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Growth Performance and Economic Benefit Analysis of Weiner - Grower Pigs Fed Brewer Yeast Slurry: Maize Offal Mixture Included Diets

*Achadu, G.O[1]., Kaankuka, F.G[1]., Ikurior, S.A[1]. And Adenkola, Y.A[2]
1. Department of Animal Nutrition, University of Agriculture, Makurdi
2. Department of Veterinary Physiology and Anatomy, University of Agriculture, Makurdi
**Corresponding author: Achadu, G.O. Email: godwinachadu@gmail.com*

Abstract: *This study was conducted to evaluate the replacement value of full-fat Soya beans (FFSB) with brewers yeast slurry- maize offal (BYS –MO) mixture in the diets of weaner grower pigs. Sixteen cross-bred (Large White X Landrace X Hampshire breeds) pigs averaging 14 kg body weight were allocated to four treatments such that each treatment had four pigs, each pig serving as a replicate in a Completely Randomized Experimental Design (CRD). The diets which were formulated to contain 18% crude protein and 3300 Kcal/kg Metabolizable energy (ME), had BYSMO replacing full fat soy bean at 0, 33, 66 and 100% (corresponding to T1, T2, T3 and T4 respectively). The pigs were fed the test diets for 56 days. Parameters measured included growth performance and economic benefit assessment. Results showed that the fluid BYS had a CP of 45.27% on dry matter basis, and a dry matter (DM) of 15.40%.The dried resultant (BYS- MO) mixture had a CP of 36.60% and a DM of 90%, which compared favourably with FFSB whose CP and DM values were 38.20% and 90.24% respectively. Replacement of BYS-MO for FFSB did not elicit any significant effect on growth performance parameters. Average daily feed intake and average daily weight gain decreased as the BYS-MO mixture increased in the diets. Feed conversion ratio (FCR) and protein efficiency ratio (PER) increased as the BYS- MO mixture increased in the diets. The economic benefit assessment showed that the feed cost ₦/kg and the cost/kg weight gain decreased as the inclusion levels of BYSMO increased. It was concluded that the BYSMO inclusion offered a viable alternative for efficient feeding of weaner grower pigs. It was recommended that farmers can adapt the mixture levels of BYS and MO as well as its complete replacement of FFSB in diets of weaner- grower pigs.*

Keywords*: Growth performance; Pigs; Full fat Soya beans; Brewer yeast slurry – maize offal mixture*

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I. Introduction

The problem of feed supply and availability on a sustainable basis has been the major concern of the livestock industry in Nigeria and other developing nations of the world. This global feed crisis may not necessarily be attributed to shortage in production alone, but also to the various uses to which agricultural produce are put in recent times [1]. For instance, apart from the use of agricultural produce for food, animal feed, production of industrial chemicals like starch and glue, most recently, the conversion of energy foods to bio-fuel, constitutes some of the major causes for feed shortage [1][2].The animal protein intake of the average Nigerian is about 70 g per caput per day[3] whereas the minimum protein intake as recommended by FAO [3] is about 77 g per caput per day for developing countries and that at least 50% (i.e. 38.5 g /caput/day) should be of animal origin (meat, milk, eggs, and fish).

It has been reported that feed accounts for about 70-80% of cost of livestock production [4]. With today's prevailing economic crunch, it has become imperative to source for alternative feed ingredients, which should be cheap and yet capable of supplying the nutrients required by the animal for optimal growth and production. These alternative feed sources will also reduce the cost of livestock production in the country. 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 [5][6].According to [7], protein of animal origin as constituted in milk, meat, cheese and eggs provides a concentrated source of amino acid in suitable proportions for human need The importance of animal protein is not only because it is palatable but also due to its high biological value and amino acid balance compared to those of plant origin [8][7]. The reason for the low level of animal protein intake is the low productivity of the various classes of livestock [9] occasioned by the slow growth rate, long generation interval and reproductive cycle of the cattle, which supply the greater proportion of meat in Nigeria. Because of the high demand for these animal products and their short supply, their prices are usually beyond the reach of most of the populace.

The most plausible way out of this problem is to find a means of rapid expansion in the production of the quick-turnover type of animals such as broilers, rabbits and the pig. This is because the pig has got all the attributes to meet the objective. It requires a relatively small space, has a fast growth rate, good feed conversion efficiency, high dressing percentage of between 60-80% and is highly prolific, with a high fecundity, farrowing 10-14 piglets per litter and two and a half litters a year [10][11]. The pig does best when fed cereal based diets which will place it in direct competition with man where grain supply is inadequate and this is because the pig is a monogastric, an omnivore, and a voracious eater. Protein source is most frequently the limiting factor in pig diets both in quantity and quality. This is because cereal grains and their by products which form the bulk of pig diets are low in protein and their protein is deficient in the essential amino-acids [12][4]. Since good quality conventional protein supplements are the most expensive, there is the tendency to feed too little with the resultant consequence of deficiencies and retarded performance of the pigs. One possible way out of this problem therefore, is to look for less expensive, readily available and nutritionally competent unconventional protein source for inclusion in pig rations such as oil seedcakes, brans, offal, peels, pulps and oil sludge. One of such materials is brewer's yeast slurry (BYS), an agro-industrial by-product. Brewer's yeast slurry is a spent product of yeast, which has been used in the fermentation of malt in beer brewing. It is brown slurry, which is normally run off through gutters as a waste product and discharged in water bodies by most breweries in Nigeria. This slurry that could otherwise cause environmental hazard has a potential for use in livestock feeding. It is a valuable by-product containing high amounts of proteins (about 45% of its dry matter) [12][13][14]. The protein is high in amino acids, particularly lysine, vitamins, carbohydrates and fats [15][16]. Despite its good attributes, the use of BYS as a sole protein source is limited due to its short shelf life; low dry matter content as well as the power constraints in drying the slurry, which has compelled most breweries to discard it.

Following the development of a simple on-farm adaptable technology for preserving brewers yeast slurry [13], and its application in feeding growing-finishing pigs [17][18][14], whereby the BYS is mixed with the powdery carbohydrate feedstuffs which is less proteinous e.g. ground maize, ground dried cassava chips, cassava peel meal, rice bran and maize offal whose powder absorbs most of the moisture in the BYS before sun-drying to a moisture content of 10% or less. This technology increases the protein quantity and quality of such feedstuffs, and also stores for longer periods. The objective of the study was to evolve an effective method of preserving brewers yeast slurry (BYS) and to determine the replacement value of brewers yeast slurry-maize offal mixture (BYS-MO) for full –fat Soya beans (FFSB) in diets of weaner-grower pigs.

II. Materials and Methods

2.1 Location of Study

The laboratory assay of the different feed ingredients and test diets were carried out at the Animal Nutrition Laboratory of the Federal University of Agriculture, Makurdi. The feeding trial was conducted at the Pig Production Unit of the Livestock Teaching and Research Farm of the Federal University of Agriculture, Makurdi, Benue State, Nigeria. The experimental site is located at the North Core area of the University of Agriculture, Makurdi and lies approximately on latitude 7^0 43' N and longitude 8^0 3' E [19]. It is within the Southern Guinea Savannah Zone of Nigeria. The climate is tropical, with an annual rainfall of about 1016-1200mm and a relative humidity of about 57-85% [20].

2.2 Preparation of Brewers Yeast Slurry – Maize Offal Mixture

Fifteen batches of brewers yeast slurry (BYS) of *Saccharomyces carlsbegensis* were obtained in 50 litre screw-top plastic containers from Benue Brewery Plc, Makurdi, Benue State over a period of six months. The material was collected from fermenting vats/vessels when yeast used in the fermenting process was judged to be spent. Each batch was taken to the University of Agriculture Makurdi within 30 minutes of collection, and immediately sampled for dry matter (DM) and crude protein (CP) analysis. One sample from each of five batches was analyzed for proximate chemical composition, using the [21] methods. The BYS was mixed with the maize offal (MO) within one hour of its collection, in the ratio of 2:1 weight/weight, (2 parts of BYS to 1 part of MO). The ratio was selected on the basis of the absorbability of MO and on the adjudged ease of sun-drying the mixture effectively considering the prevailing weather conditions, and experience from previous studies [17][14]. The mixing was done by hand in plastic containers until a homogenous blend was achieved and then spread thinly on concrete floor to sun-dry to a moisture content of about 8%. While drying, the mixture was manually agitated many times to ensure that it dried quickly without the formation of clods which would harden on drying. The dried mixtures were sampled for proximate chemical composition using the [21] procedure.

2.3 Experimental Pigs and Management

Sixteen (16) crossbred weaner-grower pigs of Large White X Landrace X Hampshire breeds, weighing an average 14 kg were used for the study. Four (4) pigs (two males and two females) were randomly allocated to each of the four treatments in a Completely Randomized Design. There were four replicates per treatment. The

pigs were housed on concrete floors and in individual feeding pens measuring 1.8m x 0.76m. All pigs were dewormed with an injectable dewormer (levamisole) at the rate of 1.0 ml per 20 kg body weight.
The pigs were individually weighed and allocated in such a way as to balance for initial body weights in all the treatments. The experimental diets (Table 1), in mash form, and clean drinking water were provided throughout the experimental period of 56 days.

Growth Performance Assessment

Feed intake, weight gain, feed conversion ratio, protein efficiency ratio, and economic analysis were the indices used to assess performance.

For Feed intake determination, a measured quantity of feed (900 g/pig) was supplied daily, initially until when it was found that the pigs could eat more of the diets. This feed allowance was split into two with one-half fed in the morning (8:00 am) and the other half fed in the afternoon (2:00 pm). This was to avoid feed wastage. The left over feed each morning was subtracted from quantity supplied to obtain the daily feed intake.

For weight gain determination, all the pigs were weighed at the inception of the experiment and weekly thereafter to compute the weekly change in weight. Weighing was normally done before morning feeding.
Protein efficiency ratio (PER) was calculated as the ratio of body weight gain to protein consumed as:

$$PER = \frac{\text{Gain in body weight (g)}}{\text{Protein consumed (g)}}$$

The feed conversion ratio or feed/gain ratio was calculated as the ratio of feed intake to live weight gain.

$$FCR = \frac{\text{Total feed intake (kg)}}{\text{Total weight gain (kg)}}$$

2.4 Statistical Analysis

Mean values of various parameters for the dietary treatments were subjected to one way analysis of variance (ANOVA) using [22] and where significant differences occurred; the means were separated using New Duncan Multiple Range Test as outlined in the [22] package.

Table 1: Ingredient and nutrient composition of diets containing BYS-MO fed to weaner – grower pigs

Ingredient (%)	T1	T2	T3	T4
Maize	46.80	46.80	46.80	46.80
Full fat Soya beans	30.00	20.00	10.00	0.00
BYS – MO	0.00	10.00	20.00	30.00
Brewers dried grain	20.00	20.00	20.00	20.00
Bone ash	2.50	2.50	2.50	2.50
Salt	0.50	0.50	0.50	0.50
Vitamin mineral premix [(a)]	0.20	0.20	0.20	0.20
Zinc oxide [(b)]	+	+	+	+
Nutrient composition				
Crude protein	18.20	18.80	18.88	18.00
Crude fibre	4.50	5.85	6.87	7.88
Ether extract	5.00	4.80	4.65	4.50
Ash	4.46	5.10	5.24	5.81
Nitrogen free extracts	67.84	65.45	64.45	63.81
ME (Kcal/kg)[++]	3490.72	3411.72	3366.90	3300.71

(a) Vitamin Mineral Premix (Bio-Mix Grower), supplied the following per kg of the product Vit. A 8,000,000.00 iu; Vit. D_3 1500,000.00 iu; Vit. E 7,000.00 mg; Vit. K_3 1,500.00mg; Vit. B_1 2,000.00mg; Vit. B_2 2,500.00mg; Niacin 15,000.00mg; Pantothenic Acid 5,500.00mg; Vit. B_6 2,000.00mg; Vit. B_{12} 10.00mg; Folic Acid 500.00mg; Biotin 25.00mg, Choline Chloride 175,000.00mg; Cobalt 200.00mg; Copper 3,000.00mg; Iodine 1,000.00mg; Iron 21,000.00mg; Manganese 40,000.00mg; Selenium 200.00mg; Zinc 31,000.00mg; Antioxidant 1,250.00mg.
(b) Zinc Oxide added at the rate of 12.48g/100kg ration to supply 100ppm elemental zinc.
ME^{++} - Metabolisable Energy calculated from the determined proximate components using the formula.
ME = 37.0 (%CP) + 81.8(%EE) + 35.5(%NFE) (Pauzenga, 1985)

III. Results

3.1 Proximate Composition of the Test and dietary Inputs

The proximate composition of the test inputs, BYS and MO and BYS-MO are presented in Table 2 while that of ground maize (GM) and FFSB are presented in table 3. The proximate composition of BYS were 15.40, 45.27, 2.88, 0.92, 4.68 and 46.25; that of MO were 89.60, 10.40, 8.15, 2.90, 2.00 and 76.55 while that of BYS-MO were 90,00, 36.60, 3.84, 1.72, 2.44 and 55.40% for DM, CP, CF, EE, Ash and NFE respectively. Comparatively, the GM had a very high DM (89.90%), a low CP (9.76%), low CF (2.14%), moderate EE

(11.20%), Ash (1.51%) and a high NFE (82.39%). The FFSB had a high DM (90.24%), high CP (38.20%), high EE (18.00%) but low CF (4.25%), low Ash (4.20%) and a moderate NFE (35.50%).

Table 2. Proximate composition of brewer yeast slurry, maize offal and brewer yeast slurry-maize offal mixture

Nutrient (%)	BYS	MO	BYS – MO
Dry matter	15.40	89.60	90.00
Crude protein	45.27	10.40	36.60
Crude fibre	2.88	8.15	3.84
Ether extract	0.92	2.90	1.72
Ash	4.68	2.00	2.44
Nitrogen free extracts	46.25	76.55	55.40

Values are means of five determinations
BYS – Brewers yeast slurry; MO - Maize offal; BYS – MO Brewers yeast slurry – Maize offal mixture

Table 3. Proximate composition of ground maize and full fat Soya bean

Nutrient (%)	GM	FFSB
Dry matter	88.90	90.24
Crude protein	9.76	38.20
Crude fibre	2.14	4.25
Ether extract	4.20	18.00
Ash	1.51	4.20
Nitrogen free extracts	82.39	35.50

Means are values of three determinations; GM – Ground maize; FFSB - Full-Fat Soya beans

3.2 The Effect of replacing full-fat Soya beans with BYS-MO mixture in diets on the growth performance and economic benefits of weaner-grower pigs

The weaner-grower pig performance and economics of production data are presented in table 4. In general, there were no significant effects (P>0.05) of the replacement of FFSB by the BYS-MO on the growth performance of the weaner – grower pigs. The average initial body weights of the pigs were approximately 14 kg and the average final weights were approximately 32.73 kg. Average daily feed intake decreased with increased BYS-MO mixture inclusion in diets from 0.85 kg in T1 to 0.82 kg in diet T4. Average daily gain decreased with increased BYS-MO mixture inclusion from 0.31 kg in T1 to 0.28 kg in T4. The FCR increased, while the protein efficiency ratio (PER) decreased with increased dietary BYS-MO mixture.
The feed cost (₦/kg) decreased with increase in BYS-MO level of inclusion, making T1 most expensive and T4 least expensive. Increasing levels of BYS-MO resulted in reduction in quantity of FFSB (the most expensive component) and consequently the cost of these diets. The cost (₦) per kilogram weight gain decreased as the BYS-MO levels increased from T1 (₦232.22) to T4 (₦150.16).

Table 4. Growth performance and economic benefits of weaner – grower pigs fed BYS-MO included diets

Parameter	T1	T2	T3	T4	SEM	LOS
Initial body weight (Kg)	14.15	14.13	14.18	14.23	-	-
Average daily feed intake (Kg)	0.85	0.84	0.83	0.82	0.09	NS
Average daily weight gain (Kg)	0.31	0.30	0.29	0.28	0.02	NS
Final body weight (Kg)	33.50	32.68	32.55	32.13	0.81	NS
Feed conversion ratio	2.74	2.80	2.86	2.93	0.11	NS
Protein efficiency ratio	1.78	1.72	1.73	1.68	0.11	NS
Feed cost (₦/kg)	84.75	74.58	62.42	51.25	-	-
Cost / kg weight gain (₦)	232.38	208.82	178.65	150.10	-	-

T1= had 0.00% BYS-MO; T2= had 10.00% BYS-MO; T3= had 20.00% BYS-MO; T4= had 30.00% BYS-MO

IV. Discussion

The analyzed chemical composition of the BYS-MO mixture shows the material to be at par with full-fat Soya beans (FFSB) in crude protein content (36.60%). Its dry matter (DM) content was also enhanced to 90%. These enhancements in the CP and DM value of the mixture in this study agree with earlier work by [13][17][14]. It also corroborates the reports of [23][24][16][25] that BYS contains 45% CP, 1% EE, and 3% CF. [26] had earlier reported a chemical composition of yeast grown on feed/food supplement as 45-49% CP, 4-7% EE, and 36% NFE. The results from the present study also agrees with those of [13][17] who reported that BYS contained 15.95% DM, 45.60% CP, 4.52% CF, 0.87% EE, 8.95% Ash and 40.00 % NFE. The quantitative enhancement of the protein content of the mixture has shown that the mixture (BYS-MO) is a useful replacement for FFSB which has always been the conventional protein source in pig diets [10][17][4].

The final body weight of pigs, average daily feed intake, average daily weight gain values were reported to have decreased non-significantly (P>0.05) with increasing BYS-MO levels in the diets. The lack of significant difference in these parameters show that the BYS-MO mixture served very well as a replacement for full- fat Soya beans in the production of pigs at least cost. According to [27] pigs of 10-20 kg live weight should consume 0.95 kg of feed and have a daily gain of 0.45 kg with an FCR of 2.11. The pigs in the present study consumed 0.82 -0.85 kg of feed daily, which was somewhat lower than [27] value. The feed intake decreased with increase in BYS-MO mixture which would be due to the hops in the BYS, which is bitter, and would have reduced their appetite [28]. Furthermore, even though these NRC standards are temperate values, workers in the tropics, [17][14] reported similar intake (0.72-0.85 kg) of feed per pig per day for this category of pigs. Average daily weight gain was somewhat lower than the value of [27] which could be due to the reduced average daily feed intake. The FCR increased with increase in BYS-MO which shows a reduction in feed efficiency due to the increased crude fibre as BYS-MO increased in feed [29][30]. These workers reported that increase in crude fibre of a diet reduced its digestibility, FCR, and feed utilization. The PER did not show any definite response as the differences were only marginal. The feed cost per kg and cost ₦ per kg gain all reduced with increase in BYS-MO levels. The reduction in cost was due to the price differential between the BYS-MO and FFSB, but this did not translate to better performance by pigs fed the control diet over those fed the BYS-MO diets [17][14].

The higher cost of T1 did not translate into better performance by the pigs compared to those in the other treatments. This means that it costed ₦23.40, ₦53.57 and ₦82.06 for T2, T3 and T4 respectively to produce 1.0 kg pork than T1. This added incentive in the price reduction of the feed further supports the assertion that economic optimisation is one of the major reasons for the use of alternative feeds [31].

V. Conclusion

It was concluded that;

i. The preliminary study evolved an effective method for the preservation of BYS for use in pig diets by carrying it with a less proteinous but higher energy feedstuff, MO.
ii. The mixing ratio of 2:1 BYS-MO resulted in a mixture (BYS-MO) whose CP content of 36.6% was at par with that of full-fat soya beans (38.20% CP).
iii. The BYS-MO mixture levels used did not adversely affect performance of the pigs.
iv. The high cost of T1 did not translate into superior performance of pigs over the other treatments.
v. The total replacement (100%) of FFSB by the BYS-MO mixture substantially reduced the feed cost and increased the profit margin in pig production.

Recommendations

Based on findings from the present study, it was recommended that:

i. BYS should be preserved by carrying it on a less proteinous energy feedstuff, MO and sun-drying the mixture (BYS-MO). This is an equivalent replacement for FFSB in pig diet. The drying should be done during the dry periods to ensure proper drying without the formation of moulds.
ii. The use of BYS-MO mixture at up to 100% replacement level for FFSB in pig feeding resulted in economic benefits.
iii. The results from this study should be extended to pig farmers through the unified extension system for adoption to enhance reduced cost of pork production among the teeming pig farmers in Benue State and beyond.

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