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# Nutritional Value of the Fluted Pumpkin (*Telfaria occidentalis*)

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The proximate, mineral, fatty acid, amino acid, and carbohydrate compositions of several parts of the fruit of the fluted pumpkin were analyzed. Meals were prepared from raw full-fat (RFM), cooked full-fat (CFM), raw defatted (RDM), and cooked defatted (CDM) seeds without testa and their nutritive values determined by using rats. The seed contained 53% fat and 27% crude protein. Oleic and linoeleic acids were the predominant fatty acids while glutamic acid, arginine, and aspartic acid were the most abundant amino acids. RFM and RDM gave low digestibility values which were improved by cooking and oil extraction. Metabolizable energy (ME), which was 20.5 and 13.4 kJ/g for RFM and RDM, respectively, increased on cooking.

The search for lesser known crops, many of which are potentially valuable as human and animal foods, has been intensified to maintain a balance between population growth and agricultural productivity, particularly in the tropical and subtropical areas of the world. The value of cucurbit seeds as useful sources of proteins and oils has been reviewed by Jacks et al. (1972), Bemis et al. (1967, 1975), and Tu et al. (1978).

The fluted pumpkin (*Telfaria occidentalis*), a tropical cucurbit, may be a possible source of such nutrients. It is a fast growing, climbing annual that bears heavy fruits which are furrowed. Mature fruits, weighing between 2 and 5 kg, contain many seeds. The young green leaves form a very delicious vegetable when cooked, and the young seeds are sometimes eaten when cooked. The seed contains a smooth flowing, golden-yellow oil.

While extensive work has been accomplished to elucidate the nutritional qualities of cucurbits (Zucker et al., 1958; Oyenuga and Fetuga, 1975; Berry et al., 1976), little information is available on the composition or nutritive value of the fluted pumpkin.

The present report accounts for the chemical composition of various parts of the fruit and the nutritional quality of the seed.

## EXPERIMENTAL SECTION

**Materials.** Mature, fresh fluted pumpkin fruits were obtained from the International Institute of Tropical Agriculture and National Horticultural Research Institute of Nigeria. The fruits were carefully separated into seeds, pulp, and husk and sun-dried. The testa was removed from the cotyledons of the dried full-fat seeds (RFM) and milled while some other fresh seeds were boiled for 2 h in water. The deep purple water produced was changed after 1 h of boiling to obtain the cooked full-fat sample (CFM) which was also dried and milled. Seed meals (RFM and CFM) were ether extracted for 7 h and defatted meals (RDM and CDM, respectively) obtained were spread on trays and air-dried to expel residual ether.

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**Methods.** All samples were analyzed for proximate composition by methods of the Association of Official Analytical Chemists (1970). Gross energy was determined in a Gallenkamp oxygen ballistic bomb calorimeter by using thermochemical-grade benzoic acid as a standard. The ground samples were wet-ashed in concentrated sulfuric acid–concentrated perchloric acid–concentrated nitric acid (0.5:1.0:5.0 by volume), and the metallic elements were determined after dilution by using a flame atomic absorption spectrophotometer (Model No. 703, Perkin-Elmer). Phosphorus was determined colorimetrically as the phosphomolybdovanadate complex. Chemical interference due to $PO_4^{3-}$ on calcium and magnesium was eliminated by the addition of lanthanum chloride (Perkin-Elmer, 1980). The carbohydrates and lignin were fractionated as outlined by Southgate (1969a,b), and sugars were quantified as total sugars (Dubois et al., 1956).

The fatty acid components of the total lipid extract was determined by converting an aliquot into methyl esters (Metcalfe and Schmitz, 1961) which were separated by gas–liquid chromatography. Amino acids of seed samples were determined in a Technicon automatic sequential amino acid analyzer after hydrolysis of test materials in 6 M hydrochloric acid at 110 °C for 24 h. For the determination of sulfur amino acids, the samples were first oxidized with performic acid for 18 h according to the method of Lewis (1966) before acid hydrolysis. Tryptophan was chemically determined by the method of Miller (1967).

**Animal Feeding Experiment.** Weanling albino rats of the Wistar strain weighing between 45 and 50 g were distributed into treatment groups of four male rats each on the basis of weight and litter origin such that mean group initial weights were identical. They were individually housed in cages that allowed for separate fecal and urinary collection and the measurement of food intake. The protein quality of the raw and cooked seed meals was assayed by using the digestibility procedure. The experiment lasted 21 days, the first 7 days being the preliminary period. True protein digestibility was calculated by the method of Mitchell and Carman (1926). The energy trial was carried out according to the procedures followed by

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Table I. Composition (g/100 g) of the Basal Diets Used for Digestibility Test and Energy Determination

| ingredients | digestibility test | energy determination |
|---|---|---|
| maize starch | 64.8 | |
| ground maize | | 16.20 |
| glucose | 5.0 | 40.00 |
| sucrose | 10.0 | |
| nonnutritive cellulose | 5.0 | |
| groundnut cake | | 28.42 |
| fish meal | | 5.38 |
| groundnut oil | 10.0 | 5.00 |
| vitamin premix[a] | 1.0 | |
| mineral premix[a] | 4.0 | |
| salt mixture[b] | | 4.00 |
| vitamin mixture[c] | | 1.00 |
| choline chloride | 0.2 | |

[a] Oyenuga and Fetuga (1975). [b] Bernhart and Tomarelli (1966). [c] Cuthbertson (1957).

Nelson et al. (1974). Food and water were offered ad lib.

The composition of the basal diet for the estimation of digestibility is given in Table I. The test diets were prepared by incorporating RFM, CFM, RDM, and CDM into the basal diet at the expense of maize starch to supply 10% or 15% crude protein. Metabolic nitrogen was determined with the protein-free diet (Table I) to estimate true digestibility. The basal diet used for energy determination is also presented in Table I. The meals were included in this basal diet at a level of 30% at the expense of glucose (Longe, 1980).

**Statistical Analysis.** All data relating to digestibility and energy values were subjected to analysis of variance, and treatment means were compared by using Duncan's multiple range test (Steele and Torrie, 1960).

## RESULTS AND DISCUSSION

The fruits contained averagely 60 seeds although some were as high as 130. The mean percentage of seed coat to seed was 25.7. Table II gives the proximate composition of various parts of the fruit. The total ash value of 8.3–9.3% for the defatted seeds is close to that reported by Berry et al. (1976) for buffalo gourd. The minerals are concentrated in the testa, pulp, and husk (Table III), and there are particularly high levels of Ca, P, Mg, and K in all the various parts of the fruit. Fe and Na are also present in moderate concentrations.

Values ranging between 58.1 and 80.9% of fiber were observed in the testa, pulp, and husk. This will most likely restrict usage of these fractions to ruminant feeding. Total soluble sugars were very low, and although starch has been reported to be absent by Earle and Jones (1962) in some cucurbits, traces were found in some parts of the fruits (Table IV). Hemicellulose was as high as 29.6% in the pulp (Table IV) while cellulose ranged between 2.5 and 18.4%. Lignin was highest in the husk (49%); such a high lignin content would obviously limit utilization by animals.

The high oil content, 50.6–53.4%, makes the seed a potential source of commercial vegetable oil. Oils from raw and cooked seeds contained by weight 0.2% myristic acid, 15.0–17.0% palmitic acid, 15–16.0% stearic acid,

Table II. Proximate Composition of Parts of the Fluted Pumpkin (g/100 g Dry Matter)

| source | crude protein | crude fiber | ether extract | total ash | nitrogen-free extract[a] |
|---|---|---|---|---|---|
| raw full-fat pumpkin seed without testa (RFM) | 26.6 | 3.1 | 53.4 | 2.3 | 14.6 |
| raw defatted pumpkin seed without testa (RDM) | 69.7 | 8.2 | 6.5 | 9.3 | 6.3 |
| cooked full-fat pumpkin seed without testa (CFM) | 27.1 | 3.1 | 50.6 | 5.2 | 14.0 |
| cooked defatted pumpkin seed without testa (CDM) | 71.1 | 9.3 | 10.2 | 8.3 | 1.1 |
| raw full-fat pumpkin seed with testa | 16.4 | 8.4 | 47.5 | 2.1 | 25.6 |
| pumpkin testa | 8.2 | 20.7 | 6.7 | 5.6 | 58.8 |
| pumpkin pulp | 13.1 | 40.1 | 10.5 | 10.7 | 25.6 |
| pumpkin husk | 9.0 | 36.1 | 3.5 | 6.3 | 45.1 |

[a] By difference.

Table III. Mineral Constituents of Parts of the Fluted Pumpkin (mg/100 g Dry Matter)

| source | Ca | P | Mg | K | Na | Mn | Zn | Cu | Fe | Co | Cr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| raw full-fat pumpkin seed without testa (RFM) | 30.9 | 162.5 | 402.5 | 1110.8 | 24.8 | 2.3 | 10.0 | 2.2 | 37.8 | 0.2 | 0.2 |
| raw defatted pumpkin seed without testa (RDM) | 49.5 | 359.4 | 699.0 | 2219.3 | 23.1 | 3.8 | 13.9 | 4.7 | 31.7 | 0.1 | 0.3 |
| cooked full-fat pumpkin seed without testa (CFM) | 74.9 | 148.9 | 216.9 | 1379.0 | 20.5 | 1.9 | 2.1 | 21.8 | 0.2 | 2.1 | 0.2 |
| raw full-fat pumpkin seed with testa | 170.0 | 137.5 | 285.7 | 1019.3 | 26.8 | 5.2 | 11.4 | 3.8 | 162.5 | 0.2 | 0.2 |
| pumpkin pulp | 190.9 | 90.6 | 565.8 | 3839.0 | 56.7 | 5.8 | 53.6 | 5.1 | 45.6 | 0.2 | 0.1 |
| pumpkin husk | 331.3 | 112.5 | 440.5 | 2855.8 | 53.0 | 5.3 | 61.8 | 1.3 | 35.3 | 0.1 | 0.1 |

Table IV. Carbohydrate Constituents and Lignin of Part of the Fluted Pumpkin (g/100 g)

| source | total soluble sugars | starch | water-soluble polysaccharide | hemicellulose | cellulose | lignin |
|---|---|---|---|---|---|---|
| raw pumpkin seed without testa | 0.9 | 0.5 | 4.6 | 2.1 | 2.5 | 1.9 |
| raw pumpkin seed with testa | 0.6 | | 4.1 | 7.5 | 3.1 | 6.4 |
| pumpkin pulp | 1.7 | | 12.4 | 29.6 | 11.6 | 18.8 |
| pumpkin testa | 0.1 | | 6.9 | 22.1 | 12.2 | 23.8 |
| pumpkin husk | 0.3 | 0.1 | 0.8 | 13.5 | 18.4 | 49.0 |

Table V. Amino Acid Composition of Raw and Cooked Fluted Pumpkin Seed (g/16 g of Nitrogen)

| | raw full-fat pumpkin seed (RFM) | cooked full-fat pumpkin seed (CFM) | whole egg[a] |
|---|---|---|---|
| lysine | 4.82 | 4.58 | 6.99 |
| histidine | 3.92 | 3.65 | 2.43 |
| arginine | 11.67 | 11.96 | 6.24 |
| aspartic acid | 10.98 | 7.79 | 9.02 |
| threonine | 3.57 | 3.32 | 5.12 |
| serine | 4.75 | 3.97 | 7.65 |
| glutamic acid | 17.27 | 12.73 | 12.74 |
| proline | 4.88 | 4.38 | 4.16 |
| glycine | 5.81 | 5.32 | 3.31 |
| alanine | 4.17 | 4.26 | 5.92 |
| cystine | 1.54 | 1.54 | 2.43 |
| valine | 4.97 | 5.12 | 6.85 |
| methionine | 1.15 | 1.11 | 3.46 |
| isoleucine | 6.91 | 6.57 | 8.79 |
| tyrosine | 3.79 | 3.67 | 4.16 |
| phenylalanine | 5.13 | 4.39 | 5.63 |
| tryptophan | 1.32 | 1.34 | 1.62 |

[a] Oyenuga and Fetuga (1975).

39.1–41.0% oleic acid, and 27.0–28.1% linoleic acid. The greater proportion of oil in cucurbit seeds has been found to be composed of unsaturated fatty acids, the majority of which are good edible oils used for cooking in various parts of the world (Bemis et al., 1967; Girgis and Said, 1968; Vasconcellos et al., 1980).

RFM and CFM have crude protein contents of 26.6% and 27.1%, respectively, in comparison with 69.7% and 71.1% in RDM and CDM. The pulp, testa, and husk are low in crude protein. The amino acid profiles of the seeds indicate that the sulfur-containing amino acids are the most limiting when compared with the whole egg (Table V). Lysine and threonine are the second limiting amino acids based on whole egg reference standard. Like most other oil seeds, cucurbit seed products are deficient in methionine, cystine, and lysine (Jacks et al., 1972; Weber et al., 1977; Thompson et al., 1978). Supplementation of buffalo gourd seed flour with these amino acids has been found to improve the growth rate (Tu et al., 1978). Aspartic, arginine, and glutamic acid were the most plentiful amino acids (Table V). Similar reports have been given for seed meals and globulins of certain cucurbits by Weber et al. (1969), Jacks et al. (1972), Hensarling et al. (1973), and Tu et al. (1978).

In the feeding trial with rats, results obtained with RFM solely supplying 15% crude protein in the diet revealed 100% mortality of the rats within 8 days of commencement of the experiment. Weber et al. (1977) also reported 100% mortality within 5 days of feeding the whole seed of *Citrullis colocynthis* to weanling mice. The presence of a naturally occurring toxin was suggested as being responsible for the high mortality by these authors. For the fluted pumpkin, growth was improved with cooking and oil extraction, suggesting removal of growth inhibitors by these treatments. Weight changes for CDM at the 10% and 15% levels were significantly better ($P < 0.05$) than others. Both apparent and true digestibility values for the protein of the meals are also presented in Table VI. The digestibility values are far below those reported for whole egg (Oyenuga and Fetuga, 1975). Analysis of variance of the results indicates that there were significant differences ($P < 0.05$) between groups. The digestibility of RFM was particularly poor. Toxic factors which are soluble in oil and extractable in ether may have also affected the protein quality. The observation of increased amino acid retention

Table VI. Food Intake, Body Weight Change, and Digestibility of Full-Fat and Defatted Pumpkin Seed Fed to Weanling Albino Rats

| source | protein level, % | food intake, g | change in body wt, g | apparent digestibility, % | true digestibility, % |
|---|---|---|---|---|---|
| raw full-fat pumpkin seed without testa (RFM) | 10 | 19.4[a] [b] | −17.9[a] | 51.1[a] | 58.6[a] |
| raw full-fat pumpkin seed without testa (RFM) | 15 | | | | |
| raw defatted pumpkin seed without testa (RDM) | 10 | 22.0[a] | −21.1[a] | 45.2[a] | 51.4[a] |
| raw defatted pumpkin seed without testa (RDM) | 15 | | | | |
| cooked full-fat pumpkin seed without testa (CFM) | 10 | 35.6[b] | −7.9[b] | 74.0[b] | 82.6[b] |
| cooked full-fat pumpkin seed without testa (CFM) | 15 | 37.7[b] | −4.4[c] | 79.2[b] | 84.5[b] |
| cooked defatted pumpkin seed without testa (CDM) | 10 | 57.9[c] | 4.6[d] | 81.8[b] | 85.1[b] |
| cooked defatted pumpkin seed without testa (CDM) | 15 | 56.6[c] | 8.6[e] | 87.2[b] | 88.8[b] |

[a] 100% mortality occurred within 8 days of commencement of trial. [b] Letters in the same vertical line differently superscripted are significantly ($P < 0.05$) different.

Table VII. Energy Value[a] of the Fluted Pumpkin Seed Fed to Weanling Albino Rats (kJ/g)

| source | gross energy | digestible energy | metabolizable energy | ME/DE | DE/GE | ME/GE |
|---|---|---|---|---|---|---|
| raw full-fat pumpkin seed (RFM) | 33.3 (8.0) | 26.7 (6.4) | 20.5 (4.9) | 76.8 | 80.2 | 61.6 |
| raw defatted pumpkin seed (RDM) | 20.2 (4.8) | 17.4 (4.2) | 13.4 (3.2) | 77.0 | 86.1 | 66.3 |
| cooked full-fat pumpkin seed (CFM) | 32.4 (7.7) | 28.6 (6.8) | 23.5 (5.6) | 82.1 | 88.4 | 72.4 |
| cooked defatted pumpkin seed (CDM) | 20.8 (5.0) | 18.8 (4.5) | 15.7 (3.8) | 83.3 | 90.6 | 75.6 |

[a] Energy values presented in parentheses are expressed in kcal/g.

by Weber et al. (1969) for other extracted *Cucurbita digitata* seems to support this. Poterfield (1955), Enslin et al. (1957), and Whitaker and Davis (1962) have reported the presence of one or more terprenoid glycosides, some of which are water soluble, in various parts of the cucurbit plant. There may, however, be species differences among non-ruminants in their ability to utilize raw seed meals from cucurbits as suggested by the results of Bressani and Arroyave (1963) with rats and chicks. While rats were found to respond well to graded levels of raw pumpkin supplying in part or entirely the dietary protein, these authors observed that abnormal behavior was exhibited by chicks treated similarly and mortality was found to increase as the amount of pumpkin flour in the diet increased. The superior performance of rats receiving 15% crude protein from CDM over the 10% level also agrees with the findings of these authors. The possibility of a nutritional imbalance at low levels of protein intake is suggested, maximum gain probably being allowed at higher levels.

Energy values are presented in Table VII. No mortality was recorded. ME was 61.6% and 66.7% of GE for RFM and RDM, respectively, but 72.4% and 75.6% for CFM and CDM. Energy utilization was not grossly impaired, probably because the raw meals were in combination with other protein sources present in the basal diet.

The findings of this study suggest that the protein of the pumpkin seed can only support growth if fed as the sole protein source when defatted and cooked. Even though the defatted meal is considerably higher in crude protein, the deficiency in the sulfur amino acids may have to be augmented for efficient utilization. Investigation into the nature of the oil components and identification and characterization of possible toxic factors in the seed are necessary.

**Registry No.** Ca, 7440-70-2; P, 7723-14-0; Mg, 7439-95-4; K, 7440-09-7; Na, 7440-23-5; Mn, 7439-96-5; Zn, 7440-66-6; Cu, 7440-50-8; Fe, 7439-89-6; Co, 7440-48-4; Cr, 7440-47-3; starch, 9005-25-8; cellulose, 9004-34-6; hemicellulose, 9025-56-3; lignin, 9005-53-2.

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