RESPONSE OF WEANER-GROWER PIGS TO DIETS CONTAINING SUN-DRIED MIXTURES OF BREWERS YEAST SLURRY WITH MAIZE GRAIN AND CASSAVA ROOT MEAL.

S.A. IKURIOR, F.G. KAANKUKA and S.I. DAVID

Department of Animal Production, University of Agriculture, Makurdi, Benue State, Nigeria.

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ABSTRACT

Brewers yeast slurry (BYS) was mixed with ground maize grain (GMG) at 1:1 and 1:1.5 ratios W/W and with cassava root meal (CRM) at 1:1 ratio w/w and were sun-dried to moisture contents of 10% or less within 48 hr. Two separate feeding trials were conducted to determine performance of weaner-grower pigs fed diets containing the BYS mixtures. In the first trial, 3 diets were formulated: the maize-based control (GMG 1), and those containing mixtures of GMG and BYS at 1.5:1 (MYS2) and 1:1 (MYS3) ratios w/w. Three-way crossbred weaner pigs of Large White, Landrace and Hampshire breeds averaging 11.78kg liveweight and approximately 8 wk old were allocated in groups of 4 and fed each of the 3 test diets in two replicates, for 35 days. Performance data showed that ADG, ADF, Feed conversion ratio and feed cost/kg liveweight gain (N) were 0.43, 0.42, 0.40 kg; 1.03, 0.95, 0.96 kg; 2.59, 2.35, 2.39 and 17.28, 14.78, 14.11 for CMG1, MYS2, MYS3, respectively. In the second 35-day feeding trial, approximately 14 wk old three-way crossbred pigs similar to the above, and averaging 25.60 kg liveweight were fed diets based on maize grain (MSB), cassava root meal alone (CRM), or CRM mixed with BYS (CYS). ADG, ADF, FCR ratio and feed cost/kg liveweight gain (N) for MSB, CRM, CYS were 0.58, 0.56, 0.66 kg; 1.63, 1.60, 1.71 kg; 2.84, 3.07, 2.62 and 16.68, 13.42, 9.46, respectively. The inclusion of BYS in diets reduced their cost and improved feed utilization with consequent reduced cost of weaner-grower pig liveweight gain.

Key Words: Brewers Yeast Slurry, Maize, Cassava, Weaner-Grower Pigs.

INTRODUCTION

Brewers yeast slurry (BYS) is an industrial brewing by-product which is rich in protein, amino acids, vitamins, minerals, carbohydrates and fats (Peppler, 1970; Hough *et al.*, 1982). Animal feeding studies involving lactating cows (Steckley *et al.*, 1979a), growing-finishing pigs (Martynov *et al.*, 1984); broiler starters (Njike *et al.*, 1987), portray BYS as a valuable and qualitative alternative protein material for livestock feeding. Despite this potential, the role of BYS in animal feeding regimes remains largely obscure in Nigeria (and perhaps many other countries globally). This may not be unconnected with preservation imperative if BYS is to maintain its nutritional keeping qualities. The factory drying which has been the most effective method of preserving BYS is no longer popular due to global concern over energy costs. Preservation of BYS has been carried out by addition of chemicals (Namory, 1975; Steckley *et al.*, 1979b), but the stability in DM and protein could not be maintained beyond 2 months.

Cassava (*Manihot spp.*) products have for long been utilized as energy sources in livestock feeding in Asian, European and Tropical countries (Hutagalung, 1977). It is widely believed that due to its high yield and favourable price compared with feed grains, cassava production will increase globally; and a grater proportion of it will be utilized in animal feeding towards the end of the 20th Century. Since it is much lower in protein content than the cereal grains it replaces in diets, enhancing the protein status of cassava would improve its feed value and usability by farm stock. Microbial fermentation has reportedly improved cassava protein content by a factor of 6-8 (Gray and Abou-El-Seoud,

1966). Fermentation with *Rhizopus* fungi (Stanton and Wallbridge, 1969; Varghese *et al.*, 1977), and with *Aspergillus* sp (Reade and Gregory, 1975), was reported to have substantially increased the protein content of cassava. The fermented cassava products were found to be promising in pig feeding (Hutagalung and Tan, 1976). The present study was designed to preserve BYS on ground maize grain and cassava root meal, and to determine the effect of including the preserved materials on the performance of weaner-grower pigs.

MATERIALS AND METHODS

Brewers Yeast Slurry Preservation

Brewers yeast slurry was collected in several batches from Benue Breweries Limited, Makurdi over a 12 wk period. Each batch was sampled immediately after collection and analysed for DM and CP. Preservation of the BYS was based on the principle of reducing its moisture content by diffusion or absorbance with a dry, powdery material providing a large surface area, and thereafter achieve a quick and effective sun-drying. The BYS was mixed with ground maize grain (GMG) at 1:1.5 and 1:1 ratios w/w; and with cassava root meal (CRM), sun-dried, milled whole cassava root chips, at 1:1 ratio w/w. The mixtures were sun-dried to moisture levels of approximately 10%, usually within 48 hours during the dry harmattan weather.

Proximate chemical composition of BYS, GMG, CRM and their sun-dried mixtures was determined using the A.O.A.C. (1984) methods. The batch mixtures were pooled and stored in polythene sacks until they were incorporated into test diets for the conduct of pig feeding trials.

Pig Feeding Trials

Two separate feeding trials were conducted to observe the effects of including the preserved BYS mixtures in diets on the performance of weaner-grower pigs. In the first trial, approximately 8wk old three-way crossbred weaner pigs of Large White,

Landrace and Hampshire breeds were obtained from the Pig Production Unit of University of Agriculture, Makurdi. The pigs were held on a balanced 18% CP weaner ration and dewormed prior to being placed on the experimental diets. At the average liveweight of 11.78 kg, the pigs were allocated to each of the test diets in groups of four, and in two replicates. All groups of pigs were balanced in respect of their litter origin, liveweight and sex. The pigs were randomly housed in their groups, in concrete - floor pens measuring 2 x 3m, where they were fed their test diets to appetite, while water was provided *ad libitum*.

Three test diets were formulated, which were, a maize-based control (CMG1) containing 20% of a 44% CP prepress solvent extracted soyabean meal. The other two diets contained mixtures of GMG and BYS at 1.5:1 (MYS2) and at 1:1 (MYS3) ratios w/w. These mixtures replaced all the GMG and respectively 40% and 55% of the soyabean meal component of the control diet. The percentage composition of the test diets is given in Table 2. The diets were costed (Table 2) using 1993 Benue State market prices of the feed ingredients (Table 1). Daily feed consumption and weekly pig weights were recorded on group basis, from which data, average daily feed (ADF), average daily weight gain (ADG) and feed/gain ratios were calculated. Feed cost per kg liveweight gain (N), was obtained for all pig groups by multiplying the feed/gain values by the respective dietary costs. The data were analysed using the single-factor classification analysis of variance according to Steel and Torrie. (1980).

In the second feeding trial, approximately 14 wk old crossbred grower pigs (as with the weaners) of approximately 25.60 kg liveweight were allocated in groups of four, to each of 3 dietary treatments. The source and breeds of the pigs, the experimental design and conduct, were the same as described in the first feeding trial. The test diets comprised a control (MSB) which contained mainly maize and roasted full-fat soyabean, while in the other

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TABLE 1: MARKET PRICES OF FEED INGREDIENTS USED IN THE FEEDING TRIALS^a.

Ingredient	1993 Market Price (N/tonne)
Maize grain	7,500.00
Cassava root meal	3,600.00
Soyabean (Full-fat)	7,500.00
Soyabean meal	9,000.00
Maize offals	1,200.00
Brewers dried grain	1,000.00
Bone meal (ash)	2,500.00
Salt (NaCl)	5,000.00

^a Operating price in Benue State, Nigeria, between January - August, 1993.

TABLE 2: SUN-DRIED MAIZE-BREWERS YEAST SLURRY MIXTURES IN PIG DIETS: PERCENTAGE COMPOSITION AND COST OF THE TEST DIETS, TRIAL 1.

Ingredient	Dietary Treatment		
	CMG1	MYS2	MYS3
Maize	67.0	-	-
GMG-BYS 1.5:1 ^a	-	75.0	-
GMG-BYS 1:1 ^b	-	-	78.0
Soyabean meal	20.0	12.0	9.0
Dried brewers grain	10.0	10.0	10.0
Bone meal	2.5	2.5	2.5
Salt (NaCl)	0.5	0.5	0.5
Zinc Oxide ^c	+	+	+
Cost of Diet, N/tonne	6,912.50	6,289.50	5,954.79
Cost Differentials, %	0.00	9.01	13.85

^a Mixture (dry) contained average 13.56% CP; 89.28% GMG, 10.72% BYS.

^b Mixture (dry) contained average 14.56% CP; 84.74% GMG, 15.26% BYS.

^c Added to supply 100 ppm zinc.

TABLE 3: SUN-DRIED MAIZE-BREWERS YEAST SLURRY MIXTURES IN PIG DIETS. CHEMICAL COMPOSITION OF THE TEST DIETS (%DM) TRIAL 1.

Component	CMG1	Dietary Treatments	
		MYS2	MYS3
Dry Matter	90.47	91.12	90.88
Crude protein (N x 6.25)	18.05	18.40	18.94
Ethyl extract	5.00	4.35	4.23
Crude fibre	4.54	4.02	4.00
Ash	2.98	3.17	3.06
Nitrogen-free-extract	69.43	70.06	69.77
Calcium ^a	1.01	1.00	0.99
Phosphorus (available) ^a	0.60	0.62	0.58
Lysine ^a	0.84	0.88	0.92
Methionine + Cystine ^a	0.59	0.58	0.59
Metabolizable energy (Kcal/kg) ^a	3411	3402	3393

^a Calculated values.

TABLE 4: PERCENTAGE COMPOSITION OF EXPERIMENTAL DIETS. TRIAL 2.

Component	MSB	Dietary Treatments	
		CRM	CYS ^a
Maize	60.00	-	-
Cassava root meal	-	60.00	-
CRM-BYS ^a	-	-	70.00
Maize Offals	12.00	-	-
Soyabean	15.00	27.00	17.00
Dried brewers grain	10.00	10.00	10.00
Bone meal	2.50	2.50	2.50
Salt (NaCl)	0.50	0.50	0.50
Zinc oxide ^b	+	+	+
Cost of Diet, N/tonne	5,956.50	4,372.50	3,611.34
Cost Differentials, %	0.00	26.59	39.37

^a Mixture (dry) contained average 8.65% CP, 85.27% CRM, 14.73% BYS.

^b Added to supply 100 ppm zinc.

TABLE 5: CHEMICAL COMPOSITION OF THE EXPERIMENTAL DIETS (%DM) TRIAL 2.

Component	MSB	Dietary Treatment	
		CRM	CYS
Dry matter	89.89	91.06	91.33
Crude protein	16.43	16.04	16.22
Ether extract	6.16	5.69	4.45
Crude fibre	6.56	5.10	6.21
Total ash	3.06	4.00	3.97
Nitrogen-free extract	67.76	69.17	69.15
Calcium ^a	1.00	1.13	1.12
Phosphorus ^a	0.59	0.61	0.69
Lysine ^a	0.72	0.94	0.99
Methionine ^a	0.26	0.23	0.24
Metabolisable energy (KCal/kg) ^a	3376	3525	3447

^a Calculated values.

TABLE 6: PROXIMATE CHEMICAL COMPOSITION^a OF BYS, GMG, CRM, AND THE BYS - PRESERVED MIXTURES.

Material	DM %	Crude Protein	Crude Fibre	Ether Extract % of DM	Ash	NFE**
BYS	15.92	45.90	4.52	0.87	8.95	40.00
GMG	88.98	9.67	2.15	4.10	1.50	82.60
CRM	92.30	2.40	2.20	0.60	2.80	91.50
GMG:BYS						
1.5:1	90.08	13.58	2.47	3.89	2.48	77.58
1:1	89.88	14.60	2.58	3.59	2.76	76.48
CRM:BYS	91.55	8.68	2.54	0.74	3.89	84.15

^a Means of 5 determinations.

NFE = Nitrogen-free extract.

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TABLE 7: CRUDE PROTEIN CONTENTS^a OF 6 BATCHES OF BYS AND THE PRESERVED MIXTURES WITH GMG.

Batch No.	BYS	GMG: BYS Mixtures	
		Ratios w/w	
		1.5:1	1:1
% of DM ^b			
1.	45.72	13.78	14.52
2.	49.18	13.82	15.09
3.	44.90	13.15	14.40
4.	45.90	13.89	14.87
5.	45.22	13.30	14.26
6.	45.03	13.43	14.21
Mean $\pm$ SD	45.99 $\pm$ 1.61	13.56 $\pm$ 0.24	14.56 $\pm$ 0.35
Average % increase in CP content of GMG ^c		40.23	50.57

^a Values are means of two (duplicate) determinations
^b The 6 batch DM mean $\pm$ SD; range = 15.46 $\pm$ 0.93; 14.72-17.90.
^c GMG contained average of 9.67% CP on dry matter basis.

TABLE 8: CRUDE PROTEIN CONTENTS^a OF 6 BATCHES OF BYS AND THE PRESERVED MIXTURES WITH CRM

Batch No.	BYS	CRM: BYS Mixture at 1:1 Ratio w/w <u>% of DM^b</u>	Percent increase in CP content\ of CRM ^c
1.	46.85	8.79	266.25
2.	46.23	8.75	264.58
3.	46.66	8.48	253.33
4.	43.35	7.90	229.17
5.	50.98	9.08	278.33
6.	47.55	8.90	270.83
Mean $\pm$ SD	46.99 $\pm$ 2.46	8.65 $\pm$ 0.42	260.42 $\pm$ 17.36

^a Values are means of two (duplicate) determinations.
^b The 6-batch DM mean $\pm$ SD; range = 16.16 $\pm$ 0.96; 14.57-17.49.
^c CRM contained an average CP of 2.40% on dry matter basis.

TABLE 9: MAIZE-BREWERS YEAST SLURRY MIXTURES IN PIG DIETS. SUMMARY OF PIG PERFORMANCE AND FEED COST/KG BODY WEIGHT GAIN

Parameter	Dietary Treatments SE			SE
	CMG1	MYS2	MYS3	
Number of pigs	8	8	8	
Avg. initial weight (kg)	11.92	11.50	11.92	
Avg. final weight (kg)	26.67	26.04	25.88	
Avg. daily gain (kg)	0.43	0.42	0.40	0.03 NS
Avg. daily feed (kg)	1.03	0.95	0.96	0.05 NS
Avg. Feed/gain ratio	2.50	2.35	2.37	0.22 NS
Avg. Feed cost/kg gain (N)	17.28 ^b	14.78 ^a	14.11 ^a	1.55 [*]
Feed Cost/kg gain Differentials, %	0.00	14.47	18.34	

NS = Not significant (P < 0.05).

^{*}Significant treatment differences (P < .05)

^{a,b} Means within the same rows with different superscripts differ (P < .05).

TABLE 10: PERFORMANCE OF PIGS FED MAIZE, CASSAVA ROOT MEAL OR CASSAVA ROOT MEAL MIXED WITH BREWERS YEAST SLURRY IN DIETS.

Parameter	Dietary Treatments			SE
	MSB	CRM	CYS	
Number of pigs	8	8	8	
Avg. initial weight (kg)	25.70	25.32	25.67	
Avg. final weight (kg)	45.70	44.85	48.68	2.05 NS
Avg. daily gain (kg)	0.58	0.56	0.66	0.06NS
Avg. daily feed (kg)	1.63	1.60	1.71	0.05NS
Avg. feed/gain ratio	2.84	3.07	2.63	0.25 NS
Avg. Feed cost/kg gain (N)	16.68 ^b	13.42 ^b	9.46 ^a	3.62 [*]
Feed cost/kg gain Differentials, %	0.00	19.54	43.29	

NS = Not significant (P > .05)

two, the maize was replaced by cassava root meal alone (CRM), or by the CRM-BYS mixture (CYS). The percentage composition and cost of the diets are presented in Table 4. The data were analysed as in the first trial.

RESULTS AND DISCUSSION

Proximate Composition of Brewers Yeast Slurry and its Mixtures with Maize and Cassava Root Meal

The proximate chemical composition of BYS, the carbohydrate base materials and the sun-dried mixtures is summarized in Table 6. The mean DM and CP values of 15.92% and 45.90%, respectively show that the BYS involved in the present study is a very wet material which is rich in protein content. The values reported in Tables 7 and 8 indicate batch variability in DM and CP. These values are within the range reported by Steckley *et al* (1979b), but could vary from brewery to brewery according to the strain of yeast used, type of fermenting vessel used, and other operational brewing conditions. When mixed with GMG and CRM at the defined rations, the BYS mixtures dried effectively within 48 hour during the dry harmattan season. It took longer periods (3 to 4 days) to dry the mixtures during the rainy season, and mould infestation was difficult to avoid. The BYS greatly enriched the crude protein contents of GMG and CRM on which it was preserved (Tables 7 and 8). Of particular importance was the increase in CP content of CRM from 2.40% to 8.65%, the enhanced value which was close to GMG protein content. The BYS-enriched CRM could thus replace maize grain in diets without the high protein deficits which would result if CRM as a sole energy source were to replace maize. It is of course recognized that in non-ruminant animal nutrition, crude protein content of a feed is important especially for purposes of ration formulation. However, the amino acid profile of such a feed portrays its nutritive values more fully. Thus it would have been of greater benefit had the amino acid composition of the BYS mixtures been determined. In the absence of such information, the pig feeding

trials involving the mixtures were conducted which brought out the practical nutritive value of the material.

Performance Characteristics and Economics of Weaner-Pig Production: Trial 1.

Performance of weaner pigs fed diets containing GMG-BYS mixtures is summarized in Table 9. Average daily feed, average daily gain and feed/gain values were the same ($P > 0.05$) for all the dietary treatments. It is probable that amino acid balance was not adversely affected as BYS protein replaced portions of soyabean meal protein in the diets. Feed cost for each kg body weight gain was however significantly lower ($P < 0.05$) for pigs consuming BYS in diets than for the control diet. Brewers yeast slurry obtained at no cost and preserved as described, had reduced the soyabean meal content of CMG1 by 40 and 55% in MYS2 and MYS3 respectively. The cost of the diets were thus reduced proportional as BYS increased in the mixtures (Tables 2). The marginal improvement in the utilization of MYS2 and MYS3 combined with their lower cost appeared to magnify the production cost advantage of these diets over the control (Table 9).

Performance Characteristics and Economics of Grower Pig Production: Trial 2.

The performance data obtained from the second feeding trial, for grower pigs fed maize, CRM or CRM/BYS mixture in diets (Table 10) showed no significant differences ($P > 0.05$) due to dietary effects. Worthy of note however were the marginally better pig growth rate and feed utilization recorded for CYS over the other two diets. Brewers yeast slurry was thought to have been responsible for the improved performance of the pigs fed this diet. This observation tends to support that of Barber *et al* (1971), who compared yeast with methionine and fishmeal at the same dietary level of nitrogen and observed that dietary yeast resulted in significantly better growth rate and feed efficiency of pigs fattened from 20 to 90 kg liveweight. Feed

cost per kg body weight gain was significantly lower for CYS ($P < .05$) than for CRM and MSB. This was because cassava, whose market price was less than half that of maize (Table 1) combined with BYS, an industrial waste product containing high CP, to produce a mixture which was both cheaper and of higher nutritional value than maize/soyabean and CRM/soyabean diets. Gohl (1981) reported BYS protein to contain higher levels of all the essential amino acids than those of cassava products, with the exception of arginine. Brewers yeast slurry protein also contains higher levels of the essential amino acids than those of maize grain, except for histidine, leucine and phenylalanine. It is therefore to be expected that when BYS is preserved on the carbonaceous feedstuffs using the simple technology described, the quantity and, more importantly, quality of protein of the feedstuffs will be markedly improved. Including such protein enriched material in diets has resulted in their more efficient utilization-as observed in both feeding trials of the present study. Additionally, the BYS - preserved mixtures are likely to contain irradiated yeast, which according to Krider (1971), is a cheap, more potent and practical source of vitamin D for pigs. Other workers (Ohle *et al.*, 1977; Salo and Pekkarinen, 1981), have also reported favourable performance of pigs fed yeast in diets. Martynov *et al* (1984) reported better weight gains for pigs fed hydrolysed yeast than the control-fed pigs. Avila *et al* (1985) reported the highest economic return when 40% of dietary concentrate was replaced by yeast culture.

SUMMARY AND CONCLUSION

The data obtained and discussed in the present study appear to have achieved the objective of obtaining alternative energy and protein feeds especially for non-ruminant animals. Cassava root meal is cheaper than maize grain but it replaced maize in grower pig diet without any ill-effects, and with reduced dietary cost of 26.60%. Using both maize and cassava root meal to absorb BYS moisture resulted in mixtures that were

effectively sun-dried (which preserved BYS); and which contained much higher protein levels than the carbohydrate feedstuffs. Including the preserved mixtures in diets reduced dietary cost even further and improved utilization of the diets by weaner-grower pigs. This method of preserving BYS is simple and adaptable and would benefit small - and medium - holder producers. Cassava can be produced in nearly all ecological zones in Nigeria, and may be used as the energy source especially in pig finishing schemes in place of the more expensive and scarce cereal grains. Producers who have access to brewers yeast slurry may further benefit from using CRM by producing the CRM:BYS sun-dried mixture for improved pig performance at markedly reduced production costs. It is recognized of course that a wide adoption of the practice may inevitably attract some cost to BYS, which would reduce its production cost advantage. However, it is expected that at its highest, such a cost would remain far below that of conventional protein sources. Furthermore, that an alternative protein source exists would make the BYS-mixtures scheme attractively lasting.

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