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RESEARCH NOTE

Nutritional constituents of the seeds of the African pear, *Dacryodes edulis*

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Analysis of the seeds of *Dacryodes edulis* showed it to contain 76 g kg^{-1} carbohydrates, 338 g kg^{-1} proteins, 110 g kg^{-1} fixed oil, 126 g kg^{-1} ash, 273 g kg^{-1} crude fibre and appreciable amounts of K, Ca, Na, Mg and P. The amino acid profile showed it to be rich in the essential amino acids lysine, phenylalanine, leucine and isoleucine. The oil had the following fatty acids: palmitic (61·9%), oleic (18·3%) and linoleic (19·0%). Preliminary studies did not reveal the presence of toxic principles.

INTRODUCTION

Dacryodes edulis (G. Don) H. J. Lam (formerly *Pachylobus edulis*) is a common forest tree in tropical Africa. The morphology of the plant has been described (Hutchinson & Dalziel, 1958; Keay *et al.*, 1964). The plant is commonly cultivated for its edible fruit-pulp. Omoti & Okiy (1987) reported that the pulp/fruit ratio (%) is 54·9 : 73·0. This implies that the seeds contribute up to 27–45·1% of the fruit.

Usually the seeds of many African fruits are discarded after eating the edible pulp. However, analysis of these seeds may reveal acceptable nutritional qualities. Recently, Obasi (in press) analysed the testaless seeds of *Chrysophyllum albidum*, which are usually discarded, and showed them to be rich in carbohydrates, essential amino acids, fatty acids and minerals. Most published works on *D. edulis* have focused mainly on the composition of the pulp (Kent, 1966; Eka, 1979; Tchendji *et al.*, 1981; Omoti & Okiy, 1987). The pulp is reported to have up to 330–550 g kg^{-1} of fixed oil on a dry weight basis (Eka, 1978; Tchendji *et al.*, 1981) and to contain essential fatty acids. The defatted cake is rich in essential amino acids and minerals; hence it is recommended as a feed supplement for animals (Omoti & Okiy, 1987). The authors have chosen to investigate the usually discarded seeds for their constituents and to determine their possible utility. In this paper the nutritional constituents of the seeds of *D. edulis* are presented.

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MATERIALS AND METHODS

Mature fruits of *D. edulis* were obtained from a tree growing in Uselu, Benin City, Nigeria in August 1990. The pulps were scraped off and the seeds were dried below 40°C and pulverised.

Moisture, ash value and crude fibre were determined as described in the *African Pharmacopoeia* (1986). The total carbohydrate was determined using the anthrone method (Yemm & Willis, 1954) on both the 800 ml $litre^{-1}$ ethanol-soluble fraction and the 350 ml $litre^{-1}$ perchloric-acid-soluble fraction. Nitrogen (N) was determined by the AOAC (1965) (microKjeldahl) method, and crude protein was estimated as N × 6·25. Potassium, calcium and sodium were determined by flame photometry with an EEL instrument while magnesium and phosphorus were determined by colorimetry using a Technicon autoanalyser and zinc by complexometric titration with EDTA (Vogel, 1961). Copper was estimated using diethylthiocarbamate (Cheng & Bray, 1953) on a Perkin Elmer 5505 instrument at 440 nm (Perkin Elmer, Norwalk, CT).

The amino acids were determined by gas liquid chromatography. Dry and defatted seed powder (20 g) was autoclaved with 15M sulphuric acid (100 ml) at 115°C and 0·7 kg cm^{-2} pressure for 5 h. The hydrolysate was neutralised with barium hydroxide and the ensuing precipitate removed by filtration. The residue was washed with boiling water and the combined filtrates reduced to small volume *in vacuo*. The concentrate was chromatographed on Whatman 3MM paper using the mixed solvents 1-butanol/acetic acid (6 : 1), and ninhydrin spray reagent was used to detect the amino acids.

The amino acid bands were recovered and converted into their phenylthiohydanthoins (Pisano *et al.*, 1962) and chromatographed on a Pye Unicam 304 chromatograph (Pye Unicam, Cambridge, UK) equipped with a 2 m × 4 mm i.d. glass column packed with 50 g kg^{-1} SE 30 on chromosorb W-AW 150–175 μm. The column temperature was programmed from 100 to 280°C at 10°C per min and the carrier (nitrogen) gas flow rate was 45 ml per min.

The oil was characterised by specific gravity saponification value, iodine value and percentage of free fatty acids by AOAC methods (1965). Methylesters of the fatty acids were obtained as described by Obasi *et al.* (1990). The esters were analysed on a Pye Unicam 304 chromatograph equipped with 1·5 m × 5 mm i.d. glass column packed with diethylene glycol adipate on 150–175 μm diatomite C-AW treated with H_3PO_4 and maintained at 190°C. Nitrogen flow rate was 40 ml per minute.

The calorific value was obtained by multiplying mean values of carbohydrate, protein and fixed oil by Atwater constants 4, 4 and 9, respectively, and expressing their sum in kilocalories.

RESULTS AND DISCUSSION

The gross chemical and mineral composition of the seeds of *D. edulis* are shown in Tables 1 and 2. The dried seeds yielded a lower level of carbohydrate (76 g kg^{-1}) than the fruit pulp (135 g kg^{-1}). 58·6% of the seed carbohydrates was soluble in 800 ml litre^{-1} perchloric acid. The carbohydrate content of the seeds is higher than that of peanut (56 g kg^{-1}; Martley, 1936). This is lower than the carbohydrates of winged beans (354 g kg^{-1}; Garcia & Palmer, 1980) and melon seed (102 g kg^{-1}; Kamel *et al.*, 1985) but it approximates those of maize (69·6 g kg^{-1}; Bjorn *et al.*, 1978) and wheat (72 g kg^{-1}; Mohammed & Bjorn, 1979).

The protein content of the seeds (338 g kg^{-1}) is higher than those of the fruit pulp (259 g kg^{-1}) and those of the common seeds maize (128 g kg^{-1}; Bjorn *et al.*, 1978) and peanut (69·5 g kg^{-1}; Martley, 1936). The amino acid composition of the defatted dry seeds is shown in Table 3. The major essential amino acids are lysine, phenylalanine, leucine and isoleucine. The major non-essential amino acids are aspartic acid, alanine and proline. The amino acid profile of the seed resembles that of the fruit-pulp reported by Omoti and Okiy (1987). The content of amino acids in the protein of *D. edulis* seeds seems to be adequate to justify its recommendation as a protein supplement in cereal and starchy foods.

Table 1. Proximate composition of the seeds and fruit pulp of *Dacryodes edulis* (g kg^{-1} DW)

	Seeds[a]	Fruit pulp[b]
Carbohydrate	76 ± 0·91	135
Protein (N × 6·25)	338 ± 4·38	259
Oil	120 ± 3·74	319
Energy (kcals kg^{-1})	2736 ± 35·69	4447
Ash	126 ± 2·27	108
Fibre	173 ± 2·52	179

[a] Mean of four determinations ± SE.
[b] After Omoti & Okiy (1987).

Table 2. Mineral composition of the seeds of *Dacryodes edulis* (g kg^{-1} DW)

Mineral	Content
K	23·94
Ca	7·30
Mg	10·80
Zn	0·36
P	2·18
Cu	0·05

The seeds had a high fibre content. They had up to 110 g kg^{-1} fixed oil with the fatty acids palmitic, oleic and linoleic. Table 4 shows the characteristics of the oil. Both seed and pulp oils separated into a liquid upper layer and a semisolid lower layer at room temperature (27°C). They are green in colour but become straw yellow when partially bleached. The seed oil is richer in palmitic acid (61·9% of total fatty acids) than in unsaturated acids. This explains why the iodine value of the seed oil is lower than that of the pulp oil which has up to 49·1% of unsaturated acids. The low iodine value of the seed oil makes it less prone to oxidative rancidity than the pulp oil. The saponification value of 173·9 is indicative of the preponderance of long chain (high molecular weight) acids in the oil. Free acids are lower in the seed oil that in the pulp oil implying that the seed oil has a better edible quality.

The authors conclude that the usually discarded seeds of *D. edulis* could be harnessed for their nutritional constituents. They could become a valuable feed supplement for animals. The fixed oil would be useful in the margarine industry. Preliminary studies did not reveal the presence of saponins, alkaloids or toxic principles in the seeds.

Table 3. Amino acid composition of the seeds of *Dacryodes edulis* (% total amino acids)

Amino acid	Content
Essential	
Lysine	8·41
Phenylalanine	4·97
Leucine	18·56
Isoleucine	7·50
Methionine	0·94
Valine	3·45
Arginine	2·90
Non-essential	
Aspartic	13·08
Serine	4·49
Glutamic	12·02
Proline	5·72
Glycine	2·29
Alanine	7·12
Tyrosine	4·52

Table 4. Characteristics of the fixed oil of the seeds and fruit pulp of *Dacryodes edulis*

	Seed	Fruit pulp[a]
Free fatty acids (%)	7·3	14·1
Saponification value	173·9	201·4
Iodine value	8·8	59·6
Specific gravity	0·8430	0·9
Non saponifiable matter	1·0	—
Fatty acids (%)		
Palmitic	61·9	47·89
Oleic	18·3	31·25
Linoleic	19·0	17·50

[a] After Omoti and Okiy (1987).

REFERENCES

African Pharmacopoeia, Vol. II (1986). OAU/STRC Scientific Publication, Lagos.

AOAC, *Official Methods of Analysis* (10th edn). (1965). Association of Official Agricultural Chemists, Washington, DC.

Bjorn, O. E., Eva, M. V. & Surinder, K. V. (1978). Quality maize grown in Mexico. *J. Sci. Food Agric.*, **30**, 1148–53.

Cheng, K. L. & Bray, R. H. (1953). Two specific methods of determining copper in soil and plant materials. *Anal. Chem.*, **25**, 655–9.

Eka, O. U. (1979). Nutrient status of African Pear tree (*Pacylobus edulis*). *W. A. J. Biol. Appl. Chem.*, **20**, 3–20.

Garcia, V. V. & Palmer, J. K. (1980). Proximate analysis of five varieties of winged beans *Psophocorous tetragonolobus* (L) DC. *J. Food Technol.*, **15**, 469–76.

Hutchinson, J. & Dalziel, J. M. (1958). *Flora of West Tropical Africa Vol. I, Part 2*. Crown Agents, London.

Kamel, B. S., Dawson, H. & Kakuda, Y. (1985). Characteristics of melon and grape seed oil. *J. Amer. Oil Chem. Soc.*, **62**, 881–3.

Keay, R. W. J., Stanfield, D. P. & Onochie, C. F. A. (1964). *Nigerian Trees, Vol. 2*. Department of Forestry Research, Ibadan, Nigeria.

Kent, N. L. (1966). *Technology of Cereals (1st edn.)*. Pergamon Press, Oxford.

Martley, J. (1936). Groundnuts and their cultivation. *East African Agric. J.*, **1**, 501.

Mohammed, Ak. & Bjorn, O. E. (1979). Improved varieties of wheat grown in Pakistan. *J. Sci. Food Agric.*, **30**, 779–84.

Obasi, N. B. B. (in press). Analysis of the testaless seeds of *Chrysophyllum albidum. J. Sci. Food Agric.*, **56**.

Obasi, N. B. B., Igboechi, A. C. & Benjamin, T. V. (1990). Seasonal variations in the seed oil of *Thevetia peruviana. J. Amer. Oil Chem. Soc.*, **67**, 624–5.

Omoti, U. & Okiy, D. A. (1987). Characteristics and composition of the pulp oil and cake of the African pear, *Dacryodes edulis. J. Sci. Food Agric.*, **38**, 67–72.

Pisano, J. J., Van den Heuvel, W. J. A. & Horning, E. C. (1962). Gas chromatography of phenylhydanthoins and dinitrophenyl derivatives of amino acids. *Biochem. Biophys. Res. Commun.*, **7**, 82–6.

Tchendji, C., Severin, M., Wathelet, J. P. & Deroanne, C. (1981). Composition of the fat from *Dacryodes edulis* (G. Don) H. J. Lam. *Rev. Fr. Corps. Gras.*, **28**(3), 123–45.

Vogel, I. A. (1961). Determination of Zinc Using Eriochrome Black T as Indicator. *In A Textbook of Quantitative Inorganic Analysis* (3rd edn). Longman, London.

Yemm, E. W., Willis, A. J. (1954). *Biochem. J.*, **57**, 508–14.