The Effects of Feeding Graded Levels of Wheat Offals and Groundnut Shells to Pigs on their Performance and Carcass Characteristics and Nutrient Utilization

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SUMMARY

A TOTAL of 70 weaner pigs were used in these studies designed to study the effects of feeding graded levels of wheat offals and groundnut shells in the diets of pigs on their performance characteristics, carcass quality and nutrient utilization abilities. They were all of the Yorkshire and Yorkshire x Landrace crosses, and were reared from about 25 kg to approximately 92 kg liveweight on diets containing 5, 10 and 15% of wheat offals or groundnut shells compared with the control diet which contained neither of these. All the diets were roughly isonitrogenous, containing about 20% protein.

All pigs on the graded levels of the fibre sources gained more than those on the control diet, consumed more feed and higher digestible energy daily and had inconsistently better feed/gain ratios, but the differences were not significant. Pigs on the groundnut shell diets also gained more weight daily, consumed more feed and digestible energy, but had poorer efficiencies of feed and energy utilization than those on the wheat offals diets, but the differences were also not significant for the three weight categories covered. Generally, feed intake slightly increased, digestible energy intake slightly decreased, while the other response parameters were not consistently affected by the increases in the levels of fibre inclusion. The carcass measurements were not significantly influenced by the levels of fibre inclusion, and there were no definite trends in nearly all the carcass measurements as the fibre levels increased, but there were significant differences due to sources in most of the carcass parameters. Most of the nutrients were significantly depressed in their utilization by the fibre levels and sources.

INTRODUCTION

STUDIES on the uses of various types of fibres for various categories of pigs are not new, and in fact, there are several reports on various aspects of this topic from the workers in the temperate countries. The commonest reason for including fibrous feeds in the diets of pigs is for the

improvement of carcass quality and this has been well documented by several reports, among which are those of Merkel *et al*, (1958), Teague and Hanson, (1954), Bohman, Kidwell and McCormick, (1963), Crampton, Ashton and Lloyd, (1954) and Hochstetler *et al*, (1959), to cite a few. This is, however, dependent on the level of inclusion of the fibrous feeds, for, unless the levels are sufficiently high to prevent the intake of the minimum energy requirement, they will not have significantly reduced fat cut measurements or significantly increased lean cuts. Other reasons for deliberate inclusion of fibrous feeds are the promotion of bowel movement to aid digestion and the supply of vitamins, minerals and some unidentified growth factors which not only improve growth but also enhance the reproductive processes in the breeding and pregnant animals. For these particular purposes, the green fibrous feeds, particularly the fresh, succulent pasture species (legumes and cereals) are most efficient as the studies of Fairbanks, Krider and Carroll (1945) and Teague and Robinson, (1954) have clearly demonstrated.

Even though the presence of high amounts of fibre is known to depress the digestibilities of many of the nutrients, the level at which this happens is not yet clearly defined, and so, fibrous feeds can

be expected to contribute some significant amounts of nutrients and energy up to a point, to the pigs. Since fibrous feeds are much cheaper than the concentrate feeds, their inclusions at beneficial levels should cheapen the cost of animal feeds, and since the country, as well as many other African countries, is faced with the problem of rising feed prices, all efforts should be directed to finding solutions to these rising feed prices. And one of such solutions is the inclusion of the lesser-used fibrous feeds such as wheat offals and groundnut shells in the diets of pigs. The studies reported here were, therefore, designed to investigate what effects the inclusions of wheat offals and groundnut shells at up to 15% level in the diets of weaner and growing-fattening pigs would have on their performance and carcass characteristics.

EXPERIMENTAL PROCEDURES

The 70 weaner pigs used in these studies

were weaned at about 12 kg. liveweight, but since they were small in size at that time, they were specially placed on a high protein diet (25%) and reared on this till they weighed 25 kg approximately at which weight they were put on the experiments. The breeds used, the methods of assigning the animals to treatments, and all the experimental procedures followed in these investigations were similar to the ones followed in the first part of these studies and reported in our earlier paper (Babatunde *et al*, 1975) the only thing that differed was the diet, and this was in respect of the source of fibre. In these studies, wheat offals and ground groundnut shells were the sources of fibre also included at the levels of 5, 10 and 15% as in the first trial. All the performance and carcass measurements taken and the statistical analyses carried out were similar to the ones reported in the first paper too. The details of dietary and ingredient composition are represented in tables 1 and 2 respectively.

TABLE 1
Composition of diets

Dietary Composition, (% air dry)							
Ingredients	1	2	3	4	5	6	7
Ground yellow maize	64.25	64.25	58.75	53.25	64.25	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	—	—	—	—	—	—
Wheat offals	—	5.0	10.00	15.00	—	—	—
Groundnut Shell	—	—	—	—	5.00	10.00	15.00
Oyster Shell	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 (NaCl)	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	100.00
Analysed Crude protein (%DM)	19.10	20.00	20.60	21.00	19.71	20.00	20.20
Analysed Crude fibre (%DM)	3.72	3.10	2.80	4.60	3.30	4.30	5.20
Gross energy (Kcals/kg)	4318	4294	4297	4303	4282	4274	4266
Digestible energy (Kcals/kg)	3662	3701	3648	3554	3653	3556	3479

a/ A Pfizer product supplying the following vitamins per kilogram of diet: A, 9323 IU; D₃, 1965 IU; B₁₂, 10 ug/ton; Riboflavin, 41mg; Niacin 246mg; Pantothenic acid, 98 mg; Folic acid 10 mg; and the following trace elements per kilogram of diet: Manganese, 341 mg; Copper 244 mg; Zinc, 100 mg; Iodine, 20 mg; and oxytetracycline hydrochloride, 20 g/ton.

TABLE 2
Composition of major dietary ingredients a/(% Dry matter)

	Wheat offals	Groundnut Shell	Rice bran	Groundnut meal	Blood meal	Yellow maize
Dry matter	86.4	89.1	88.8	87.9	84.1	86.4
Crude protein	16.0	10.0	9.6	51.0	74.1	9.9
Ether extract	5.1	3.0	7.6	9.3	1.0	3.5
Crude fibre	10.0	20.0	36.6	4.5	—	1.7
Ash	8.0	2.0	7.5	5.4	7.8	1.3
Nitrogen-free-extract	60.9	65.0	38.7	29.8	17.0	81.2
Calcium	0.17	0.27	0.09	0.18	0.63	0.08
Phosphorous	1.26	0.09	0.42	0.70	0.22	0.30
Gross energy (Kcals/kg)	4386	4138	4864	4774	4368	4380
Digestible energy (kcal/kg)	2486	1524	1694	4270	2949	4020

a/ Analysed according to the AOAC (1970) Methods of Analysis.

RESULTS

The summaries of the performance characteristics as affected by the different levels and sources of fibre for the 25 to 56 kg, 45 to 92 kg and 25 to 92 kg live-weight categories are given in tables 3, 4 and 5 respectively.

Average daily gains (ADG)

There were no significant differences among the treatment means for the three weight groups, but the pigs grew at a faster rate during the 45 to 92 kg liveweight than the other weight groups. In the three weight groups also, pigs on the various graded levels of the two sources of fibre outgained those pigs on the control diet that had some rice bran included at low level. All the ADG figures were remarkably close for all the treatments. There were also no significant differences between the means for the two sources but the pigs on the groundnut shell diets grew a little faster than those on the wheat offals diets. Similarly, there were no significant differences in the means for the various levels of the two sources combined which also had very closely similar ADG.

Average daily feed intake

Although there were no significant differences among the treatment means in the average daily feed consumption figures for the three weight categories, there were general trends of increases in feed consumption figures as the fibre levels increased for both sources of fibre. The differences between the two sources at all levels combined were not significant also, but pigs on the groundnut shells consumed more feed than those on wheat offals diets. There was also a general trend of slight increases in feed consumption figures when the various levels of the two sources combined were compared but not significantly different.

Average daily digestible (DE) energy intake

There were no significant differences among treatment means for this parameter for the three weight groups, and, unlike the parameters above, no consistent trends were established. However, pigs on all the groundnut shell diets combined consumed more DE daily than those on all wheat offals diets, though not significantly larger, while a comparison of the three

TABLE 3
Performance characteristics of pigs grown from about 25 to 56kg liveweight as influenced by level and source of fibre

Source	Individual treatment means					Main effect means				
	Control	Wheat offals			Groundnut Shell	SE of Means	Source of offals	Groundnut Shell	SE of means	Levels
Level added (%)	—	5	10	15	5	10	15	5	10	15
Initial liveweight (kg)	25.0	25.9	26.3	26.1	27.0	25.9	24.3	26.1	25.2	25.2
Final liveweight (kg)	57.3	56.5	57.1	56.7	57.4	56.6	56.8	56.8	56.8	56.8
Daily gain (kg)	0.53	0.56	0.56	0.55	0.57	0.57	0.54	0.55	0.55	0.55
Daily Feed Intake (kg)	1.55	1.53	1.56	1.61	1.80	1.78	1.77	1.78	1.67	1.69
Digestible energy intake (Mcal)	5.66	5.88	5.68	5.61	6.57	6.33	6.14	6.35	6.01	5.88
Kg feed consumed/kg weight gained	2.90a	2.83a	2.81a	2.89a	3.16b	3.14b	3.27b	3.19	3.00	3.08
Digestible energy (Mcal) consumed/kg weight gained	10.61	10.58	10.23	10.10	11.47	11.12	11.37	11.32	11.03	10.74
						0.46	0.08**	0.26	0.05	0.36

** = Highly significant differences among treatment means ($P < 0.01$).

a, b, Means not followed by the superscripts in the same horizontal columns are significantly different from one another.

TABLE 4
Performance characteristics of pigs from about 45 kg to 92 kg liveweight as influenced by level and source of fibre

Source	Individual treatment means				Main effect means			
	Control	Wheat offals	Groundnut Shell	SE of Means	Source of Wheat offals	Groundnut Shell	SE of Means	Levels
Level added (%)	—	5	10	15	5	10	15	5
Initial liveweight (kg)	45.9	46.4	44.6	45.9	45.6	45.2	—	46.1
Final liveweight (kg)	93.0	93.2	93.0	92.5	92.9	92.6	—	92.8
Daily gain (kg)	0.67	0.71	0.70	0.72	0.71	0.72	0.02	0.72
Daily Feed intake (kg)	2.52	2.27	2.29	2.35	2.30	2.45	0.07	2.37
Daily digestible energy intake (Mcal)	9.26	8.40	8.41	8.34	8.52	8.72	0.25	8.57
Kg feed consumed/kg weight gained	3.97	3.28	3.31	3.30	3.30	3.38	0.11	3.35
Digestible energy (Mcal) consumed/kg weight gained	13.87	12.12	12.17	11.60	11.86	12.12	0.38	12.15
								12.26
								0.47

** = Highly significant differences among treatment means ($P < 0.01$).
a, b, Means not followed by the superscripts in the same horizontal columns are significantly different from one another.

TABLE 5
Performance characteristics of pigs grown from about 25 to 92 kg liveweight as influenced by level and source of fibre

Characteristics	Control	Wheat offals			Groundnut Shell			SE of means	Source Wheat offals groundnut Shell			SE of means	Levels			SE of means
		5	10	15	5	10	15		26.1	25.8	26.5		5	10	15	
Level added (%)	—	25.9	26.3	26.1	27.0	25.9	24.3	—	92.9	92.1	92.6	—	26.5	26.1	25.2	—
Initial liveweight (kg)	25.0	93.2	93.0	92.5	91.9	92.6	91.9	—	0.61	0.62	0.61	0.00	0.61	0.63	0.61	0.02
Final liveweight (kg)	93.0	0.60	0.63	0.61	0.61	0.63	0.61	0.02	2.02	2.12	2.07	0.01	2.01	2.08	2.13	0.07
Daily gain (kg)	0.59	1.96	2.09	2.00	2.05	2.07	2.25	0.10	7.32	7.55	7.37	0.20	7.37	7.49	7.45	0.25
Daily Feed intake (kg)	2.07	7.27	7.61	7.09	7.47	7.37	7.81	0.33	3.29	3.42	3.28	0.08	3.28	3.31	3.47	0.10
Digestible energy intake (Mcal)	7.56															
Kg feed consumed/kg weight gained	3.53	3.28	3.30	3.28	3.28	3.31	3.66	0.13	11.97	12.16	12.05	0.28	12.05	11.94	12.22	0.35
Digestible energy (Mcal) consumed/kg weight gained	12.92	12.13	12.14	11.64	11.97	11.73	12.80	0.47								

** = Highly significant differences among treatment means $P < 0.01$.
a, b, Means not followed by the same superscripts in the same horizontal columns are significantly different from one another.

levels of inclusion of the two sources of fibre combined revealed no consistent trends, nor were there significant differences among treatment means.

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

The only weight group with significant treatment differences among means was the 25 to 56 kg category in which pigs on the control, 5 and 10% wheat offals diets had significantly lower F/G ratios than the pigs on the 10 and 15% groundnut shell diets. ($P < 0.05$). In the other weight categories, no consistent trends were observed with the pigs on wheat offals diets as the level increased, but with the groundnut shell diets, there were steady but not significant increases as the level increased. With respect to both sources combined, there were no significant differences between the two, but pigs on groundnut shell diets had higher F/G ratios than those on the wheat offals. There were also no significant differences among the treatment means for the two sources combined, but pigs on the higher levels of fibre inclusion tended to have higher F/G ratios than those on the lower levels.

DE consumed/kg liveweight gain

Here also, there were no significant differences among the various treatment means, between the two sources, and among the three main levels of inclusion for the three weight categories. There were no consistent trends among the treatments, but pigs on the groundnut shell diets consumed more DE/kg of liveweight gain than those on the wheat offals. There was also no consistent trend of increase or decrease in DE consumed/kg of liveweight gained, and the heavier pigs consumed more DE/kg of gain than the lighter weight pigs.

Carcass quality measurements as influenced by fibre levels and sources

Table 6 shows the summaries of the essential carcass measurements of the pigs as influenced by the various treatments compared while table 7 contains the summaries of the same measurements showing the main sources and levels effects combined.

The data presented in table 6 show no significant differences among the treatment means except for the empty gut weight which was significantly increased ($P < 0.05$) by the dietary treatments. Pigs on the control and 5% wheat offals diets had the lowest empty gut weights, significantly lower than that of pigs on the 15% groundnut shell diet ($P < 0.05$) which had the highest empty gut weight. Except for the average backfat measurements which tended to increase with increases in fibre levels and sources though not significantly, there were no consistently uniform trends in all the other carcass measurements.

However, highly significant differences ($P < 0.01$) were obtained between the two sources when they were compared in most of their carcass measurements. Those measurements that were significantly influenced by sources of fibre include carcass length, loin eye area, dressing percentage, percent lean cuts, percent shoulder, percent trimmed fat, lean meat and fat plus skin percentages. Generally, it would appear that pigs on the wheat offals diets had significantly leaner carcasses than those on the groundnut shell diets, although more fat was trimmed from the carcass of pigs on the wheat offals diets than those on the groundnut shell diets.

With respect to the overall levels of both sources combined, only the leaf fat percentage was significantly influenced by the fibre levels, pigs on the 15% levels

TABLE 6

Carcass characteristics of pigs grown from about 25 to 92 kg as influenced by levels and source of fibre

Characteristics	Individual treatment means							SE of means
	Control	Wheat offals			Groundnut Shell			
	—	5	10	15	5	10	15	—
Level added (%)	77.5	79.0	81.5	78.0	81.0	77.0	81.5	0.87
Carcass length (cm)	3.22	2.96	3.12	3.24	3.24	3.08	3.26	0.14
Backfat thickness (cm)	23.9	22.1	22.4	22.5	22.5	21.7	22.5	1.24
Eye muscle area (cm ²)	77.5	76.4	77.3	75.1	75.9	75.8	74.9	0.89
Dressing percentage	61.6	62.2	60.9	63.4	61.1	61.7	61.0	1.41
Lean cuts (%)	13.5	14.4	13.7	13.9	13.8	13.8	13.9	0.44
Loin (%)	25.8	26.2	24.8	26.6	25.1	25.5	25.5	0.58
Ham (%)	21.2	20.4	20.6	21.6	21.0	21.3	20.7	0.73
Shoulder (%)	24.1	24.4	24.1	23.6	24.1	24.5	23.7	0.59
Fat cuts (%)	15.2	15.4	16.7	16.9	16.2	14.9	16.2	1.01
Trimmed fat (%)	1.95	2.02	2.31	1.56	1.94	2.22	1.78	0.19
Kidney fat (kg)	5.0a	4.9a	5.1ab	5.4ab	5.4ab	5.5ab	6.0b	0.26*
Empty gut (kg)	58.5	58.7	56.7	59.4	59.3	57.4	58.2	1.18
Lean meat (%)	9.9	9.8	9.9	10.2	9.7	10.5	9.8	0.53
Bone (%)	29.7	29.8	32.4	28.2	29.7	30.2	31.4	1.43
Fat plus Skin (%)								

TABLE 7

Carcass characteristics of pigs grown from about 25 to 92 kg as influenced by level and source of fibre

Characteristics	Main Sources			Main Levels (%)			SE of means
	Wheat offals	Groundnut Shell	SE of means	5	10	15	
Carcass length (cm)	79.1	78.5	0.54**	78.5	79.3	78.3	0.66
Backfat thickness (cm)	3.1	3.2	0.08	3.1	3.1	3.2	0.10
Eye-muscle area (cm ²)	22.3	22.1	0.68**	22.3	22.1	22.5	0.84
Dressing Percentage	76.2	75.5	0.50**	76.2	76.6	75.6	0.59
Lean cuts (%)	62.2	61.3	0.178**	61.6	61.3	62.2	0.97
Loin (%)	14.0	13.9	0.26	14.1	13.8	13.9	0.29
Ham (%)	25.9	25.4	0.36	25.7	25.2	26.1	0.44
Shoulder (%)	20.9	21.0	0.42*	20.7	21.0	21.2	0.52
Fat cuts (%)	24.0	24.1	0.33	24.3	24.3	23.7	0.40
Trimmed fat (%)	16.3	15.8	0.58**	15.8	15.8	16.5	0.72*
Leaf fat (kg)	1.96	1.98	0.12	1.98ab	2.27b	1.67a	0.13*
Empty gut (kg)	5.1	5.6	0.16	5.2	5.3	5.7	0.20
Lean (%)	58.3	58.3	0.70**	59.0	57.1	58.8	0.81
Bone (%)	10.0	10.0	0.29	9.8	10.2	9.8	0.36
Fat + Skin (%)	30.1	30.4	0.84**	29.8	31.3	29.8	1.02

** and * = Significant differences between treatment means ($P < 0.05$ and $P < 0.01$ respectively).

combined having significantly smaller leaf fat percentage than those on the 10% fibre levels ($P < 0.05$). There were also no consistent trends in the carcass measurements of these pigs as influenced by the various levels of fibre.

Correlation and regression analyses of some performance and carcass measurements (Y) against the average daily digestible energy intake (X)

Table 8 shows the correlation (r) and regression (b) coefficients of some performance and carcass measurements against the average daily digestible energy intake. Although only few of the relationships shown in the table are significantly large, it is worth noting that except in some cases, the magnitudes of the relationships were very close for the two sources

of fibre compared, indicating that the pigs on both sources of fibre were reacting in fairly identical ways to the dietary fibre sources provided to a large extent. But the lack of consistency in some of the relationships shown in which positive and negative ' r ' or ' b ' values were shown for the two sources of fibre for the same relationship is also worth noting, although the fact that those relationships were very low and insignificant would probably indicate that they actually did not mean much. Of all the variables compared only the feed/gain ratio was most positively and significantly related to the average daily digestible energy intake. The average daily gain was next, while all the carcass measurements regressed on the digestible energy intake showed very low and insignificant relationships.

TABLE 8

Correlation [r] and Regression [b] Coefficients of some performance and carcass parameters [Y] on the average daily digestible energy [DE] consumed [X] of pigs reared from 25 to 92 kg liveweight on graded levels of wheat offals and groundnut shell

Variables		Regression Coefficients Correlation Coefficients 't' for regression					
X	Y	Wheat offals	G. nut Shell	Wheat offals	G. nut Shell	Wheat offals	G. nut Shell
Avg. daily DE intake	Average daily gain	0.037	-0.011	0.55*	-0.17	2.350*	-0.616
"	Feed/gain ratio	0.236	0.285	0.61*	0.62*	2.768*	2.871*
"	Backfat thickness	0.011	0.013	0.03	0.03	0.096	0.107
"	Percent lean meat	1.682	-0.730	0.49	-0.21	2.008	-0.774
"	Percent lean cuts	-0.082	0.081	-0.02	0.02	-0.081	0.088
"	Loin eye area	0.423	-0.997	0.09	-0.35	0.342	-1.246
"	Percent fat plus skin	0.258	0.480	0.16	0.27	0.582	1.007
"	Percent fat cuts	-0.360	0.426	-0.07	0.10	-0.268	0.507

* Significant Correlation or Regression Coefficients ($P < 0.05$).

Apparent Digestibility and Retention of Nutrients

The treatment means for the various nutrients are shown in table 9.

Dry matter digestibility

The dry matter digestibility was not significantly affected by the sources and levels of fibre tested, but there were slight reductions in the means as the levels increased. Groundnut shell diets were

slightly better digested than the wheat offals diets.

Crude protein digestibility

The treatment means for crude protein digestibility were also not significantly different from one another, although there was a reduction in crude protein digestibility as the fibre levels increased for both sources. The crude protein fraction of the groundnut shell diets was also slightly better digested than those of the diets containing wheat offals.

TABLE 9

Mean apparent digestibility of nutrients and nitrogen retention as influenced by source and level of crude fibre.

Characteristics	Control	Wheat offals			Groundnut Shell			SE means
		5	10	15	5	10	15	
Level (%)	—	5	10	15	5	10	15	
Digestibility Coefficients (%)								
Dry matter	86.5	85.5	84.6	82.9	88.5	86.8	84.5	1.22
Crude protein	84.9	85.9	84.5	83.3	86.4	85.8	82.7	1.24
Crude fibre	53.6ab	56.6b	54.3b	47.2a	64.2c	56.0b	49.8a	0.92*
Ether extract	71.9a	72.8a	73.6a	70.5a	79.8b	76.2ab	76.9ab	1.03
Nitrogen-free extract	84.7	83.4	82.9	79.4	85.6	82.9	79.8	1.53
Energy	84.8	86.2	84.9	82.6	86.3	85.2	83.4	1.15
Nitrogen retention: (%)								
Percent ingested-N retained	47.8b	46.2b	41.4a	38.8a	48.0b	46.1b	40.2a	0.76*
Percent digested-N retained	54.2b	62.0b	46.7a	44.6a	54.2b	52.7b	45.3a	0.88**

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

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

a,b,c,... Means not underscored by the same letters in the same horizontal columns are significantly different from one another.

Crude fibre digestibility

This was highly significantly depressed ($P < 0.01$) by increases in fibre levels. The highest crude fibre digestibility was obtained on the 5% groundnut shell diet, significantly higher than all others ($P < 0.01$), while the lowest digestibility figures were obtained on the 15% wheat offals and groundnut shell diets, signifi-

cantly lower than those for all the other diets except the control diet. Groundnut shell diets also had higher crude fibre digestibility figures than the wheat offals diets.

Ether extract digestibility

Significant treatment differences were also obtained among treatment means for

this parameter. The 5% groundnut shell diet also had the highest ether extract digestibility, significantly higher than those on all the wheat offals diets but not significantly higher than the 10 and 15% groundnut shell diets. The ether extract fractions of the groundnut shell diets were also better digested than those of the wheat offals diets.

Nitrogen-free extract digestibility

The treatment differences in this nutrient were not significantly large, but there was reduction as the levels of the fibre sources increased in both cases. It appears that the nitrogen-free extract fractions from both sources were equally digested.

Energy digestibility

There were also no significant differences among treatment means, but, like the other nutrients above, there were slight reductions in energy digestibility means as the fibre levels increased for both sources. It also appears that the energy content of the groundnut shell diets was also better digested than that of the wheat offals diets.

Apparent nitrogen retention

There were significant treatment differences in both the percent ingested nitrogen retained and the percent digested nitrogen retained ($P < 0.05$). The trends in both parameters were the same, and the best nitrogen retention figures were obtained on the 5% groundnut shell diets, closely followed by the control diet, while the lowest nitrogen retention figures were obtained on the 15% wheat offals diet, closely followed by the 15% groundnuts shell diets, both of which were significantly lower than the nitrogen retained on all the other diets ($P < 0.05$) for both categories of nitrogen retention. Also, the nitrogen ingested and digested on the

groundnut shell diets were better retained than those on the wheat offals diets.

DISCUSSION

The results which have been carefully laid out in the preceding pages will be discussed from the standpoints of fibre effects on the performance and carcass characteristics of the pigs and on their nutrient utilization abilities.

From the standpoint of performance characteristics, the most commonly scrutinized parameters are the average daily gains and the average feed/gain ratios, the two most important economic response measures. As the results have shown, it was not only that the average daily gains were not significantly influenced by fibre sources and levels, it was also impossible to establish consistent trends in the two responses, and these results are entirely contrary to the earlier reports of Merkel *et al.* (1958) Bohman *et al.*, (1953) Crampton *et al.* (1954) Hochstetler *et al.* (1956), Teague and Hanson, (1954) and Thrasher, Mullins and Scott, (1966). The most probable reasons are (a) that we have used insufficiently high levels of fibre sources in the diets; (b) that the protein levels in all the diets were higher than those used in those literatures cited; (c) the sources of fibre are also different from those used by those authorities cited. Almost without exception, the consequences of fibre inclusions at high levels in the diets of pigs that have a limited capacity to utilize fibre have been reduced weight gains and increased feed/gain ratios, and the authorities cited above have used fibre levels ranging from zero to 30 or even 60% of the diets.

At these high levels, it was not possible for the pigs to ingest their minimum energy requirement for good daily gains and acceptable feed/gain ratios. Further-

more, most of these workers employed the *ad libitum* feeding methods and challenged the pigs with the maximum they could consume. In our studies, however, we not only used lower levels of fibre sources, but also employed a semi-restricted feeding regime for all the pigs. Under these conditions, all the pigs consumed enough energy to promote good growth rates and in fact, pigs on the higher fibre diets even tended to consume slightly higher DE daily than those on the lower levels of fibre. It would thus appear that the bases for direct comparisons of these results with those cited above do not exist except to indicate the possible reasons for the 'rather different' results. It is yet an unchallenged fact that fibrous feeds which contain low densities of digestible energy prevent the pigs from growing fast and having poor feed/gain ratios. As for the similarities in the average daily DE values consumed, this was principally because the animals were somewhat restricted in their feed intake since they were not on *ad libitum* regime.

A comparison of the performances of the pigs at both weight groups shows that the lighter pigs grew at a slower rate, but utilized feed and energy more efficiently than the heavier pigs and these are in line with the physiological principles involved in nutrient utilization which basically states that as the animals become heavier and fatten more, they consume more feed and energy per unit of weight gain than the younger, lighter animals since the amount of energy required for fat deposition is so much higher than that required for lean meat production.

The aspect of carcass measurement also shows some differences when compared with the results of previous workers cited earlier. Here again, significant and consistent reductions have been obtained in all parameters of fat measurements and

significant increases in all measures of lean meat as the levels of fibre were increased in those studies cited, but in our studies, inconsistent trends typified all our findings. This paradox is also best explained on the basis of the virtually identical digestible energy intakes of those pigs on all the diets. The primary basis for reductions in fat measurements is significant reduction in digestible energy intake which is what is deposited as fat when it is supplied in excess amounts. Since the pigs on our experiments did not suffer a reduction in their energy intakes even when those two fibre sources were included at 15% level, it would be expected that there would be no significant changes in the carcass measurements, particularly in those fat measurements.

Although the gut weights were not significantly enlarged by the levels employed, there was, nevertheless, a consistent trend of increases as the levels increased. This is in line with the earlier observations of Dinusson *et al*, (1953) Bohman *et al*, (1953), Bohman, Hunter and McCormick, (1955) and McCormick and Kidwell, (1953), all of whom had observed various degrees of enlargement of the gastrointestinal tracts of the pigs, particularly the stomach, on various levels and sources of fibre. This enlargement is regarded as an adaptive feature to cope with the larger volume of feed intake on the highly fibrous but low energy density rations. In most cases, it is the stomach and the large intestines which are so significantly increased in weight by high fibre diets. Again, the mild differences obtained in our studies were principally due to the fact that the pigs were not challenged with all they could eat on those fibre diets.

The trends observed with nutrient digestibilities and retention are in agreement with what several scientists have observed

and obtained (Whiting and Bezeau, 1951a, b; Boenka, Tribble and Pfander, 1969; Lloyd and Crampton, 1955, and Pond, Lowrey and Maner, 1962). These depressions in nutrient digestibilities as fibre levels increased are associated with either the prevention of absolute and more complete contact between the digestive enzymes and the nutrients by the fibre in the diet (particularly at high levels) or the increase in the metabolic faecal nitrogen that has been found to be one of the inescapable consequences of the consumption of highly fibrous diets (Whiting and Bezeau, 1957 a, b, and Meyer, 1956). The degrees of depression are not only dependent on the amount of fibre, but also on the a type of fibre included in the diets of these animals, which would be a reflection of the differences in the amounts of lignin present in the fibre sources. And when the two sources of fibre are compared in these trials with respect to the differences in nutrient digestibilities and retention, it would appear that wheat offals might contain higher amounts of lignin than the groundnut shells, but there is no scientific basis for this speculation which is based principally on the fact that nutrients were slightly better digested on the groundnut shell diets than the diets containing wheat offals.

Again, the lack of strong positive or negative relationships between the average digestible energy intake versus the performance and carcass measurements is another point against the well-accepted concepts but this is not a result to disprove these well-accepted concepts. Rather, it showed that perhaps the levels of fibre employed and/or the system of feeding adopted did not allow these relationships to show well because the variables were not significantly changed. Much higher levels will have to be employed and the

relationships re-examined before any valid statements can be made.

In conclusion, since neither the performance nor the carcass measurements were significantly influenced by the levels of the two fibre sources employed in these studies, it would appear that the rations of pigs could be made cheaper by replacing part of the expensive maize component of the diet with the cheaper, more fibrous wheat offals or groundnut shells. In this connection, it appears that groundnut shells are slightly better than wheat offals when all the yardsticks of performance are compared.

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