Effects on some performance and carcass traits of feeding different levels of a cereal-based diet to grower pigs with or without plantain pseudostem

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ABSTRACT

Fifteen large, white castrate pigs (5-6 months old; 35-45 kg initial live weight) were used in an experiment over a 5-week period to investigate the potential value of plantain pseudostem (stalks) as feed for pigs. The experiment which consisted of three treatments, each with five replicates, was arranged in a randomized complete block design. Blocking was by initial live weight. The treatments were as follows: (i) cereal-based concentrate offered at 100 per cent (T_1); (ii) cereal-based concentrate at 90 per cent, plus pseudostem (T_2); and (iii) cereal-based concentrate at 80 per cent, plus pseudostem (T_3). Proximate analysis of plantain pseudostem showed 8 per cent DM, 2.4 per cent CP, 20.5 per cent CF, 14.3 per cent Ash, and 60.5 per cent NFE. Mean daily intake was significantly lower ($P<0.05$) in pigs on T_3 (10.0) than on T_1 (11.4 kg/week). Pigs on T_1 had significantly higher ($P<0.05$) ADG (0.59 kg) than those on T_3 (0.44 kg). FCE was not significantly affected ($P>0.05$) by dietary treatment, nor were the hot carcass weights, carcass length, loin eye area, and back fat thickness. Kidney weight was, however, heavier ($P<0.05$) in pigs on T_3 (0.18) than on T_2 (0.11) or T_1 (0.16 kg). The study suggests that a cereal-based diet could be fed with up to 10 per cent plantain pseudostem without deleterious effect on intake and growth in pigs, resulting in some saving in feed costs. Further studies need to be done to evaluate longer term effects on pigs fed plantain pseudostem.

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RÉSUMÉ

ODOI, F. N. A., MENSAH, C. D. B., NKRUMAH, J. D., DZAKPATA, J. S. & DZATHOR, R. F. K.: *Effets sur les performances et les traits de carcasse par les différents niveaux d'alimentation avec un régime basé sur la céréale pour les cochons producteurs avec ou sans la pseudo-tige de plantain.* Quinze grands cochons blancs châtrés (5-6 mois d'âge; 35-45 kg de poids vif initial) étaient utilisés dans une expérience sur une période de 5-semaines pour étudier la valeur potentielle de pseudo-tige (les queues) de plantain comme nourriture pour les cochons. L'expérience qui consistait en trois traitements, avec cinq replicatifs par chacun, était arrangée dans un dessin de bloc complet choisi au hasard. Le bloc complet était basé sur les poids vif initial. Les traitements étaient : (i) un concentré basé sur la céréale offert à 100 pour cent (T_1); (ii) un concentré basé sur la céréale à 90 pour cent plus la pseudo-tige (T_2); et (iii) un concentré basé sur la céréale à 80 pour cent plus la pseudo-tige (T_3). Analyse immédiate de pseudo-tige de plantain montrait 8 pour cent DM, 2.4 pour cent CP, 20.5 pour cent CF, 14.3 pour cent Cendre, et 60.5 pour cent NFE. La consommation quotidienne moyenne était considérablement plus basse ($P< 0.05$) dans les cochons sur T_3 (10.0) que sur T_1 (11.4 kg/semaine). Les cochons sur T_3 avaient considérablement les plus éleves ($P < 0.05$) ADG (0.59 kg) que ceux sur T_3 (0.44 kg). FCF n'était pas considérablement influencé ($P> 0.05$) par le traitement diététique, ni étaient les poids de carcasse chaude, longueur de carcasse, zone du filet de reins et grosseur de graisse dorsale. Poids de rein était cependant plus lourde ($P< 0.05$) dans les cochons sur T_3 (0.18) que sur T_2 (0.11) ou T_1 (0.16 kg). Les résultats de l'étude sugère qu' un régime basé sur la céréale pourrait être donné à manger jusqu' à 10 pour cent de pseudo-tige de plantain sans effet délétère sur la consommation et la croissance des cochons, aboutissant à quelques épargnes en coûts d'alimentation. Des études supplémentaires devraient être faites pour évaluer des effets à plus long terme sur les cochons nourris avec pseudo-tige de plantain.

Introduction

The profitability of any animal production venture is based on the availability of cheap but good quality feed. The traditional sources of energy and protein for feeding pigs in Ghana are cereal grains and high quality fish and fish products that are also in demand for human food. Perennial shortage, coupled with high prices of these feed ingredients, has usually led to poor feeding of pigs. Fortunately, pigs also thrive on by-products from agro-based industries and other materials not in demand by humans. Developing feeding systems that are based on the use of such "non-conventional" ingredients have proved profitable, particularly with cereal by-products, oil seed cakes, and other industrial by-products. However, the suitability of several other by-products as feed for pigs in Ghana is yet to be explored. Banana and plantain are important food crops in this country. Harvesting of the fruits leaves in its wake large quantities of waste, especially leaves and pseudostems (or stalks), which constitute the bulk of the plant. The pseudostem is potential feed for pigs (Babatunde, 1992), though it is only used as mulch material or left on farms.

The objectives of this study were as follows:

1. To determine the nutritive value of pseudostem of the plantain plant obtained after fruit harvest.
2. To investigate the effects on live weight gain by partially replacing a cereal-based ration with pseudostem in grower pigs.
3. To evaluate the effect on some carcass characteristics of pigs fed rations including pseudostem.
4. To assess the effect of incorporating plantain pseudostem into rations on cost of feeding pigs.

Materials and methods

Animals

Fifteen large, white grower pigs aged 5-6 months with average initial weight of 40.1 kg per treatment group (s.e. 0.05) were used. There were five pigs per treatment. A randomized complete block design was adopted, with blocking done on basis of initial weight of pigs.

Treatments

Three diets were designed as treatments, each with five replicates:

1. A cereal-based ration fed with no pseudostem, i.e. fed at 100 per cent (T_1).
2. A cereal-based ration fed at 90 per cent of T_1 levels, plus pseudostem (T_2).
3. A cereal-based ration fed at 80 per cent of T_1 levels, plus pseudostem (T_3).

Management

The pigs were housed in pens having concrete floors and walls, insect-proof screen, and a metal roof. All pigs were fed once daily. The cereal-based ration was offered dry at 1.5-2.0 (T_1), 1.35-1.8 (T_2), and 1.2-1.6 (T_3) kg/pig/day based on individual weights of pigs. Chopped fresh plantain pseudostem was offered separately to pigs in treatments T_2 and T_3. Water was provided *ad libitum*. Intake was estimated by difference between feed offered and what was left over after 24 h. The pigs were individually weighed, at 7-day intervals. At the end of the 5-week trial period, the pigs were slaughtered, scalded, and cleaned. The carcasses were chilled at 1-2 °C for 24 h, and dressing percentage, carcass length, back fat thickness, and loin eye area were measured. The weights of gastro-intestinal tract (i.e. stomach, large and small intestines), liver, kidney, heart, and lungs were also taken (details of procedures as described by van Loon (1978).

Chemical analyses

Samples of feed offered and samples from the carcasses were chemically analyzed according to procedures of AOAC (1980). The data were subjected to analysis of variance (ANOVA) procedures, and differences between treatments determined by the Duncan's Multiple Range Test (Steele & Torrie, 1980).

Results and discussion

Composition of basal ration

Table 1 shows the composition of the cereal-based diet offered to pigs, and Table 2 shows the chemical composition of mature pseudostem used in feeding pigs. Plantain pseudostem has high moisture, crude fibre (CF), and ash contents, but a low crude protein (CP) level. It could potentially be a good source of energy, with its high nitrogen-free extract (NFE) value. The pseudostem could also be a good source of minerals, being particularly rich in calcium and potassium. The high fibre and low CP contents may, however, limit the use of the pseudostem by pigs (Just, 1982; Close, 1993), though Gouwens (1966) and Kennelly & Aherne (1980) have suggested that if the feed source does not contribute significant amounts of the dietary protein intake (as for the pseudostem in this study), high fibre levels may not affect protein digestibility significantly.

TABLE 1

Composition of Cereal-based Diet Offered to Pigs

Ingredient	*Composition (%)*
Maize	57.3
Wheat bran	27.5
Fish meal	11.5
Oyster shell	2.7
Vitamin & mineral premix	0.5
Common salt	0.5
Total	100.0
Nutrient (determined)	*Composition (% of DM)*
Crude protein	17.7
Crude fibre	4.0
Ether extract	5.5
Calcium	1.6
Phosphorus	0.5

TABLE 2

Nutrient Composition of Mature Plantain Pseudostem Fed to Pigs

Nutrient	*Composition (%)*
Dry matter	8.0
Crude protein	2.4
Crude fibre	20.5
Ether extract	2.3
Ash	14.3
NFE	60.5

Feed intake

Table 3 shows DM intake for the three treatments over the experimental period. Mean intake was highest ($P<0.05$) for pigs on T_1, followed by those on T_2 and T_3 treatments. It had been expected that the high fibre content in the plantain pseudostem may stimulate increases in intake, because pigs will attempt to maintain energy intake (ARC, 1981; Low, 1985; Close, 1993). Thus, as the level of the concentrate in the diet decreased, the intake of the pseudostem would correspondingly increase, so that total voluntary feed intake will be maintained. This was not so because of the restriction placed on the amounts of pseudostem fed to pigs. Results from this work suggest that further trials offering pseudostem *ad libitum* to pigs would be worth undertaking, as all the pigs readily consumed virtually all the pseudostem offered each day.

Live weight gain and feed conversion

Live weight gains in pigs were highest ($P<0.05$) on T_1 compared to T_2 and T_3 (Table 3). This was likely the result of decreasing nutrient intake (especially CP) with decreasing level of the cereal-based diet offered. The replacement of part of the cereal-based diet with pseudostem decreased energy concentration of the total diet eaten, as fibre intake increased (McDonald, Edwards & Greenhalgh, 1987). Restricted feeding of pseudostem reduced total energy intake (Close, 1993), resulting in the poor growth rates recorded for the two pseudostem treatments (T_2 and T_3). The study, however, shows that pseudostem could be fed to pigs for satisfactory growth rates.

The conversion of feed into muscle/fat is an important measure of the efficiency in production

TABLE 3

Mean Values of Some Performance Characteristics in Pigs on Different Treatments

Treatment	*(T_1) 100 %*	*(T_2) 90 %*	*(T_3) 80 %*	*s.e.*
Average initial weight (kg)	40.2	40.0	40.2	0.05
Average final weight (kg)	56.7	54.2	52.5	1.00
Average total weight gain (kg)	16.5^{a}	14.2^{ab}	12.3^{b}	0.99
Average feed intake (kg/wk)	11.4^{a}	11.1^{b}	10.0^{c}	0.35
Average daily gain (kg)	0.59^{a}	0.50^{ab}	0.44^{b}	0.141
Feed conversion efficiency* (FCE)	2.8	3.2	3.8	0.12

Values with same superscript within a row are not significantly different ($P<0.05$)
* Kg feed intake/kg live weight gain

of animals. Although differences in feed conversion efficiency (FCE) were not significant ($P>0.05$), the FCE appeared to decrease with decreasing levels of the cereal-based ration fed. Increasing fibre levels in diets decrease FCE (Kennelly & Aherne, 1980; McDonald *et al.*, 1987). The pigs may not have met their amino acid requirements on T_2 and T_3 diets, as the higher fibre contents were likely to depress digestion and availability of amino acids (Kidder & Manners, 1978). Tannins were reported to be present in plantain pseudostem which may inhibit enzyme action, or form complexes with proteins and carbohydrates, thus, reducing digestibility (Babatunde, 1992; Kumar & D'Mello, 1995).

Carcass characteristics and internal organs

Pigs on T_1 had heavier carcasses than those on T_2 and T_3 (Table 4), although differences were not significant ($P>0.05$). Pigs fed bulky, high fibre feeds were reported to have developed larger digestive tracts containing greater amounts of feed and feed residues. This reduces dressing percentage (Crampton, Ashton & Lloyd, 1954). The rather high backfat thickness in pigs on T_3 treatment may have been due to lower protein intake which is known to affect tissue deposition and carcass yield (Chuba *et al.*, 1985). The values recorded from loin eye area measurements (Table 4) indicate an inverse relationship between backfat thickness and loin eye area. Pigs on T_3 recorded the lowest loin eye area among the three treatments, indicating likely lower returns from meat sales.

The weights of spleen, lungs, liver, and heart of the pigs did not show significant differences ($P>0.05$) for treatments (Table 5). Pigs on T_3, however, had significantly heavier kidneys

TABLE 4

Mean Weights of Some Carcass in Pigs Fed the Three Diets

Carcass trait	*100 %*	*90 %*	*80 %*	*S.e.m*	*Sig.*
Slaughter weight (kg)	55.50	53.50	51.80	-	-
Hot carcass weight (kg)	42.15	39.50	38.95	0.81	NS
Dressing %	76.00	74.00	75.20	0.48	NS
Carcass length (cm)	69.00	69.00	68.50	0.14	NS
Loin eye area (cm^2)	20.88	21.20	19.80	0.35	NS
Backfat thickness (cm)	1.80	1.68	1.79	0.03	NS

TABLE 5

Mean Weights of Internal Organs From Pigs Fed the Three Diets

Carcass trait	*100 %*	*90 %*	*80 %*	*S.e.m*	*Sig.*
Weight of GIT# plus contents (kg)	5.95	7.00	5.78	0.31	NS
Weight of empty GIT	2.49	2.52	2.03	0.13	NS
Weight of stomach plus contents (kg)	1.50[a]	1.50[a]	1.37[b]	0.04	*
Weight of empty stomach (kg)	0.62	0.58	0.62	0.01	NS
Digestive tract as % of carcass weight	8.30	11.40	9.60	0.73	NS
Weight of internal organs+ (kg)	2.00	1.81	1.71	0.07	NS
Weight of liver (kg)	1.00	1.00	0.90	0.03	NS
Weight of kidneys (kg)	0.16[ab]	0.11[b]	0.18[a]	0.02	*

#GIT = Gastro-intestinal tract.
+Internal organs = Liver, spleen, lungs, heart, and kidneys.

(P<0.05) than those on the other treatments. This may possibly have been a reaction to the chemical components or astringents present in pseudostem which were absorbed during feed utilization. A similar observation was reported in pigs fed *Leucaena leucocephala* leaf meal which was ascribed to retention of absorbed mimosine (Laswai *et al.*, 1997). There were no significant differences (P>0.05) between treatments, in weight of the digestive tract (i.e., stomach, small and large intestines) taken as a percentage of the total carcass weight.

Cost of live weight gain

Feed cost per kg live weight gain was lowest for pigs on T_1, increasing as the proportion of the cereal-based diet in total intake decreased (Table 6). Differences were, however, not significant (P>0.05). Means for feed cost per kg live weight gain appear to increase with decreasing levels of the cereal-based diet fed. The high cost of live weight gain in pigs on T_2 and T_3 treatments may be a direct result of a corresponding reduction in total intake of energy and protein, with decreasing levels of the cereal-based diet offered. It is possible that if the levels of pseudostem offered had been adjusted to ensure uniform intake of nutrients across treatments, live weight gain, especially in pigs on the T_2 treatment, would have been higher than recorded.

TABLE 6

Mean Feed Cost (¢) per Kilogram Live Weight Gain on Different Treatments

Treatment	*Cost/kg live weight gain (¢)*
100 % of basal ration offered (T_1)	1605.33
90 % of basal ration offered (T_2)	1672.75
80 % of basal ration offered (T_3)	1722.08

Conclusion

The study has indicated that pseudostem from plantain can provide some of the energy needs of growing pigs for maintenance and weight gain, as the material is high in soluble carbohydrates (and thus, readily available energy). However, the use of the energy value of the pseudostem is likely to be limited by low levels of protein. Plantain pseudostem offered to replace about 10 % of a cereal-based diet for grower pigs was without detrimental effects on live weight gain and FCE. Backfat thickness, an important carcass measure in marketing pigs, was reduced. This has important implications for the consumer and the pig producer in Ghana.

REFERENCES

AOAC (1980) *Official methods of analysis*, 4th edn. *Association of Official Analytical Chemists*, Washington.

ARC (1981) *The nutrient requirements of pigs.* Technical Review by an ARC Working Party. Commonwealth Agricultural Bureaux, Slough, United Kingdom.

Babatunde, G. M. (1992) Availability of banana and plantain products for animal feeding. In *Roots, tubers, plantains and bananas in animal feeding* (ed. D. Machin and S. Nyvold). *FAO Animal Production and Health Paper* **95**.

Chuba, L. I., Peo, J. R., Lewis, A. J., Brum, M. C., Fritschem, R. O. & Crenshow, J. D. (1985) Effect of dietary fat on pig performance and dust level. *J. Anim. Sci.* **61,** 763-766.

Close, W. H. (1993) Fibrous diets for pigs. In *Animal production in developing countries* (ed. M. Gill, E. Owen, G. E. Pallott and T. L. J. Lawrence; Tech. ed. H. Davies and M. C. Pitkethly). **16,** 107-117.

Crampton, E. W., Ashton, G. C. & Lloyd, L. E. (1954) Improvement of bacon carcass quality by the introduction of fibrous feeds into the hog finishing ration. *J. Anim. Sci.* **13,** 327-331.

Gouwens, D. W. (1966) *Influence of dietary protein and fibre on faecal amino acid excretion of swine* (MSc Thesis). University of Illinois, Urbana.

Just, A. (1982) The influence of ground barley straw on the net energy value of diets for growth in pigs. *Livestock Prod. Sci.* **9,** 717-729.

Kennelly, J. J. & Aherne, F. X. (1980) The effect of fibre in diets formulated to contain different levels of energy and protein on digestibility coefficients in swine. *Can. J. Anim. Sci.* **60,** 717-726.

Kidder, D. E. & Manners, M. J. (1978) *Digestion in the pig.* Bristol: Scientechnea Bristol.

Kumar, R. & D'Mello, J. P. F. (1995) Anti-nutritional factors in forage legumes. In *Tropical legumes in animal nutrition* (ed. J. P. F. D'Mello and C. Devendra). UK: CAB International **5,** 95-111.

Laswai, G. H., Ocran, J. N, Lekule, F. P. & Sundstol, F. (1997) Effects of dietary inclusion of *Leucaena leucocephala* leaf meal, with and without ferrous sulphate, on digestibility of dietary components and growth of pigs over the weight range of 20-60 kg. *Anim. Feed Sci. Technol.* **65,** 45-57.

Low, A. G. (1985) The role of dietary fibre in digestion absorption and metabolism. *Proceedings of 3rd International Seminar on Digestive Physiology in the Pig. Report No.* 580. Copenhagen, Denmark: Beret Statens. Husdyrbugsfors.

McDonald, P., Edwards, R. A. & Greenhalgh, J. F. D. (1987) *Anim. Nutr.*, 4th edn. England: Longman Scientific and Technical.

Steel, R. G. D. & Torrie, J. H. (1980) *Principles and procedures of statistics: A biometrical approach.* 2nd edn. New York: McGraw-Hill Book Co.

van Loon, D. (1978) *Small-scale pig raising.* Storey Communications Inc., Vermont, Garden Way Publishers. 263 pp.