Food Chemistry **45** (1992) 175–178

Chemical evaluation of the pod and pulp of the fluted pumpkin (*Telfairia occidentalis*) fruit

A. I. Essien,[a] R. U. B. Ebana[b] & H. B. Udo[a]

[a] *Department of Animal Science,* [b] *Microbiology Unit, Department of Biological Sciences, University of Calabar, Nigeria*

(Received 25 September 1991; revised version received and accepted 2 January 1992)

The pod and pulp of fluted pumpkin (*Telfairia occidentalis*), which are discarded after seed removal, and which together constitute about 64% of the whole fruit weight, were analysed for their proximate chemical and mineral element composition. The effects of fermentation on the crude protein, crude fibre and ether extract contents of the pod and pulp were also investigated. The moisture, crude protein, crude fibre, ether extract, ash, and nitrogen-free extract contents of the fresh pod were: 91·30%, 1·40%, 0·85%, 0·50%, 0·40% and 5·60%, respectively, and for the pulp: 92·80%, 1·30%, 0·46%, 0·30%, 0·30% and 4·84%, respectively. Fermentation (0–120 h) increased the per cent crude protein and generally decreased the crude fibre and ether extract contents of the pod and pulp samples.

Analyses of the fruit pod and pulp, respectively, for mineral elements revealed the following in mg/100 g dry matter: sodium (10·50; 27·50), potassium (1584; 2320), magnesium (665·90; 147·20), calcium (196·7; 162·10), phosphorus (30·00; 260·00), iron (16·76; 13·86), zinc (5·31; 4·30), copper (1·26; 1·13) and manganese (0·07; 0·06). The results of this study show the potentials of these fruit parts as livestock feedstuffs.

INTRODUCTION

The fluted pumpkin (*Telfairia occidentalis* (Hook)) is a member of the Cucurbitaceae family. It is widely cultivated in the eastern (Akwa Ibom, Anambra, Cross River, Imo and Rivers) States of Nigeria, which constitute an area that lies between 4.50°N, 6.25°E and 6.90°N, 7.50°E, with an annual rainfall of 2000–3000 mm. The peak planting period of this crop is between February and April while the fruits mature and are harvested between October and December. The significance of this crop in the diets of many Nigerians has generated some research interest in the seeds (Okigbo, 1977; Okoli & Mgbeogu, 1983; Asiegbu, 1987; Odoemena & Onyeneke, 1988) and the leaves (Oyenuga, 1968; Maduewesi, 1977; Taylor *et al.*, 1983).

There is, however, a paucity of information on the chemical composition and possible uses of the pod and pulp of the fluted pumpkin. The fruits are about 40–60 cm long and 20–30 cm in diameter with, usually, 10 deep ridges. They are green and coated with a white wax which wears off as the fruit matures. The pulp is a yellow fibrous flesh which contains purple seeds, the number of which is directly proportional to fruit size. The pod and pulp are discarded after seed removal, a practice that has led to sanitation problems in urban and suburban areas where they are used. Since the pod and pulp so discarded constitute about 50–60% of the total fruit weight, it was deemed necessary to evaluate these components for their proximate chemical composition. The chemical compositions of the fermented pod and pulp were also determined with a view to their possible exploitation in nutritional studies. The findings of this study are reported in this paper.

MATERIALS AND METHODS

Collection of fruits and sample preparation

Fresh fruits of *Telfairia occidentalis* were obtained from the local markets in Calabar, Cross River State, Nigeria, and conveyed to the laboratory. Each whole fruit was weighed and split longitudinally between two adjacent ridges to remove the seeds from the pulp. The seeds, pod and pulp were weighed separately and the weights and seed number recorded. The pod and pulp were chopped and the samples thoroughly homogenised to form separate pod and pulp mashes.

Each of the mashed pod and pulp samples was divided into two portions; one portion was dried at 80°C in an air-circulating oven for 24 h prior to fermentation. The other portion was used for proximate chemical analysis.

Fermentation of sample

Each sample (pod, pulp) was fermented using *Saccharomyces cerevisiae* (baker's yeast).

Ten grams of the dried sample was weighed into a sterilised beaker. One gram of baker's yeast (*Saccharomyces cerevisiae*) was weighed into another sterilised beaker and 10 ml of warm water (60°C) added to activate the yeast cells. The yeast was then transferred to the beaker containing the pod or pulp sample and mixed using a sterile glass rod. This mixture was transferred to a sterilised cotton bag. The mouth of the bag was tied with a string and left to ferment for 0, 24, 48, 72, 96, and 120 h. Adequate quantities of the pod and pulp samples were fermented for chemical analyses after 0, 24, 48, 72, 96 and 120 h.

Chemical analyses

The proximate chemical composition was determined for the fresh and fermented samples of the pod and pulp using the official methods of the Association of Official Analytical Chemists (1975): moisture (AOAC, 14.004), nitrogen (AOAC, 2.049), ether extract (AOAC, 14.018), crude fibre (AOAC, 7.054), ash (AOAC 14.006). Protein was determined as Kjeldahl nitrogen × 6·25. Nitrogen-free extract contents were calculated as the difference between the sum of the percentages of the different fractions and 100.

Mineral element analysis was carried out by the wet digestion method using perchloric and nitric acids. Potassium and sodium were determined using a flame photometer by the method of Chapman and Pratt (1961). Phosphorus was determined colorimetrically by the use of ammonium vanadate (Chapman & Pratt, 1961). Calcium, magnesium, iron, copper, zinc and manganese were determined by atomic absorption photometry. The statistical analyses were carried out by methods outlined by Steel and Torrie (1980).

RESULTS AND DISCUSSION

The means and standard errors of the absolute and relative weights of the whole fruit and fruit components of *Telfairia occidentalis* are shown in Table 1. The average fruit, pod, pulp and total seed weights were 5·06 ± 0·251 kg , 1·41 ± 0·115 kg, 1·87 ± 0·114 kg and 1·76 ± 0·090 kg, respectively. The results indicate that the pod and pulp together constitute about 64% of the whole fruit weight.

The discarded components represented 1·82 times by weight the used portion (seed). Prediction equations relating the weight of the components to the whole fruit weight are shown in Table 2. The weight of each component increased positively linearly with the fruit weight with about 66% of the variations in pod weight being accounted for by the variations in fruit weight ($P \leq 0{\cdot}001$). Variations in pulp and total seed weights were accounted for by 58% and 33·6%, respectively, of the variations in fruit weight. These equations are relevant to the prediction or estimation of the discarded portions of the whole fruit weight.

The proximate chemical compositions of the fresh *Telfairia* pod and pulp are shown in Table 3. While moisture content was slightly higher in the pulp (92·8%

Table 1. Mean[a] (± SE) absolute and relative fruit, pod, pulp and total seed weights of *Telfairia occidentalis* (Hook)

Fruit component	Range	Mean ± SE
Whole fruit weight (kg)	2·4–8·50	5·06 ± 0·251
Pod weight (kg)	0·6–2·80	1·41 ± 0·115
Pulp weight (kg)	0·7–2·8	1·87 ± 0·114
Total seed weight (kg)	0·6–2·50	1·76 ± 0·090
Total seed number	25–87	51·07 ± 2·120
% Pod weight	15·4–45·9	27·02 ± 1·336
% Pulp weight	22·7–50·00	37·43 ± 1·812
% Total seed weight	14·8–45·50	34·86 ± 2·075

[a] Mean values of 35 fruits.

Table 2. Interrelationships between *Telfairia occidentalis* fruit weight and its component parts using regression equations

Dependent variable (Y)	Independent variable (X)	Prediction equation	Regression coefficient (R)	Coefficient of determination (R^2)	Significance of R^2 in equation
Pod weight	Whole fruit weight	$Y = -0{\cdot}474 + 0{\cdot}373X$	0·8130	0·6609	$P \leq 0{\cdot}001$
Pulp weight	Whole fruit weight	$Y = -0{\cdot}137 + 0{\cdot}373X$	0·7619	0·5805	$P \leq 0{\cdot}001$
Seed weight	Whole fruit weight	$Y = 0{\cdot}518 + 0{\cdot}187X$	0·5795	0·3358	$P \leq 0{\cdot}05$
Seed number	Whole fruit weight	$Y = 15{\cdot}398 + 6{\cdot}445X$	0·8733	0·7627	$P \leq 0{\cdot}001$

Sample size n = 35.

Table 3. Proximate chemical composition of pod and pulp of *Telfairia occidentalis* (g/100 g) fresh sample[a]

Fraction	Pod	Pulp
Moisture	91·30 ± 0·20	92·80 ± 0·02
Crude protein	1·40 ± 0·08	1·30 ± 0·06
Crude fibre	0·85 ± 0·06	0·46 ± 0·01
Ether extract	0·50 ± 0·01	0·30 ± 0·00
Ash	0·40 ± 0·00	0·30 ± 0·00
NFE[b]	5·60 ± 0·05	4·84 ± 0·06

[a] Mean of three determinations.
[b] NFE (nitrogen-free extract) obtained by difference.

versus 91·3%), crude protein, crude fibre, ether extract, ash and nitrogen-free extract (NFE) contents of the pod were higher than values of the pulp. These values agree with those reported for curcubits, which are essentially high in moisture and low in dry matter (USDA, 1981; Dunu *et al.*, 1986). The per cent dry matter contents of the *Telfairia* pod (8·7%) and pulp (7·2%) are within the range reported by Oyenuga (1968) for some ingredients—cocoyam leaves (9·43%), chinese yam tuber (7·03%), unripe banana peels (7·03%), paw-paw green fruit (7·20%)—but lower than those for sweet potato peels (11·73%) and trifoliate yam peels (11·96%). These results indicate that the pod and pulp of *Telfairia occidentalis* could be used as succulent feedstuff for livestock, particularly in the dry season when the pods and pulp are discarded.

The effects of fermentation on the chemical composition of the pod and pulp are shown in Table 4. The crude protein content of the pod rose from 2·50% to 8·75% after 96 h of fermentation beyond which no further increases were observed. The highest per cent increase in the crude protein content of the fermented pod occurred between 24 h (3·75%) and 48 h (6·50%)

Table 4. Crude protein, crude fibre and ether extract composition of fermented pod and pulp of *Telfairia occidentalis*[a]

Hours of fermentation	Crude protein (%)	Crude fibre (%)	Ether extract (%)
Pod			
0	2·50 ± 0·03	0·92 ± 0·03	0·60 ± 0·01
24	3·75 ± 0·05	0·81 ± 0·01	0·40 ± 0·02
48	6·50 ± 0·05	0·72 ± 0·02	0·20 ± 0·01
72	7·50 ± 0·06	0·69 ± 0·02	0·30 ± 0·00
96	8·75 ± 0·07	0·57 ± 0·02	0·20 ± 0·00
120	8·75 ± 0·11	0·63 ± 0·04	0·40 ± 0·01
Pulp			
0	2·30 ± 0·01	0·52 ± 0·02	0·30 ± 0·00
24	2·60 ± 0·03	0·44 ± 0·01	0·20 ± 0·01
48	3·10 ± 0·02	0·24 ± 0·00	0·16 ± 0·03
72	3·20 ± 0·02	0·21 ± 0·00	0·20 ± 0·01
96	3·20 ± 0·03	0·19 ± 0·01	0·20 ± 0·00
120	3·40 ± 0·01	0·23 ± 0·03	0·21 ± 0·00

[a] Mean of three determinations.

Table 5. Mineral element composition of the pod and pulp of *Telfairia occidentalis* fruit (mg/100 g) dry matter

Mineral element	Pod	Pulp
Sodium	10·50	27·50
Potassium	1 584	2 320
Magnesium	666	147
Calcium	197	162
Phosphorus	30·0	260
Ca : P ratio	1 : 0·15	1 : 1·60
Iron	16·8	13·9
Zinc	5·31	4·30
Copper	1·26	1·13
Manganese	0·07	0·06

after fermentation, which represented a 73·3% increase in the crude protein level. A similar trend of increasing protein content with fermentation was observed with the pulp except that the actual values were lower. The highest crude protein value (3·4%) in the pulp was obtained after 120 h of fermentation and was lower than the value obtained after 24 h of pod fermentation. This difference could partially be due to the higher crude fibre content of the pod (0·85% versus 0·46%) which might have acted as the substrate for the synthesis of protein. Crude fibre and ether extract values of the pod and pulp decreased with increasing time of fermentation. These trends are similar to those reported by Abasiekong (1991) who obtained increasing and higher crude protein and lower crude fibre contents on the fermentation of brewers' dried grains and spent sorghum grains using cellulolytic bacteria. Fermentation has been known to enhance the nutritional quality of residues and wastes thereby encouraging greater utilisation of such residues (Osuji, 1982; Tibbetts, 1987; Abasiekong, 1991).

Table 5 shows the mineral element composition of the pod and pulp samples of *Telfairia occidentalis* in mg/100 g dry matter. Among the major elements, potassium constituted the highest proportion in both the pod and the pulp (1584 and 2320 mg/100 g, respectively), followed by magnesium (666 mg/100 g in the pod and 147 mg/100 g in the pulp). Calcium levels were 197 mg/100 g in the pod and 162 mg/100 g in the pulp. Phosphorus was much higher in the pulp (260 mg/100 g) than in the pod (30 mg/100 g). The results also show that the levels of trace minerals were comparatively much lower except for iron which was fairly high (16·8 mg/100 g for the pod and 13·9 mg/100 g for the pulp).

These results indicate that the fluted pumpkin pod and pulp were generally rich sources of such major mineral elements as potassium, magnesium and calcium, while phosphorus was found abundantly in the pulp. The mineral compositions of the pod and pulp, respectively, follow a similar trend to those reported for the peel and pulp of the fruits of African star-apple (*Chrysophyllum albidum*) and raffia palm (*Raphia hookeri*) by Edem *et al.* (1984*a*,*b*).

The results of the present study indicate the potentials of the pod and pulp of *Telfairia occidentalis* as livestock feed ingredients. However, further studies are being carried out on these fruit parts to assess the presence and levels of toxicants as well as to evaluate their toxicity in laboratory animals.

REFERENCES

Abasiekong, S. F. (1991). Effects of fermentation on crude protein content of brewers dried grains and spent sorghum grains. *Bioresource Technol.*, **35**, 99–102.

AOAC (1975). *Official Methods of Analysis* (11th edn). Association of Official Analytical Chemists, Washington, DC.

Asiegbu, J. E. (1987). Some biochemical evaluation of fluted pumpkin seed. *J. Sci. Food Agric.*, **40**, 151–5.

Chapman, H. H. & Pratt, P. G. (1961). *Methods of Analysis for Soils, Plants and Water*. Division of Agricultural Science, University of California, Davis, CA.

Dunu, D. J., Eka, O. U., Ifon, E. T. & Essien, E. U. (1986). Chemical evaluation of the nutritive value of fruit of calabash plant (*Lagenaria siceraria*). *Nig. J. Science*, **20**, 47–50.

Edem, D. O., Eka, O. U. & Ifon, E. T. (1984*a*). Chemical evaluation of nutritive value of the fruit of African star-apple (*Chrysophyllum albidum*). *Food Chem.*, **14**, 303–311.

Edem, D. O., Eka, O. U. & Ifon, E. T. (1984*b*). Chemical evaluation of the nutritive value of the raffia palm fruit (*Raphia hookeri*). *Food Chem.*, **15**, 9–17.

Maduewesi, J. N. C. (1977). White leaf spot disease of fluted pumpkin (*Telfairia occidentalis*) in Nigeria. *Niger. J. Pl. Prot.*, **3**, 122–8.

Odoemena, C. S. & Onyeneke, E. C. (1988). Lipids of fluted pumpkin (*Telfairia occidentalis*) seeds. *Proc. Afric. Conf. Biochem. Lipids.*, **1**, 147–51.

Okigbo, B. N. (1977). Neglected plants of horticultural and nutritional importance in traditional farming systems of tropical Africa. *Acta Hort.*, **53**, 131–49.

Okoli, B. E. & Mgbeogu, C. M. (1983). Fluted pumpkin. *Telfairia occidentalis*: West African vegetable crop. *Econ. Bot.*, **37**, 145–9.

Osuji, P. O. (1982). Agroindustrial by-products and animal feeding in the Caribbeans. *World Rev. Anim. Prod.*, **18**, 43–56.

Oyenuga, V. A. (1968). *Nigeria's Foods and Feedingstuffs* (3rd edn). Ibadan University Press, Ibadan, Nigeria.

Steel, R. G. D. & Torrie, J. H. (1980). *Principles and Procedures of Statistics*. McGraw-Hill, New York.

Taylor, O. O. A., Fetuga, B. L. & Oyenuga, V. A. (1983). Accumulation of mineral elements in five tropical leafy vegetables as influenced by nitrogen fertilization and age. *Scientia Hort.*, **18**, 313–22.

Tibbetts, G. (1987). Poultry offal ensiled with *Lactobacillus acidophillus* for growing and fishing swine diets. *J. Anim. Sci.*, **64**, 182–90.

USDA (1981). *Nutritive Value of Foods*, Home and Garden Bulletin No. 72, United States Department of Agriculture, Washington, DC, pp. 26–7.