THE EFFECTS OF GRADED LEVELS OF BREWERS' DRIED GRAINS AND MAIZE COBS IN THE DIETS OF PIGS ON THEIR PERFORMANCE CHARACTERISTICS AND CARCASS QUALITY

By

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SUMMARY

A TRIAL was run with 70 weaner Yorkshire and Yorkshire x Landrace pigs to determine the effects of graded levels of brewers' grains and maize cobs on the performance and carcass characteristics of pigs. The two products were included at the levels of 5, 10 and 15%, while the protein contents of the diet were maintained at approximately 20% throughout the experimental period that lasted from the initial weight of 17.0 kg to the slaughter weight of about 92 kg. Pigs were slaughtered at the pre-determined liveweight of 92 kg and were conventionally graded.

The results showed no significant differences among treatments and between products with respect to average daily gains and efficiencies of feed utilization, but the average daily feed and digestible energy intakes were significantly affected for the weight range of 17 to 55 kg, but not for the other weight ranges. Generally, pigs on brewers' dried grains tended to perform better than those on maize cobs but the differences were not always significant. With respect to carcass quality measurements, although there were no significant differences among treatment means, there was a tendency towards lower fat measurements and higher lean parameters as the levels of the products increased from 5 to 15%. There were some significant differences between the two products in the carcass measurements of pigs, and the measurements were closely alike in some other measurements. It is concluded that the two products can be conveniently used to replace the more expensive maize component at least up to the 15% level tested in this trial without seriously depressing the performance of pigs.

INTRODUCTION

THE whole world today is faced with a global inflation to an extent never before witnessed. While such a situation affects all industries operated by man, the livestock producer is particularly worried by the effects of such inflationary trends on his livestock feeds and hence on his cost of producing livestock and livestock products. When the ingredients for livestock feeds are available in large quantities, his problems are much more reduced than when they are in scarce supply as it is usually with the developing countries of the world. Even before the global inflation, the competition between humans and his livestock, particularly pigs and poultry with similar nutritional requirements as man himself, has always been very acute, principally because of under-production that has typified the economy of many of the developing countries. Naturally, the solution is to drastically increase the production of those ingredients commonly used in livestock feeds such as maize, guinea corn, groundnut and others, so as to cater for the needs of both the humans and his pigs and poultry. But when this cannot work, attempts should be made to look for alternative sources of feedingstuffs for livestock which the humans cannot consume and are only therefore cherished by farm livestock.

The studies being reported here were, therefore, prompted by the factor mentioned above. Nigeria today is fast developing industrially, and, with the number of breweries increasing steadily, thousands of tons of such by products as the brewers' dried grains will be turned out annually. Right now, only a small fraction of the annual production is used in the feeding of cattle and much of it is dumped away. Even though this product, as well as maize cobs, is very fibrous and would appear best suited to the feeding of ruminant animals, it would seem that advantage should be taken of the fact that it is fairly rich in the fermentation products, particularly the B-vitamins, by including it also in swine diets. If an optimal level of inclusion could be established, it might not only serve as a source of the B-vitamins, it might also contribute some energy and hence reduce the level of maize that is presently being included in the diets of pigs. Maize is not only inadequately produced, it is also strongly liked by humans. This experiment was, therefore, planned to determine the effects of using graded levels of these products, brewers' dried grains and maize cobs, in the diets of pigs on their performance and carcass characteristics, with the view to establishing their optimal levels of inclusion in pigs' diets.

EXPERIMENTAL

The 70 weaner pigs used in these investigations were started on the experiment at an average initial liveweight of about 17.0 kg ± 1.0 kg. They were weaned about two weeks prior to the commencement of the trial, and were all on 22% protein diet up till that time. The males among them had also been castrated earlier and the wounds had healed well. They were randomly assigned to seven equal treatment groups of 10 pigs, although somewhat restricted by equal sex ratios per treatment, approximately equal initial liveweights, and approximately equal breed ratios in each treatment. They were then randomly assigned to the feeding pens within the Rockefeller Pig Nutrition Unit of the University, with facilities for individual feeding and ample play-pen space. Each feeding unit within each pen had its number correspondingly stamped on the back of the pig that was assigned to that unit to facilitate feeding, because such pigs would be led directly to those pens bearing their numbers at feeding time.

Each treatment group of 10 pigs was also randomly assigned one of the 7 diets formulated to contain, on the average, approximately 20% protein (tables 1 & 2). The first diet served as the control which contained rice bran as the source of fibre, while all the other diets differed from the control in having graded levels of brewers' dried grains (diets 2, 3 and 4 contained 5, 10 and 15% of brewers' grains respectively) and maize cobs (diets 5, 6 and 7 contained 5, 10 and 15% of maize cobs respectively). These levels of brewers' grains and maize cobs were made to replace, weight for weight, equivalent quantities of maize from the control diet, while the groundnut meal was slightly adjusted to maintain a roughly iso-nitrogenous condition in all the diets. Fish meal was deliberately omitted from the formulation since one of the major objectives of this trial was to get away from the use of scarce or expensive feedingstuffs such as fish meal. Blood meal, the source of animal protein, was added at a constant level throughout so as to block another source of variation that could complicate the interpretation of results.

TABLE 1

Composition of diets using brewers' grains and maize cobs at three levels (% air dry basis)

Ingredients	1	2	3	4	5	6	7
Yellow	64.75	64.75	58.75	53.25	64.75	58.75	53.25
Groundnut meal	18.00	18.00	18.50	19.00	18.00	18.50	19.00
Blood meal	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Molasses	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Rice bran	5.00	—	—	—	—	—	—
Brewer's grains	—	5.00	10.00	15.00	—	—	—
Maize cobs	—	—	—	—	5.00	10.00	15.00
Oyster sheel	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Dicalcium phosphate	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vit-Min-Premix-a/	+	+	+	+	+	+	+
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.0–
Analysed crude protein (%)	19.08	20.17	21.40	20.50	18.50	18.30	18.10
Analysed crude fibre (%)	3.90	3.70	5.00	6.10	5.90	7.60	9.20
Gross energy (kcals/kg)	4318	4297	4299	4300	4309	4328	4347
Digestible energy (Kcals/kg	3634	3668	3558	3500	3628	3480	3278

a) A Pfizer Livestock Feeds Product, Ikeja, supplying the following per kg of ration; Vit. A, 9823 IU; Vit. D_3, 1965 IU; Vit. E, 69 IU; K, 20mg; B12, 10mg/ton; Riboflavin 41mg; Nicotinic acid, 246 mg; Pantothenic acid, 98mg; Folic acid, 10mg; Cobalt, 5mg; Copper, 244mg; iodine, 20mg; Manganese, 341 mg Zinc, 100mg; and Oxytetracycline hydrochloride, 20g/ton.

TABLE 2

Proximate chemical composition-a) of major dietary ingredients (% dry matter)

	Groundnut cake	*Blood meal*	*Maize cobs*	*Brewers grains*	*Rice bran*	*Yellow maize*
Dry matter	87.9	84.1	90·0	92.4	88.8	86.4
Crude protein	51.0	74.1	3.4	27.6	9.6	9.9
Crude fibre	4.5	—	32.1	19.6	36.6	1.7
Ether extract	9.3	1.0	1.2	6.1	7.6	3.5
Ash	5.4	7.8	6.2	2.9	7.5	1.3
Nitrogen-free extract	29.8	17.0	56.1	43.8	38.7	81.2
Calcium	0.18	0.63	0.16	0.36	0.09	0.08
Phosphorous	0.70	0.22	0.06	0.62	0.42	0.30
Gross energy (Kcals/Kg)	4774	4368	4683	4996	4864	4380
Digestible energy (Kcals/Kg)	4270	2949	983	1978	1694	4020

a) Used the methods outlined in the AOAC (1970) methods of analysis.

All the diets were served in weighed quantities to the individual pigs in their individual feeding troughs. At feeding times which were done four times each day, viz at 08.00 hr., 12.00 hr, 15.00 hr and 18.00 hr, the pigs were individually led to the feeding units bearing their numbers and were locked up there to feed uninterrupted by others for 60 minutes, after which they were driven out into the play pens where they drank water *ad libitum*. After about 6 weeks on the diets, three pigs from each of the treatment groups were randomly selected (all males) and used in the nutrient digestibility studies which lasted for 10 days, the first 3 days being allowed for aclimatisation to the environment (since they were already on the same diets for as long as 6 weeks before being caged in the metabolism crates, it was considered unnecessary to have a long period of adjustment to diets). and the next 7 days for collection of faeces and urine. Chromic oxide was used as a marker for faecal collection, each day's sample being weighed and kept in the freezer until we were ready for analysis. Urine was similarly stored under toluene in the freezer after measuring each day's collection. All the faecal and urine specimens were pooled at the end of the period, the faeces were dried in the oven at 100^{0}C for two days, ground, and analysed for crude protein, ether extract and crude fibre according to the AOAC (1970) methods of analysis. Urine was thawed and filtered before aliquot quantities were analysed for nitrogen contents. All the figures collected were used to calculate the digestion coefficients for those nutrients mentioned above, as well as the nitrogen retention.

At the pre-determined slaughter weight of 92.0 $\pm$ 1.5 kg the pigs were taken off feed and starved for 18 hours during which they drank water only. The next day, they were bled to death and conventionally dressed, followed by 24 hour chilling in the cold room maintained at 5^{0}C, after which they were also conventionally graded.

All the data on feed consumption, liveweight gains (the pigs were weighed on the same day once every week throughout) calculated feed/gain ratios, nutrient digestion coefficients and retention, and the carcass measurements were subjected to the analysis of variance, followed by the Duncan's Multiple Range Test (Steel and Torrie, 1960) whenever significant differences were indicated. Simple t-test was used on the comparison of the two sources. In addition, simple correlation and regression analyses were carried out on the average daily digestible energy intake against a series of response parameters such as the average daily gains, feed conversion efficiency, backfat thickness, percent lean meat, percent lean cuts, loin eye area, percent fat plus skin and the percent fat cuts. The average daily DE intake was the independent variable (X) while all the others were the dependent variable (Y).

RESULTS

The entire weight range from the starting weight of 17 kg to the slaughter weight of 92.0 kg has been divided into the growing stage (17 to 55 kg) the fattening stage (45 to 92 kg) and the entire weight range, 17 to 92 kg, for the convenience of stating the results and discussing them.

Average daily gains

In the liveweight range of 17 to 55 kg, (Table 3) all the pigs grew at approximately the same rate and there were no significant differences among treatment means, nor were there definite trends in the responses. Similarly, the two sources of fibre promoted growth to nearly the same extent,

TABLE 3

Performance Characteristics of Pigs reared from about 17 kg to 55 kg Liveweight as Influenced by the Levels and Sources of fibre in Pigs' Diets

	Treatment Means								*Average of all*			*Average of all fibre levels*			
Characteristics	*Control*	*Brewers' grains*			*Maize cobs*			*S.E. Means*	*Brewers' grains diets*	*Maize cobs diets*	*S.E. Means*	5.0%	10.0%	15.0%	*S.E. Means*
Level of fibre source (%)	0.0	5.0	10.0	15.0	5.0	10.0	15.0	..	--	—	—	—	—	—	—
Initial live-weight (kg)	17.3	17.2	16.8	17.3	17.7	16.8	17.7	--	17.1	17.4	—	17.5	16.8	17.5	—
Final live-weight (kg)	55.0	56.8	55.0	55.4	55.6	56.3	55.3	—	55.7	55.7	—	56.1	55.7	55.6	—
Daily gain (kg)	0.54	0.55	0.54	0.56	0.54	0.56	0.47	0.03	0.55	0.52	0.08	0.55	0.55	0.52	0.02
Daily feed intake (kg)	1.53ab	1.45b	1.54ab	1.59ab	1.66a	1.71a	1.47b	0.06*	1.53	1.61	0.04	1.55	1.63	1.53	0.05
Daily digestible energy intake (Mcal)	5.53ab	5.33ab	5.48ab	5.58a	6.02a	5.88a	4.84b	0.21**	5.46	5.58	0.15	5.68	5.73	5.21	0.17
kg feed consumed/kg live-weight gained	2.82	2.68	2.86	2.86	3.11	3.10	3.16	0.13	2.80	3.12	0.08	2.90	2.98	3.01	0.10
Digestible energy (Mcal) consumed/kg weight gained	10.22	9.74	10.17	10.00	11.30	10.68	10.41	0.45	9.97	10.80	0.25	10.52	10.43	10.21	0.34

* = Significant differences ($P<0.05$) among treatment means.
** = Significant differences ($P<0.01$) among treatment means.
a,b = Treatment means not superscripted by the same letters in the same horizontal columns are significantly different from one another. Those not superscripted at all are not significantly different ($P>0.05$).

TABLE 4

Performance Characteristics of Pigs reared from 45 to 92 kg liveweight as influenced by the Levels and sources of fibre in the diets of Pigs

Characteristics	Treatment Means: Control		Brewers' grains			Maize cobs		S.E. Means	Average of all Brewers' grains diets	Average of all Maize cobs diets	S.E. Means	Average of all fibre levels: 5.0%	10.0%	15.0%	S.E. Means
Level of fibre source (%)	0.0	5.0	10.0	15.0	5.0	10.0	15.0	—	—	—	—	—	—	—	—
Initial live-weight (kg)	45.5	45.5	45.1	46.3	46.8	45.2	47.2	—	45.6	46.0	—	46.2	45.2	46.8	—
Final live-weight (kg)	92.3	94.0	92.7	92.5	92.4	92.8	91.4	—	93.1	92.2	—	93.2	92.8	92.0	—
Daily gain (kg)	0.64	0.65	0.68	0.65	0.64	0.65	0.58	0.04	0.66	0.62	0.02	0.65	0.67	0.61	0.02
Daily feed in-take (kg)	2.24	2.25	2.33	2.40	2.59	2.61	2.41	0.13	2.33	2.54	0.07	2.42	2.47	2.41	0.09
Daily digestible energy intake (Mcal)	8.11	8.16	8.24	8.41	9.38	9.08	7.90	0.45	8.27	8.79	0.26	8.77	8.66	8.16	0.32
kg fee con-sumed/kg live-weight gained	3.45a	3.47ab	3.43a	3.71ab	4.05b	3.94ab	4.15b	0.16*	3.54	4.05	0.10	3.76	3.69	3.93	0.14
Digestible ener-gy (Mcal) in-take/kg weight gained	12.76	12.66	12.12	12.99	14.67	13.71	13.62	0.67	12.59	14.00	0.39**	13.67	12.92	13.31	0.54

* = Significant differences among treatment means (P<0.05)

** = Significant differences among treatment means (P<0.01)

a,b = Treatment means not underscored by the same letters in the same horizontal column are significantly different from one another. Those not underscored at all are not significantly different from one another (P<0.05).

though growth on brewers' grains was slightly better than that on maize cobs. When all the fibre levels were compared, the 5 and 10% levels promoted growth equally, slightly higher than the growth rate on 15% fibre level, though not significantly so.

Between 45 and 92 kg liveweight, (table 4) there were also no significant differences among treatment means. The fastest growth rate was on the 10% brewers' diet while the slowest growth was from 15% maize cobs diet. Pigs on all the brewers' grains diets promoted faster growth than those on maize cobs diets but not significantly so, while there were also no significant differences in the growth rates of pigs on the various levels of both fibre sources combined.

The growth rates of pigs covering the entire period have been summarized in table 5, and they are all similar in trends to the partitioned weight groups above, with no significant differences among treatment means, nor between sources and levels of fibre.

Average daily feed intake

Within the liveweight range of 17 to 35 kg, (table 3) significant differences were obtained in the average daily feed intake ($P<0.05$) among treatment means. Pigs on the 10 % maize cobs diet which consumed the largest volume of feed, and those on 5% maize cobs diet which closely followed, had significantly higher feed intake figures than the pigs on the 15% maize cobs and 5% brewers' grains diets that consumed the lowest amount of feed in all. Also, pigs on all maize cobs diets consumed non-significantly higher volume of feed than those on the brewers' grains diet while, among the three levels of fibre inclusions tested for both sources, pigs on the 10% level generally consumed slightly higher amount of feed than the others.

In the weight range of 45 to 92 kg, there were no significant differences among treatment means in the daily feed consumption rates, although pigs on the 10% maize cobs diet consumed the largest while those on the control and 5% brewers' grains diets consumed the lowest volumes of feed. The maize cobs diets stimulated more feed intake than the brewers' grains diets, while the 10% level of both sources of fibre also stimulated more feed intake than the other levels, but not significantly more.

For the entire period, (table 5), the differences in average daily feed intakes were not significant and the averages were quite close. The 10% maize cobs diet also stimulated more feed intake than the others, closely followed by the 5% maize cobs diet. Also, maize cobs diets stimulated more feed intake than brewers' grains diets, while the 5 and 10% levels of fibre stimulated more feed intake than the 15% levels but not significantly more.

Average daily digestible energy (DE) intake

Significant differences were obtained in the average daily DE intakes only for the weight range of 17 to 55 kg and not in others ($P<0.01$). In that weight range, pigs on the 5% and 10% maize cobs diets consumed significantly higher DE each day than pigs on the 15% maize cobs diet which consumed the lowest amount of DE daily. Similar trends were observed for the other weight groups although the differences were not significant. Pigs on the maize cobs diets consumed more DE daily than those on the brewers' grains diets, while the pigs on the 5 and 10% levels of both sources of fibre consumed higher amounts of DE daily than those on the 15% level, but not significantly

TABLE 5

Peformance Characteristics of Pigs reared from 17 to 92kg Liveweight as influenced by the Sources and Levels of Fibre in their Diets

Characteristics	Treatment Means: Control	Brewers' gains			Maize cobs			S.E. Means	Average of all: Brewers' grains diets	Maize cobs diets	S.E. Means	Average of all fibre levels: 5.0%	10.0%	15.0%	S.E. Means
Levels of fibre source (%)	0.0	5.0	10.0	15.0	5.0	10.0	15.0	—	—	—	—	—	—	—	—
Initial live-weight (kg)	17.3	17.2	16.8	17.3	17.7	16.8	17.7	—	17.1	17.4	—	17.5	16.8	17.5	—
Final live-weight (kg)	92.3	94.0	92.7	92.5	92.4	92.8	91.4	—	93.1	92.2	—	93.2	92.8	92.0	—
Daily gain (kg)	0.60	0.61	0.61	0.60	0.60	0.62	0.53	0.03	0.61	0.58	0.01	0.61	0.62	0.57	0.02
Daily feed intake (kg)	1.90	1.96	1.97	1.99	2.08	2.09	1.93	0.08	1.97	2.03	0.04	2.02	2.03	1.95	0.05
Digestible energy intake (Mcal)	6.84	7.12	7.00	6.96	7.54	7.28	6.31	0.28	6.56	7.03	0.34	7.33	7.14	6.64	0.20
kg feed consumed/live-weight gained	3.16	3.22	3.25	3.30	3.46	3.40	3.65	0.14	3.26	3.50	0.08	3.34	3.33	3.48	0.11
Digestible energy (Mcal) consumed/kg weight gained	11.38	11.76	11.56	11.56	12.54	11.82	11.95	0.46	11.63	12.10	0.27	12.15b	11.69a	11.76ab	0.34**

** = Highly significant differences among treatment means.
a,b = Means not underscored by the same letters in the same horizontal column are significantly different from each other. Those not underscored at all are not significantly different from one another ($P > 0.05$).

Feed consumed/kg weight gained (F/G ratio)

There were no significant differences in the treatment means for the 17 to 55 kg and the 17 to 92 kg liveweight categories, but the differences were significant for the 45 to 92 kg liveweight range ($P<0.05$). The F/G ratio was highest for the pigs on the 15% maize cobs diet, significantly lower than the ratios on the control and 10% brewers grains diets ($P<0.05$) which had the lowest ratios. In the other two weight categories there were no significant differences, and pigs on the control, 5% and 10% brewers grains diets tended to have the lowest ratios while those on the maize cobs diets had the highest ratios. As for the different levels of inclusion for the two sources of fibre combined, the F/G ratios tended to increase with increases in the level of fibre inclusion. Also, the F/G ratios of pigs in the 45 to 92 kg weight group were higher than those in the lighter weight range.

Digestible energy consumed/kg liveweight gained (DE/gain)

There were no significant differences in the DE/Gain ratios among the treatment means for the three weight groups, but in all cases, pigs on the various levels of maize cobs and brewers' grains tended to consume more energy/kg of liveweight gained than those on the control diet. When the two sources of fibre were compared, there were no significant differences in the DE/kg gained between the two sources for both the 17 to 55 kg and the 17 to 92 kg liveweight ranges, but the DE/gain of the pigs on maize cobs diets was significantly more than that of pigs on brewers' grains diets for the 45 to 92 kg weight group. With respect to the three levels of the two fibre sources combined, there were no significant differences in the treatment means for the 17 to 55 kg and the 45 kg to 92 kg weight groups, but the treatment differences for the 17 to 92 kg weight group were significant ($P<0.05$), the DE/gain ratio for the 5 % levels combined being significantly higher than that on the combined 10 % levels, but not significantly more than that on the 15 %. Generally, the DE/gain ratios were highest for the 5% levels combined for the three weight groups, while the absolute DE/gain ratios were generally lower for the lighter weight pigs than for the heavier weight pigs.

Fibre levels and sources on carcass measurements

The summaries of the carcass measurements for the general treatments and for the partitioned sources and levels appear in tables 6 and 7 respectively.

When the overall results were compared along the 7 different treatments (table 6) it was observed that there were no significant differences among treatment means in any of the carcass measurements. There were also no really well established trends in nearly all the measurements except the carcass length in which longer carcasses were obtained with increases in fibre levels, warm dressing percentages and average backfat measurements which tended to decrease with increases in the levels of fibre, and the percent trimmed fat and fat plus skin which also decreased generally with increases in fibre levels. The empty gut weight also increased with increases in fibre levels.

With respect to the two fibre sources compared, (table 7) some of the measurements showed significant differences due to sources. Maize cobs diets produced carcasses significantly longer ($P<0.01$) than the brewers' grains diets, significant larger loin eye area ($P<0.01$), higher dressing percentage ($P<0.01$) and higher

TABLE 6

Carcass characteristics of pigs reared from about 17 to 92 kg as influenced by levels and sources of fibre in the diets

Characteristics	*Treatment means*							*S.E. of Means*
	Control	*Brewers grains*			*Maize cobs*			
Level of fibre Source (%)	0.0	5.0	10.0	15.0	5.0	10.0	15.0	—
Carcass length (cm)	77.0	77.3	78.5	80.0	78.6	79.2	79.8	0.88
Backfat thickness (cm)	3.2	3.1	2.9	3.0	3.1	3.0	2.9	0.14
Loin eye area (cm^2)	23.3	23.9	24.0	24.4	23.9	24.1	24.6	1.13
Dressing percentage	75.8	76.2	74.1	74.7	75.6	75.2	75.0	0.92
Lean cuts (%)	63.2	62.2	62.7	62.7	62.2	62.3	62.2	1.20
Loin (%)	13.9	14.2	14.0	14.0	14.8	14.5	15.0	0.49
Ham (%)	25.1	26.1	25.9	26.0	25.3	25.5	25.8	0.63
Shoulder (%)	22.1	21.4	21.5	21.6	21.5	21.1	21.3	0.40
Fat cuts (%)	23.7	23.8	24.2	24.6	23.7	24.5	23.9	0.81
Trimmed fat (%)	16.1	15.0	14.9	14.5	14.8	14.8	14.7	0.70
Leaf fat (kg)	1.95	2.16	2.01	1.78	2.25	1.87	1.82	0.19
Empty gut weight (kg)	5.4	5.4	5.6	5.8	5.4	5.7	5.6	0.19
Lean meat (%)	57.8	58.2	59.3	59.5	58.6	58.6	60.2	0.75
Bone (%)	9.5	10.2	10.1	10.4	10.2	9.7	9.9	0.65
Fat + Skin (%)	30.3	29.1	28.8	29.0	29.5	29.5	28.7	1.03

TABLE 7

Carcass characteristics of pigs reared from about 17 to 92 kg liveweight as influenced by levels and sources of fibre in the diets: (Sources and levels partitioned).

Characteristics	*Averages of all*		*S.E. of Means*	*Averages of all levels*			*S. E. of Means*
	Brewers grains diets	*Maize cobs diets*		5%	10%	15%	
Carcass length (cm)	78.6	79.2	0.52**	78.0	78.6	79.9	0.60
Backfat thickness (cm)	3.0	3.0	0.06	3.1	3.0	3.0	0.08
Loin eye area (cm^2)	*24.1*	*24.3*	*0.62**	*23.9*	*24.1*	*24.5*	0.77
Dressing percentage	75.0	75.3	0.52**	75.9	74.7	74.9	0.62
Percent lean cuts	62.5	62.2	0.57**	62.5	62.5	62.6	0.72
Percent trimmed loin	14.1	14.8	0.28	14.5	14.3	14.9	0.36
Percent trimmed ham	26.0	25.5	0.27	25.7	25.7	25.9	0.34
Percent trimmed shoulder	21.5	21.3	0.20	21.5	21.3	21.5	0.25
Percent fat cuts	24.2	24.0	0.46*	23.8	24.3	23.8	0.57
Percent trimmed fat	14.8	14.8	0.28	14.9	14.9	14.6	0.34
Leaf fat (kg)	1.98	1.98	0.11	2.20	1.94	1.80	0.12
Empty gut weight (kg)	5.6	5.6	0.11	5.4	5.7	5.7	0.13
Percent lean meat	59.0	59.1	0.40	58.4	59.0	59.9	0.46
Percent bone	10.2	9.9	0.30	10.2	9.9	10.2	0.37
Percent fat plus skin	29.0	29.2	0.45*	29.3	29.2	28.9	0.57

* = Significant differences among treatment means ($P<0.05$)
** = Significant differences among treatment means ($P<0.01$)

percent fat plus skin (P<0.01) but significantly lower percent lean cuts (P<0.01) and percent fat cuts (P<0.05) than brewers' grains diets. All the other measurements were remarkably close for the two fibre sources.

When the averages of the different levels for the two sources combined were compared (table 7), there were also no significant differences among the treatment means. Generally, the observed trends were those of remarkably close measurements for the three levels in some measurements and slightly increased lean measurements or slightly decreased fat cut measurements as the levels of fibre sources increased.

Correlation and regression analyses of some carcass and performance characteristics (Y) on the average daily digestible energy intake [X].

The summaries of these appear in table 8, and they were done only for the 17 to 92 kg liveweight category. All the relationships detailed for the pigs on the maize cobs diets apparently were not significant, and both the correlation (r) and regression (b) coefficients for the maize cobs diets were much lower than those for the brewers' grains diets. On the other hand, the regression and correlation coefficients of the average daily gain, percent lean meat and the percent fat plus skin (all Y) on the average daily digestible energy intake (X) were significant for the pigs on brewers' grains diets. All the other coefficients were not significantly large for the two fibre sources.

Nutrients digestion coefficients and retention as affected by fibre levels and sources.

The summaries of these appear in table 9. All the nutrients investigated were significantly affected in their utilization by both the levels and sources of fibre in the diets.

TABLE 8

Correlation (r) and Regression (b) coefficents of some performance and carcass characteristics (Y) on the average daily digestible energy (DE) intake (X) of pigs reared from 17 to 92 kg liveweight on different levels and sources of fibre in their diets

Variables		*Regression coefficients (b)*		*Correlation coefficients*		*'t' for regression*	
X	*Y*	*Brewers' grains*	*Maize cobs*	*Brewers' grains*	*Maize cobs*	*Brewers' grains*	*Maize cobs*
Avg. daily DE intake	Avg. daily gain	0.079	0.029	0.826**	0.444	5.291**	1.787
,,	Feed/gain ratio	0.042	0.213	0.152	0.412	0.556	1.630
,,	Backfat thickness	0.212	0.021	0.361	0.100	1.397	0.354
,,	Percent lean meat	-2.170	-0.648	-0.580*	-0.424	-2.568	-1.687
,,	Percent lean cuts	-2.400	0.390	-0.503	0.150	-2.098	0.546
,,	Percent loin eye area	-0.356	-0.200	-0.076	-0.065	-0.274	-0.235
,,	Percent fat plus skin	1.870	0.162	0.520*	0.075	2.193*	0.269
,,	Percent fat cuts	-0.901	-0.577	-0.222	-0.301	-0.823	-1.139

* Significant (r) or (b) (P<0.05)
**Significant (r) or (b) (P<0.01)

TABLE 9

Mean apparent digestibility of major nutrients and apparent nitrogen retention of pigs on diets containing different levels and sources of fibres

Characteristics	*Treatment Means (%)*							*S.E. of means*
	Control	*Brewers' grains diets*			*Maize cobs diets*			
Levels of fibre source (%)	—	5.0	10.0	15.0	5.0	10.0	15.0	—
Dry matter digestibility	85.8bc	88.3c	86.7bc	83.2c	88.2c	78.8b	68.8a	1.21**
Crude protein digestibility	85.3c	84.3c	83.9c	80.7bc	84.1c	75.9b	69.7a	1.07**
Crude fibre digestibility	62.7d	62.4d	61.8cd	53.8c	55.2c	41.8b	26.6a	0.79**
Ether extract digestibility	72.3ab	77.5ab	77.4ab	76.8ab	80.2b	72.9ab	70.8a	1.22*
Nitrogen-free extract digestibility	86.2b	84.5b	85.3b	82.7b	81.9ab	80.5ab	73.7a	0.99*
Energy digestibility	83.8ab	84.6b	82.8ab	81.4ab	84.2b	80.4ab	75.4a	1.31*
Percent ingested nitrogen retained	46.9b	47.9b	46.2b	41.5a	48.4b	44.6ab	39.2a	0.72*
Percent digested Nitrogen retained	53.7b	53.2b	49.8b	48.3ab	51.4b	45.6ab	42.8a	0.75*

** and * = Significant differences among treatment means (P <0.01) and (P <0.05) respectively.
a,b,c, ... Means not underscored by the same letters in the same horizontal columns are significantly different from one another.

Dry matter digestiblity

This was significantly depressed ($P<0.01$) as levels of fibre sources increased. The best digested diets were the 5% brewers' grains and 5% maize cobs diets, significantly better digested than the 15% and 10% maize cobs diets with the lowest DM digestibility figures.

Crude protein digestibility

This was also significantly depressed by increasing levels of crude fibre. The control diet had the best protein digestibility figure, closely followed by the 5% brewers' grains and 5% maize cobs diets, all of which were significantly better digested than the 10 and 15% maize cobs diets with the lowest protein digestibility figures ($P<0.01$).

Crude fibre digestibility

There were significant depressions in the crude fibre digestibility as the dietary levels of crude fibre increased ($P<0.01$). The highest digestibility of crude fibre was obtained on the control diet closely followed by the 5% brewers' grains diet, both significantly higher than the digestibility figures obtained on all the maize cobs and 15% brewers' grains diets ($P<0.01$). The lowest crude fibre digestibility of 26.4% obtained for the 15% maize cobs diet was significantly lower than the figures for all the other diets ($P<0.01$).

Ether extract digestibility

The only significantly different treatment means were those between the 5% and 15% maize cobs diets, with the highest and lowest ether extract digestibility figures respectively. The general trend here also was that of depression in the digestibility of diets as the crude fibre level increased.

Nitrogen free extract digestibility

The 15% maize cobs diet had the lowest nitrogen-free extract digestibility which was significantly lower ($P<0.05$) than the figures for the control, and all the brewers' grains diets but not significantly lower than the other maize cobs diets. Here again, the trend was that of decreasing digestibility of the nitrogen-free extract of the diets as crude fibre levels increased.

Energy digestibility

The best digested dietary energy was that of the 5% brewers' grains diet closely followed by the 5% maize cobs diet, both significantly greater ($P<0.05$) than the energy digestibility figure for the 15% maize cobs diet. Generally, the energy digestibility of the diets decreased significantly ($P<0.05$) as the dietary fibre level increased, but the brewers' grains diets were better digested than the maize cobs diets.

Nitrogen retention data

Both the percent ingested nitrogen retained and the percent digested nitrogen retained followed closely the same trends for all the diets although the figures for the former were lower than for the latter. There were significant depressions in both as the dietary crude fibre levels increased ($P<0.05$), and the retention figures obtained on the control and the 5% maize cobs and 5% brewers' diets were significantly higher than those retained on the 15% maize cobs diets that had the lowest nitrogen retention figures in both cases.

DISCUSSION

The whole idea of feeding brewers' grains or even the more unconventional maize cobs to pigs primarily arose from our desire to look for cheap and alternative sources of feedingstuffs to our pigs. Those alternative sources must not only be cheap, they must not form regular sources of dietary nutrients to man directly except through the channels of livestock and livestock products. These two ingredients fit very well into those categories.

It is well recognized that these feedingstuffs are also more directly applicable to the feeding of the ruminant animals that have tremendous capacity to utilize fibrous feedingstuffs, but in the light of the facts that the ruminants have a much lower turnover rate and are slower to mature than the non-ruminant pigs and poultry, it would appear that there is a strong case in favour of intensifying our pig and poultry production side by side with the rearing of the ruminant animals, if we hope to improve on the presently low, per caput consumption of animal proteins in the country. This is therefore, why efforts must be made to investigate the feeding potentials of as many of our industrial by products and farm wastes as possible to our pigs and poultry.

The use of fibrous feeds in pigs feeding is not new. There are several reports from the temperate countries that have demonstrated the values of fibrous feeds, particularly alfalfa and rice bran, to the pig (Crampton, Ashton and Lloyd, 1954; Bowman, Kidwell and McCormick, 1953; Hochstetler, Hoefer, Pearson and Luecke, 1959; Pond, Lowrey and Maner, 1962; Axelsson and Erickson, 1953, and Becker, Hanson, Jansen, Terrill and Norton, 1956, among several others). The uses of fibre from various sources are due to a number of reasons, among which are the promotion of bowel movement in the animals which aids the process of digestion especially when used at low levels, the supply of vitamins, minerals and unidentified growth factors to pigs especially if those fibre sources are green forages (fresh or dried and not very stemy) and the deliberate dilution of energy densities of diets fed to the growing and fattening pigs to reduce their propensities to depositing excess fat in their bodies. In this connection, it is now a universally accepted practice to include fairly high levels of fibre in the diets of growing fattening pigs and Merkel et al, (1958) Hochstetler et al, (1950) Crampton, Ashton and Lloyd, (1954) Bohman, Kidwell and McCormick (1953) among several other workers have all obtained better carcass quality measurements through the inclusion of different levels and sources of fibrous feeds.

The studies reported here have confirmed several of the findings of the workers from the temperate countries cited above. In addition, our studies have shown that the inclusion of either brewers' grains or maize cobs (ground) at a level as high as 15% is not even enough to significantly depress the growth rate of pigs relative to the control diet even though such a level significantly depressed nutrient digestibility and retention. It is, therefore, concluded that the expensive maize fraction of the diet of growing fattening pigs can be replaced by as high as 15% level of the cheap and fibrous brewers' grains or maize cobs to reduce feed cost and hence cost of production of livestock and their products in our environment.

Their effects on carcass quality are somewhat surprisingly marginal, but this could be due to the fact that the pigs had not been sufficiently challenged with sufficiently high levels of the fibre. As tables 3, 4 and 5 show, the pigs on these graded levels of fibre except those on the 15% maize cobs diet tended to consume slightly higher digestible energy daily than the control diet, since there must be a significant reduction in energy intakes before correspondingly significant improvements in carcass measurements are obtained, the yet unreduced energy intakes on those fibre levels explains these rather marginal and insignificant changes in the carcass quality of the control versus other diets. These same high intakes daily further explain the lack of reductions in the average daily gains of the pigs on the various levels of fibre, although the several reports from the temperate countries speak of significant reductions in growth rate and energy intakes as fibre levels were greatly increased, sometimes to as high as 50% level (Bohman et al, 1953, and Teague and Hansen, 1954).

The results of nutrient digestibilities as affected by fibre levels and sources also confirm the findings of Pond et al, (1962), Lloyd and Crampton, (1955), Boenker, Tribble and Pfander, (1969), and Whiting and Bezeau, (1957), The real depressions in nutrient digestibilities were obtained on the 15% fibre levels which would tend to show that the inclusions of these fibrous feeds at between 5 and 10% levels were still very good and conducive for the promotion of bowel movements of these pigs which aided the digestive processes and hence resulted in good nutrient digestibilities and retention. This applied to all the nutrients investigated and hence the inescapable conclusion is that these two fibre sources, brewers' grains and maize cobs, can be included in the diets of growing fattening pigs at 5 to 10 % level for optimal nutrient utilization, although these optimal nutrient utilization levels are not necessarily reflected in significantly improved performance characteristics of pigs.

Finally, it is pertinent to compare the

results of the two sources. All throughout the report, brewers' grains diets were better utilized than the maize cobs diets. This phenomenon could probably be explained on the following basis (a) that brewers' grains contained higher digestible energy than maize cobs, (b) that this product is less fibrous than maize cobs cobs and (c) that it is also richer in the B-complex vitamins and some unidentified growth factors, since it is a product of fermentation process. There could be other reasons for this, but the ones mentioned above are probably the most significant.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the contributions of Mr. A. Ayoade to the data reported here, and Messrs Gbadamosi and Anthony Akpheokhai who helped with the management and grading of the animals.

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