SOME PROXIMATE COMPONENTS OF SWEET POTATO TUBERS (SPTM), PLANT FRACTIONS AND BY-PRODUCTS AND THE EFFECTS OF INCLUSION OF VARYING LEVELS OF SPTM ON PIG PERFORMANCE AND CARCASS CHARACTERISTICS

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ABSTRACT

Studies were conducted to determine some proximate components of products and by-products of the sweet potato variety, Sauti, and to determine the growth performance and carcass characteristics of pigs fed diets containing varying levels of sweet potato tuber meal (SPTM). The sweet potato vines (SPV) contained 10.5%CP, 38.7%CF, 1.9%EE and 6.6%Ash. The corresponding values for the leaves (SPL), tuber residue (SPTR), peels (SPP) and feed-grade tubers (SPTM) were 12.0, 3.2, 7.1 and 7.6%CP; 18.4; 5.2, 6.7 and 2.9%CF; 3.0, 1.5, 3.9 and 2.0%EE and 12.2, 0.5, 5.8 and 4.5% Ash. Isonitrogenous (18% CP). diets containing 0, 10, 20 and 30% SPTM which replaced similar levels of maize were formulated and fed to a total of 16 starter-grower pigs which had been housed in individual welded-mesh cages and provided with feed and water ad libitum. The feeding trial lasted 8 weeks after which all the pigs were slaughtered for carcass evaluation. The values for the mean daily feed intake, weight gain and feed conversion efficiency (FCE) were similar ($P > 0.05$) for the pigs on the 4 dietary treatments. Feed cost was lowered as the level of SPTM in the diet increased from 0 to 30%. However, the feed cost/kg liveweight gain tended to be higher in the SPTM containing diets. This was attributed to the poorer FCE values of such diets. With the exception of the relative viscera and liver weights which were significantly ($P < 0.05$) higher for the pigs fed the SPTM diets, all other carcass trait values were similar ($P > 0.05$). It was concluded that sweet potato products and by-products could assist in meeting the nutrient needs of pigs in Ghana. However, it may be necessary to ensure that their use reduces not only feed cost but also feed cost/kg liveweight gain - a very important economic parameter.

Keywords: *Sweet Potato Products, By-products, Nutritive Value, Pigs, Growth and Economic Performance.*

INTRODUCTION

Ghanaian animal nutritionists as well as their colleagues in other parts of the developing world have continued to devote much research time and money to the identification, classification and establishment of the nutritive values of non-conventional feed materials with a view to determining their usefulness as alternate feed resources for poultry and livestock. The results obtained from some of the materials studied in Ghana for use as ingredients for pigs have been summarised [1].

Cassava, yams, sweet potatoes and other root and tuber crops contribute quite significantly to the national Gross Domestic Product. The bulk of the production is used for local consumption either in the fresh or processed forms. Cassava and yams are the major crops in this category but currently there is renewed interest in the large-scale production of sweet potatoes in order to process it to obtain starch for industrial purposes either for use locally or for export. It is quite likely that the anticipated successful take-off of the production of sweet potatoes will lead to the availability of numerous sweet potato products, co-products and by-products such as sweet potato vines and leaves, fresh or dried feed-grade sweet potatoes, and starch-free sweet potato root meal, otherwise known as sweet potato tuber residue. These could be of use in non-ruminant and ruminant livestock diets and could help to reduce the non-ruminant livestock industry's dependence on maize and fishmeal as the major feed ingredients. There is a paucity of data on the nutrient composition and nutritive value of the locally available varieties of sweet potatoes and their by-products.

The objectives of this study therefore were to determine the nutrient composition of sweet potato vines (SPV), leaves (SPL), sweet potato tuber residue (SPTR), sweet potato peels, (SPP) and chipped, dried feed-grade sweet potatoes (SPTM) and to study the growth and economic performance of pigs fed diets containing varying levels of SPTM

MATERIALS AND METHODS

Experiment 1

The Roots and Tuber Programme of the Crops Research Institute (CRI) of the Council for Scientific and Industrial Research (CSIR) provided dried samples of the SPV, SPL, SPTR, SPP and SPTM for this study. All samples were ground using a 1mm mesh and were analysed for their dry matter, (DM), crude protein (CP), ether extract (EE), crude fibre (CF) and ash contents in duplicate. The analytical proce-dures used were those described in the AOAC's Official Methods of Analysis [2].

Experiment 2

The feed grade sweet potatoes (SPTM) which had been chipped and dried was provided by the Root and Tuber Programme of the CRI. The variety of sweet potato used was SAUTI. All other ingredients used (Table 1) were bought from the open market.

Four diets each containing about 18% CP (on "as-fed" basis) were formulated using maize, fishmeal, wheat bran, oyster shell and vitamins and minerals including common salt. As shown in Table 1, the varying levels of SPTM (i.e., 0, 10, 20 and 30%) were incorporated as a direct replacement for similar amounts of the maize in the control diet. The dietary treatments were described as 0% SPTM, which was the Control diet and did not contain any SPTM, and 10, 20 and 30% SPTM, respectively. In order to make the diets iso-nitrogenous it was necessary to increase the level of fishmeal as more SPTM was used.

An eight-week feeding trial using a total of 16 castrate starter pigs housed in individual welded mesh cages and weighing between 9.5 and 17.5kg was conducted after randomly allotting them to the 4 dietary treatments on the basis of their liveweights and litter origin. The design used was the completely randomised block design. Feed and water were both provided ad libitum and all pigs were weighed at weekly intervals. At the end of the feeding trial, all the pigs were slaughtered and certain carcass traits including dressed weight, dressing percen-tage, mean backfat thickness and loin eye area were determined. Both warm and cold (after chilling in a cold room for 24hr.) carcass weights were recorded. Each carcass was subsequently split into two equal halves along the vertebral column and the right half of the carcass was used to determine the backfat thickness and the loin eye area. The value for the backfat thickness was the mean of the 3 backfat measurements taken from the first and last ribs and the rump. The loin eye area was a planimeter reading (cm^2) of the tracing of the Longissimus dorsi obtained after cutting between the 12th and 13th ribs. The economic evaluation of the diets consisted of the establishment of the feed cost (¢/kg), and feed cost per unit liveweight gain, determined as feed conversion efficiency multiplied by the unit cost of each diet.

All the data collected in this experiment were analyzed using the analysis of variance technique as described in the SYSTAT COMPUTER Statistical package [3] and the Tukey's HSD multiple comparisons method was used to determine the extent of the differences between means when significant differences were observed.

RESULTS AND DISCUSSIONS

Experiment 1

The results for the proximate components of the materials studied are shown in Table 2. The values obtained for the sweet potato products and by-products indicated quite clearly that most of these are low crude protein feed materials with the leaves and vines having more CP than the tuber residues, peels and the feed grade tubers. On the other hand, the leaves and vines are quite high in crude fibre and may therefore have limited use in the diets of monogastric species such as pigs and poultry. In an analysis of 49 varieties of sweet potatoes, a wide range of values for the components studied here was reported [4]. Generally the values observed in this study fall within the range of values found earlier [4]. In that report, gross energy values of 3.5, 3.4 and 4.2 kcal/g were determined for the leaves, vines and tubers respectively; an indication that some sweet potato products may be quite high in energy.

In Ghana, the major energy source in monogastric diets is maize; however, recently efforts are being made to encourage the use of cassava chips in poultry and pig diets. Unfortunately, cassava has very little CP (3%) necessitating the inclusion of higher amounts of the expensive protein sources such as fishmeal and soyabean meal in order to meet these animals' requirements for protein and amino acids. This could lead to increasing feed cost thereby reducing wha-tever gains may have been made by the use of the generally cheaper cassava. Feed grade sweet potato tubers as shown in this experiment and reported elsewhere, [4] have more CP, i.e. 7.6% and may be a better alternative to cassava and closer in nutrient profile to maize which has about 8-10% CP. It is therefore worthwhile to establish its nutritive value and thereby determine the role that it can play in meeting the nutrient needs of poultry and livestock.

Table 1: Percentage Composition of the Diets

Item	Dietary Treatments			
	Control	10% SPTM	20% SPTM	30% SPTM
Maize	65	55	45	35
SPTM	-	10	20	30
Fishmeal	14.5	15	15.4	15.8
Wheat Bran	19.5	19	18.6	18.2
Common Salt	0.25	0.25	0.25	0.25
Oyster Shell	0.5	0.5	0.5	0.5
Vit. & Trace Min. Premix*	0.25	0.25	0.25	0.25
	100	100	100	100
%Comp. Calc.				
CP	18.3	18.3	18.3	18.2
Digestible Energy, kcal/kg	3270.5	3285.7	3300.4	3315.1
% Comp. Analysed (DM basis)				
DM	90.2	89.6	90.5	89.7
CP	20.3	19.9	21.0	20.7
CF	5.6	6.5	6.3	5.5
Ash	6.4	6.3	6.9	8.4

*The Vitamin and Trace mineral premix -provided the following/kg diet: Vit. A, 8000 iu; Vit.D;3000 iu; Vit.E:8iu; Vit.k:2mg; Vit.B_1:1mg; Vit.B_2:2.5mg;2.5mg; Vit.B_{12}:5mg; Niacin:10mg; Pantothenic acid:5mg; Antioxidant:6mg; Folic acid:0.5mg; Chlorine 150mg; Iron:20mg; Manganese:80mg; Copper:8mg; Zinc: 50mg; Cobalt:0.255mg; Iodine:2mg and Selenium:0.1mg.

Table 2: Nutrition Composition of various Sweet Potato Products and by-Products

Item	(%, DM Basis)				
	DM	CP	CF	EE	ASH
Vines	85.8	10.5	38.7	1.9	6.6
Leaves	83.8	12.0	18.4	3.0	12.2
Tuber Residues	84.1	3.2	5.2	1.5	0.5
Peels	83.9	7.1	6.7	3.9	5.8
Tubers-Feed Grade (SPTM)	89.7	7.6	2.9	2.0	4.5

Experiment 2

The growth performance of the starter pigs fed the varying levels of SPTM is shown in Table 3. There were small numerical differences in the values for the feed intake and liveweight data with pigs fed the SPTM diets generally eating slightly more feed (higher ADF) but growing at a rate either similar (10% SPTM) to the Control (0% SPTM) or less than the Control diet (i.e. 20 and 30% SPTM) diets.)

However, statistical analyses indicated that the differences in these values were not significant ($P > 0.05$).

It is possible that the slightly higher ADF for the SPTM diets could be due to the presence of more total sugars in these diets than in the control diet. It is worth mentioning however that it has been reported [4] that starter and grower pigs ate less of SPTM-containing diets

Table 3: Growth Performance of Starter-Grower Pigs fed diets containing varying levels of sweet potato tuber meal (SPTM)

Item	Dietary Treatments					
	Control	10% SPTM	20% SPTM	30% SPTM	SE	NS
Initial Wt, kg	13.5	13.6	13.6	13.4	1.37	NS
Final Wt, kg.	51.3	51.1	47.6	48.8	3.52	NS
Total Gain, kg.	37.8	37.5	34.0	35.4	2.36	NS
ADG, kg	0.67	0.67	0.61	0.63	0.04	NS
Total Feed, kg.	93.7	104.2	98.2	97.7	7.67	NS
ADF, kg.	1.67	1.86	1.75	1.74	0.14	NS
FCE	2.48	2.79	2.89	2.75	0.12	NS
Feed Cost, ¢/kg	610.15	597.23	582.80	568.38		-
Feed Cost/kg wt gain, ¢	1452.2	1667.1	1681.4	1563.3	75.28	NS

NS = Not significant at P > 0.05
SE = Standard Error of the means

Table 4: Carcass Characteristics of pigs fed varying levels of sweet potato meal (SPTM)

	Control	Dietary Treatment 10% SPTM	20% SPTM	30% SPTM	SE	NS
Mean L. wt at Slaughter, kg.	51.3	51.1	47.6	48.8	3.52	NS
Dressed wt, warm, kg	34.4	33.9	30.9	30.8	2.56	NS
Dressed wt, cold, kg	33.0	32.7	29.6	29.7	2.38	NS
Dressing %, warm	67.0	66.6	64.6	62.9	1.03	NS
Dressing %, cold	64.3	64.1	62.1	60.7	1.04	NS
Mean Backfat thickness, cm	2.18	2.20	2.13	1.93	0.23	NS
Loin Eye Area, cm^2	21.2	21.4	19.5	19.4	1.45	NS
Relative Wt of Some Body Components, %						
Viscera	16.5^a	17.1^a	18.4^a	20.2^b.	82	S
Liver	2.00^a	2.21^{ab}	2.50^{bc}	2.51^c.	11	S
Spleen	0.10	0.12	0.15	0.11.	02	NS
Kidneys+	0.37	0.39	0.41	0.42.	03	NS
G.I.T, Full	11.9	12.4	13.3	15.1.	76	NS
G.I.T, Empty	4.93	5.14	5.27	5.94.	27	NS
Heart	0.29	0.32	0.34	0.28.	03	NS
Wt. of Primal Cuts, kg						
Shoulder	2.95	2.80	2.83	2.78.	22	NS
Belly	3.56	3.40	3.21	3.16.	40	NS
Thigh	5.26	5.03	4.63	4.58.	32	NS
Loin	4.24	4.46	3.86	3.86.	34	NS

S = Significant at P < 0.05; a, b, c = All values in the same row with same or no superscripts are similar (P > 0.05); NS = Not significant at P > 0.05; + = The values for the kidneys are the means for the pair; G.I.T = Gastro intestinal tract.

and grew at a slower rate than those fed a maize control diet. The differences observed, were however only significant (P<0.05) at the starter phase.

Feed conversion efficiency (FCE) tended to decline as level of SPTM in the diet was increased from 0 to 30%.

This was perhaps not unexpected since the ADF values had tended to increase while the ADG values had dropped slightly as the level of SPTM was increased. The earlier report [4] indicated that in the starter phase FCE can be poorer in SPTM diets and similar or better during the grower phase.

Furthermore, it has been found that sun-dried sweet potato tubers may contain trypsin inhibitors which can adversely affect the digestion of the protein fraction of the feed and thereby reduce growth performance [4].

Feed cost (¢/kg) was lowered as the level of SPTM in the diets was increased from 0 to 30%. This was because the estimated cost of the SPTM was ¢300/kg while the maize it partially replaced in the diets cost more than ¢500.00/kg at the time of the experiment. Despite this lowered feed costs, the SPTM-containing diets were more expensive to feed to the pigs as indicated by the relatively higher feed cost/kg liveweight gain values (Table 3). This cost item, as stated earlier, is usually the product of the feed cost and FCE and thus the poorer FCE values for the SPTM diets may have led to this observation. The implication of this finding is that SPTM-containing diets may only be economic to feed when SPTM is cheaper than the ¢300.00/kg used here or when some other portions of the plant with high CP levels e.g. leaves and vines are included in the formulations since they will be available at very little extra cost to the farmer. These could even be fed fresh as a supplement or can be ensiled with the roots, as suggested by Nigerian data [4] and fed to pigs.

Numerical differences were observed in the values for the carcass traits determined as shown in Table 4 but with the exception of the relative values for viscera and liver, the values reported were not significantly different ($P > 0.05$). The absolute weights of the viscera for the 4 treatments were 8.46 (Control), 8.74 (10% SPTM), 8.69 (20% SPTM) and 9.25 (30% SPTM) kg and the corresponding values for the liver were 1.03, 1.13, 1.19 and 1.21kg. This trend of increasing absolute viscera and liver weight as the level of SPTM increased in the diet became significant ($P< 0.05$) when the values for these were considered on relative weight basis. It is suggested that the major reasons for these observations are the consi-derable increases in the relative full and empty gastro-intestinal tract (GIT) weights which are also indications of slower passage rate of feed and a thickening and enlargement of the GIT.

CONCLUSION

These experiments have shown that sweet-potato tubers and sweet potato by-products can be good sources of nutrients for livestock and poultry. The chipped, dried tubers can cons-titute up to 30% of the diet of starter-grower pigs as a direct replacement for maize, the main energy source in pig and poultry diets in Ghana without any significant adverse effects on growth performance. However, it is important to take cognisance of the fact that depending on the price relationships, sweet potato tuber meal diets may not be as economic to feed as a Control (maize) diet.

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