Brewers' dried grain based diets

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Digestibility and nutrient utilization of pigs fed graded levels of brewers' dried grain based diets in Nigeria

Pigs can be fed 40% BDG diet without adverse effect on nutrient digestibility and N retention, although, the optimum inclusion should be 35%. (with the permission of Livestock Research for Rural Development).

Twelve castrated male hybrid (Large white x Landrace) pigs with average live weight of 15.2 kg (14.3-16.8 kg) and aged 13 weeks were used to determine the digestibility of brewers' dried grain (BDG) based diets. The inclusion levels of BDG were 0, 30, 35 and 40% in diets 1, 2, 3 and 4, respectively. The experiment, which was in a completely randomized design (CRD) had four treatments, each replicated three times. Locally designed metabolism cages (107 cm x 60 cm x 50 cm) were used in the experiment. Parameters measured were dry matter, crude protein, crude fibre, ether extract and nitrogen free extract (NFE) digestibility coefficients. Others were energy utilization and nitrogen (N) retention. Pigs fed 35% BDG diet had significantly (P<0.05) higher crude fibre (79.4%) and ether extract (87.6%) digestibility coefficients than those fed 30% BDG diet. Also dietary inclusion level of 30% BDG in the diet significantly (P<0.05) increased DM and N intakes of the pigs, while 35% BDG diet significantly (P<0.05) decreased them. There were no significant (P>0.05) differences among the pigs fed the graded levels of BDG diets in protein and energy utilization. It was concluded that pigs could be fed 40% BDG diet without adverse effect on nutrient digestibility and N retention, although, the optimum inclusion should be 35%.

Key words
: Brewers' dried grain, digestibility, nutrient utilization, pigs

Introduction

The use of agro-industrial by-products such as brewers' dried grain (BDG), maize gluten feed, wheat offal and palm kernel meal in non-ruminant feeding appears to be the available option left for farmers in Southern Nigeria to addressing the issue of competition between human beings and pigs for cereals and other conventional feed ingredients (Alade et al 2002). There is also the need to integrate animal production into the allied processing industries to ensure that animals play a complementary, rather than a competitive role with man in meeting feed requirements (Chenost and Mayer 1977).

Brewers' dried grain (BDG), which is a by-product of the breweries, has long been fed to the ruminants (Murdock et al 1981). It is very bulky, especially when wet, low in energy but high in crude protein (21%) and crude fibre (up to 20%) as reported by Yaakugh and Tegbe (1990) and Chenost and Mayer (1977).

The feeding of varying levels of BDG in pigs' diets has been evaluated by various researchers (Wahistom and Libal 1976; Tegbe 1985; Yaakugh and Tegbe 1990). Some of the reports indicated that high BDG levels in pigs' diets depressed feed intake and growth rate (Kornegay 1973), which was attributed to high dietary crude fibre intake (Yaakugh and Tegbe 1990). Yaakugh and Tegbe (1990) also reported that the bulky nature of BDG diets may have adversely affected the digestibility, as well as the availability of amino acids and other nutrients of pigs. There is need, therefore, to determine the extent to which pigs could digest and derive nutrients from diets based on high levels of brewers' dried grains. The objective of the study was to determine the digestibility and nutrient utilization of pigs fed graded levels of brewers' dried grain based diets.

Materials and methods

Location

This research was conducted at the Piggery Unit of the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. Brewers' dried grain and pigs were obtained from Nigerian Breweries, Aba, Abia State and the University farm, respectively.

Experimental pigs and their management

Twelve castrated male hybrid (Large white x Landrace) pigs with average live weight of 15.2 kg (14.3-16.8 kg) and aged 13 weeks were used in this study. The pigs were put individually in a metabolism cage (107 cm x 60 cm x 50 cm) locally designed and constructed with wood for this purpose. The cage floor was strong expanded metal gauze. The height of the cage from the ground was 60 cm. The feed and water trough areas of the cages were each 30 cm x 30 cm x 27 cm. The metabolism cages were placed inside one of the piggery houses. There were three cages in a pen measuring 3.95 m x 2.96 m. The feeding and water troughs areas were fitted with stainless bowls tightly secured to prevent the pigs from pouring away feed and water. The cage floor was covered with metal wire net for easy and total faecal collection, while an aluminum sheet placed underneath the cages served for urine collection. Urine was channeled through a plastic funnel containing a spongy sieve into a plastic container that was properly labeled.

Diets and feeding

Table 1.
Composition of the Experimental diets of graded levels of brewers? dried grain.

White maize	35.0	25.0	20.0	15.0
Soybean meal	20.0	10.0	10.0	10.0
Local fish meal	2.00	2.00	2.00	2.00
Brewers? dried grain	0.00	30.0	35.0	40.0
Maize offal	20.0	20.0	20.0	20.0
Wheat offal	19.0	9.00	9.00	9.00
Bone meal	3.50	3.50	3.50	3.50
Vitamin Premix*	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25

Total, %	100	100	100	100
Calculated				
CP, %	18.7	18.3	18.8	19.4
ME, MJ/Kg	11.4	11.7	11.4	11.1
CF, %	4.34	8.79	9.69	10.6
Lysine, %	0.56	0.71	0.75	0.78
Methionine, %	0.28	0.31	0.32	0.33
Ca, %	1.42	1.42	1.42	1.42
P, %	0.59	0.59	0.59	0.59
Analyzed Composition				
DM, %	91.0	92.1	91.5	91.4
CP, %	20.9	22.8	20.4	21.7
Ether extract, %	6.10	4.55	6.15	5.65
Crude fibre, %	5.00	8.90	9.80	10.6
Crude ash, %	7.80	8.45	8.30	8.10
Nitrogen free extract, %	51.2	47.4	46.8	45.3

** Composition per 2.5kg: Vitamin A 10000000IU, Vit.D 2000000IU, Vit E 20000IU, Vit K 2250mg, Thiamine 1750mg, Riboflavin 5000mg, Pyridoxine 2750 mg, Niacin 27500mg, Vit B12 15mg, Pantothenic acid 7500mg, Folic acid 7500mg, Biotin 50mg, Choline chloride 400gm, Antioxidant 125g, Manganese 80g, Zinc 50g, Iron 20g, Copper 5g, Iodine 1.2g Selenium 200mg, Cobalt 200mg.*

The proximate compositions of the BDG used in the study were dry matter 89.5%, organic matter 95.3%, crude protein (N x 6.25) 22.5%, ether extract (crude ether) 6.25%, crude fibre 21.0%, crude ash 4.70% and Nitrogen free extract (NFE) 35.1%.

Experimental design and data collection

The Experimental design was completely randomized design (CRD). There were four treatments, each treatment replicated three times. One castrated male pig was allotted to a treatment / replicate. The pigs were kept in the cages for nine days to acclimatize before data collection began. This also enabled the technical assistants to get used to the protocols of the experiment.

The pigs were starved for 12 hours prior to the experimental feeding to clear the gut of the previous meals, especially as markers were not used. They were also starved for another 12 hours at the end of the feeding period to ensure total collection of faeces arising from the diet offered.

Faeces and urine were collected separately on a daily basis every morning (7.30 am-8.30 am). The faeces were oven-dried at 60oC, weighed and put in a labeled plastic bag and stored in a deep freezer. Urine was also collected three times (7.00 am, 12.00 noon and 5.00 pm) daily in a labeled plastic container, with the record of the total weight and volume. About 10% of each day's collection was stored in 10 ml of 10% sulphuric acid to prevent nitrogen losses by evaporation of ammonia and help keep the urine pH below 4. The urine was stored in a deep freezer until required for analysis.

At the end of 7 days collection period, faeces from each replicate were mixed, ground and representative samples taken for proximate composition determination. The urine from each replicate was also mixed together and representative samples taken for nitrogen determination.

Chemical and data analyses

Proximate composition of diets and faeces, and nitrogen in urine were determined according to the method of AOAC (1990). The gross energy (GE) of feeds and faeces were calculated from the proximate components according to the equation of Ewan (1989):

GE = 4143 + (56 x % EE) + (15 x % CP) - (44 x % Ash)

Dietary GE intake minus the GE of faeces gave digestible energy (DE). Metabolizable energy (ME) intake was calculated as 96 percent of DE (Farrell 1979; Agricultural Research Council 1981; National Research Council 1998). The factor used for the correction of ME to nitrogen equilibrium (MEn) was 7.83 kcal/ g according to Wu and Ewan (1979). The equations of Close and Menke (1986) were adapted in calculating biological value (BV) and net protein utilization (NPU) as follows:

$$BV = \frac{N\ intake - (faecal\ N - FNe) - (urinary\ N - UNe) \times 100}{N\ intake - (faecal\ N - FNe)}$$

Where: FNe = endogenous N losses in faeces; UNe = endogenous N losses in urine.

$$NPU = BV \times \frac{IN - FN - FNe}{IN}$$

Where: IN = Nitrogen intake; FN = Faecal nitrogen

Data obtained were subjected to analysis of variance (ANOVA) for a completely randomized design (Steel and Torrie 1980). The values in percentages were subjected to Arcsine transformation before ANOVA, while differences between treatment means were separated with Duncan's Multiple Range Test (Duncan 1955).

Results and discussion

Apparent digestibility

The feeding of graded levels of BDG diets to pigs significantly (P<0.05) affected their DM intake (Table 2). Pigs fed 30% BDG diet had a significantly higher DM intake than others while those fed control (0% BDG) diet had the lowest. These differences were attributed to the differences in the DM content of the diets (Table 1). However, this did not significantly affect faecal DM, DM retention and DM intake as percentage of BW of the pigs. Organic matter (OM) intake, faecal OM and OM retention of the pigs fed the control and BDG diets were not significantly (P>0.05) different from each other.

Table 2.
Nutrient utilization and Apparent Nutrient Digestibility coefficients of pigs fed graded levels of BDG diets

Live weight, kg	16.8	15.4	14.3	14.4	1.30
Dry matter (DM) intake, kg	0.442 d	0.448 a	0.445 b	0.444 c	0.001
DM intake as % of BW	2.63	2.91	3.11	3.08	0.19
Faecal DM, kg	0.073	0.120	0.081	0.119	0.019
DM retention	0.369	0.323	0.355	0.321	0.019
Organic matter (OM) intake, kg	0.448	0.445	0.446	0.447	0.001
Faecal OM, kg	0.064	0.108	0.071	0.112	0.017
OM retention, kg	0.384	0.337	0.375	0.335	0.017
Digestibility coefficients, %					
Dry Matter	83.4	72.9	81.5	72.9	2.92
Organic Matter	85.8	75.8	84.1	74.9	3.87
Crude Protein	89.2	79.3	85.1	81.7	2.66
Crude Fibre	70.6ab	56.4b	79.4 a	62.1 ab	3.42
Ether Extract	85.6 a	64.6b	87.6 a	80.4 ab	3.67
NFE	87.3	78.7	84.5	74.5	3.09
Digestible Energy	86.2	75.6	84.6	75.9	2.82

a, b, c, d Means in a row with different superscripts are significantly different (P<0.05).

SEM = Standard error of mean. NFE = Nitrogen Free Extract.

Apparent nutrient digestibility coefficients of pigs fed different levels of BDG diets are also shown in Table 2. Pigs fed 35% BDG diet had significantly higher (P<0.05) crude fibre (CF) and ether extract (EE) digestibility coefficients than those fed 30% BDG diet. This could be attributed to the higher crude fibre level in the diets (Table 1), which may have provided enough substrate for microbial fermentation in the large intestine (Jensen 2001). This is considered so given that there were no significant differences between pigs fed 35 and 40% BDG diet in CF and EE digestibility coefficient values. Fibre utilization has earlier been reported to be influenced by the physical and chemical composition of the whole diet (Myer et al 1975), age and weight of the animal (Zivkovic and Bowland 1970), adaptation to the fibre source (Pollman et al 1979) and individual variation among pigs (King and Taverner 1975).

It was observed that BDG diets had high CF (56.4-62.1%) and very high EE (64.6-87.6%) digestibility coefficients, which suggests that the crude fibre content is mainly hemicellulose that is more digestible than cellulose (Uden and Van Soest 1982). The pigs may have also adapted well to the diets (Pollman et al 1979), having been fed for six weeks before the commencement of the study.

The results obtained in this study are in line with the apparent digestibility coefficients of 72, 75, 72 and 84% for CP, ether extract, CF and organic matter, respectively obtained by Dung et al (2002), but higher than that obtained by Norachack et al (2004) with local pigs fed *Stylosanthes* and cassava leaves as protein supplements to a basal diet of broken rice and that of Tram and Preston (2004) with pigs fed processed cassava leaves. The differences may have been due to diet composition, breed and age of pigs used. Significant differences did not exist among the pigs fed the graded levels of BDG diets in energy intake and utilization as shown in Table 3.

Table 3.
Energy utilization of pigs fed graded levels of BDG diets

GE Intake, MJ/ kg	9.05	8.88	9.00	9.00	0.41
Faecal GE, MJ/ kg	1.25	2.16	1.39	2.17	0.10
DE Intake, MJ/ kg	7.80	6.71	7.61	6.83	0.34
ME Intake, MJ/ kg	7.49	6.44	7.31	6.56	0.33
Men, MJ/ kg	7.46	6.41	7.27	6.52	0.33
ME as % of GE	82.7	72.6	81.2	72.9	2.54

SEM = Standard error of mean. GE, DE, ME and MEn = Gross energy, Digestible energy, Metabolizable energy and Metabolizable energy corrected for Nitrogen, respectively.

Nitrogen Balance and Protein Utilization

The level of inclusion of BDG in the diets significantly ($P<0.05$) affected only N intake of the pigs (Table 4), which did not significantly ($P>0.05$) influence digested N and N retention.

Table 4.
Nitrogen Balance and Protein Utilization of pigs fed graded levels of BDG Diets.

N Intake	16.3 c	17.7a	15.9 d	16.9b	0.01
Faecal N	1.76	3.66	2.37	3.08	0.57

N in Urine	4.66	3.69	5.42	5.93	1.53
Digested	14.5	14.0	13.5	13.7	0.58
Retention	9.84	10.4	8.10	7.79	1.50
Retention as % of					
Intake	60.6	58.5	51.0	46.3	9.05
Digested	68.0	73.8	59.7	57.2	10.6
Biological value, %	69.0	74.6	61.8	58.2	6.30
NPU	63.1	60.8	54.3	48.8	9.32

a, b, c, d Means in a row with different superscripts are significantly different (P<0.05).

SEM = Standard error of mean. N = Nitrogen; NPU = Net Protein Utilization.

This is in agreement with the results obtained by Tram and Preston (2004). The differences in N intake could be attributed to the differences in the crude protein content of the diets (Table 1). Retention as percentage of intake and digested N were also not significantly (P>0.05) affected. However, it could be observed that N retention numerically decreased with increase in the inclusion level of BDG in the diets. Retention as percentage of intake and digested N equally followed this trend. Kidder and Manners (1978) had reported that the digestibility of a particular protein will vary to some extent according to the level of feeding, will be influenced by other constituents of the diet and may also depend on the age and breed of the pigs used.

In our study, differences in N intake did not result in significant differences in N utilization of the pigs suggesting that the differences in N intake were not biologically important. The results also showed that N utilization of the pigs was not affected by the level of inclusion of BDG in the diets (Stanogias and Pearce 1985). It was equally observed that differences in DM intake as percentage of BW did not affect N retention of the pigs as reported by Tram and Preston (2004) with pigs fed diets containing processed cassava leaves.

Conclusion

- Pigs could be fed up to 40% brewers' dried grain (BDG) in the diet without adverse effect on nutrient digestibility and N retention of the pigs. However, the optimum inclusion level in the diet should be 35%.

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