produce one kilogram of pork using diets II, III and IV than the diet I (control). The increasing level of BYS-MO mixture inclusion resulted in the reduction in the quantity of full-fat soybean and maize (the most expensive components) and consequently the price but not the nutritive value of these diets. Lowering the price of pig diets and the cost of producing of pork will result in the overall reduction in the cost of pig production.

At the end of Experiment 2, the final weights, average daily feed intake and gain were not significantly different ($P > 0.05$) across treatments and so were feed: gain ratio and protein efficiency ratio. These findings agree with those of Barber *et al.* (1971), Ohle *et al.* (1977) and Salo and Pekkarinen (1981) who reported that performance of pigs was unimpeded by dietary yeast. The cost per 100kg diet was highest for diet I (control), which means that as the BYS-MO mixture level increased the price decreased. These values were computed based on prevailing market prices of the ingredients as at October, 2002. The control diet was N400.15 more expensive than Diet II, N772.74 more expensive than diet III and N1141.04 more expensive than

diet IV per 100kg of diet. That there was no significant response in performance despite the price differential brings out the real feeding value of BYS-MO mixture when compared with other ingredients. The cost per kg gain on the BYS-MO diets were reduced as the level of BYS-MO mixture in the diet increased. It cost ₦16.99, ₦23.60 and ₦25.31 more to produce 1kg of pork using the control compared to the other diets in which BYS-MO was at 25, 50 and 75 per cent respectively. This price differential suggests that the inclusion of BYS-MO mixture reduced the quantity of soybean and maize and therefore total cost of production of pork. According to Alawa and Ummuna (1993) economic optimization is one of the major reasons for the use of alternative feeds.

Dietary treatments had no significant effect on jointed and linear carcass proportions and organ weights, though pigs on the control diet had slightly higher warm carcass dressing percentages. The dressing per cent across all treatments was above 75% in the present study. In a similar study, Ikurior and Achadu (1995) obtained warm carcass weights of between 78.29 and 79.06 % for the same class of pigs. Lean meat in pigs is related to availability of dietary amino acids in proper amounts and proportions and the overall nutrient balance of the diets; it would appear that the diets under study met optimal lean growth condition. This is good for the pig industry because the value based marketing system for pigs are strongly related to the high lean carcasses (Akridge *et al.*, 1990). According to Gu *et al.* (1991) lean gain reflects the increase in revenue with each increase in live weight gain and lean feed efficiency reflects the

revenue per unit of feed consumed. The fact that BYS/MO mixture replaced some soybean and maize without any discernable adverse effect on performance and carcass measurements is a manifestation of the role BYS-MO mixtures could play as a protein source in non-ruminant animal feeding. When combined with full-fat soybeans in the manner reported in this study, BYS-MO mixture significantly reduced cost of producing pigs. The preservation of BYS as discussed above would present a useful alternative feed ingredient in pig nutrition with a positive impact on productive efficiency and profitability.

Conclusion and Recommendation

The results of the study show that mixing brewers yeast slurry and maize offal in the ratio of 1.5: 1 (weight/weight) enhanced the crude protein value of the mixture to 34.3% bringing the crude protein content of the mixture close to that of full-fat soybean. The mixture can replace up to 77% maize and 75% full-fat soybean in the diets of weaner pigs and 50% maize and 75% full-fat soybeans in finishing pig diets without adverse effects on performance but with significant savings in feed costs and feed cost per kg weight gain.

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