The nutritive value of Baobab fruit (Andasonia digitata)

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VALORE NUTRIZIONALE DEL FRUTTO DI BAOBAB (Andasonia digitata)

Il seme, la polpa polverizzata ed il guscio del frutto di Andasonia digitata sono stati sottoposti ad analisi chimiche standard. Sia il seme che la polpa ed il guscio presentano basso contenuto di umidità (6,12 ± 0,14, 6,21 ± 0,02, 3,11 ± 0,17 rispettivamente); inoltre il guscio presenta un contenuto di ceneri (4,21 ± 0,31) e di fibra grezza (35,3 ± 0,47) più elevato di quello del seme e della polpa. Il contenuto di proteina grezza nel seme è 21,42 ± 0,34 mentre nella polpa e nel guscio è rispettivamente 10,90 ± 0,30 e 2,41 ± 0,17.
Prolina e valina sono gli amminoacidi limitanti. L'olio color giallo pallido estratto dal seme con una resa di 17,51 ± 0,13 presenta le seguenti caratteristiche fisico-chimiche: numero di perossidi 5,14 ± 0,12, numero di iodio 86,41 ± 0,64, numero di acidità 7,79 ± 0,33, numero di saponificazione 132,68 ± 2,14, acidi grassi liberi 6,40 ± 0,18. Nell'olio sono stati determinati 8 acidi grassi; gli insaturi rappresentano l'82% del totale.
Nella polpa sono stati determinati 5 zuccheri: glucosio, fruttosio, saccarosio, maltosio e raffinosio (43,62 ± 0,17 dei carboidrati totali). I minerali a più elevato valore nutrizionale nel seme sono il potassio, il metallo predominante (17,4 ± 0,419/100 g) ed il sodio (1,64 ± 0,18). Valori simili sono stati rilevati nel guscio e nella polpa.

The seed, powdery pulp and hard husk of *Andasonia digitata* fruit have been subjected to standard chemical analysis. The results show that there is a low moisture content in the seed, pulp and hard husk, 6.12 ± 0.14, 6.21 ± 0.02, and 3.11 ± 0.17 respectively. In addition, the husk with an ash content of 4.21 ± 0.31 and a crude fibre value of 35.3 ± 0.47, were much higher than the seed and pulp.
The crude protein content of the seed was high, 21.42 ± 0.34 while that of the pulp and husk were 10.90 ± 0.30 and 2.41 ± 0.17 respectively. Proline and valine were the limiting amino acids.
The light yellow oil extracted from the seed yielded 17.51 ± 0.13 and had the following physico-chemical properties: peroxide value 5.14 ± 0.12, iodine value 86.41 ± 0.64, acid value 7.79 ± 0.33, saponification value 132.68 ± 2.14, free fatty acid 6.40 ± 0.18. Eight fatty acids were detected in the oil with unsaturated acid accounting for 82% of the total fatty acids.
The five types of sugar identified in the pulp were glucose, fructose, sucrose, maltose, and raffinose. The sugars accounted for 43.62 ± 0.17 of the carbohydrates.
The most nutritionally valuable minerals in the seeds were potassium, the most predominant metal 17.4 ± 0.419/100 g, followed by sodium 1.64 ± 0.18. A similar trend was recorded in the husk and pulp.

INTRODUCTION

Andasonia digitata also known as Baobab, belongs to the plant family called *Bombaceae*. The pulp is edible and makes a refreshing drink with water. Irvine [1] reported that the drink has been used locally in treating fever, haemoptysis and diarrhea. It has also been reported to be used in thinning thick guinea corn dough to a thin gruel "Fura-de-nono" by the Fulani and Hausa in Nigeria and other West African countries [1].

Like many other fruits, tons of Baobab fruits rot and waste away annually despite their high nutritional value and taste. More than 92% of the fruit remain unprocessed in Nigeria annually.

The Baobab tree is a tall tree which reaches a height of 9-10 metres. The fruit is big, and varies in shape from spherical to oblong, and also varies in weight. On cracking the hard husk, the inner material contains the seed which is embedded in a whitish aciduous pulp, which, when dried, is regarded as "cream of tarta".

Baboons love the fruit, tearing open the hardy woody shell to get to the pulp, so destroying a lot of the fruit [1].

When the pulp is roasted and dissolved in salty water it is used to coagulate the latex of ceara rubber in East Africa [2].

We are studying the industrial utilization of locally available but little known and underutilized fruits, and the *Andasonia digitata*, which has been neglected for so long, has great potential value and requires further studies.

This paper considers the chemical composition of the woody husk and powdery pulp and seed of *Andasonia digitata*. The nutritionally valuable minerals in the ash are determined whilst the physico-chemical properties of the seed oil are determined.

The protein extract in the seed and pulp examined for the amino acid distribution, it is expected that this study will open a research channel on the exploitation of the whole fruit of this plant.

MATERIAL AND METHODS

Collection and sample preparation

Baobab fruits were collected randomly from the tree at the University Farm and a village near the school. The fruits were cracked, the seed and pulp were separated. The woody husk, powdery pulp and seed were stored in different containers at 4°C prior to the analysis. The pulp, woody back and seed were ground separately to a fine powder form.

Analytical method

Moisture, ash, crude fibre and crude protein were determined by standard methods described in the AOAC [3]. Starch was quantified by Clegg method [4]. The sugar content in the seed and pulp was determined using the thin layer chromatography by a method described earlier [5]. The carbohydrate fraction was analysed for free sugar, water soluble polysaccharide and starch in the seed, and pulp sugars were extracted using the procedure of Heatherball [6] and quantified using dinitrosalicylic acid method [7].

The seed proteins were hydrolysed in a sealed tube with 6MHCl for 24 hours at 110°C [8]. The amino acid content was determined by an automatic amino acid analyser while oil extraction was carried out on the seed and pulp using a soxhlet extractor with petroleum ether (40-60°C) for 6 hours.

TABLE I - Proximate chemical composition of Boabab fruit

Properties	Mean ± SD		
	Seed	Pulp	Husk
Moisture	6.12 ± 0.14	6.21 ± 0.02	3.11 ± 0.17
Oil	17.51 ± 0.13	4.28 ± 0.13	4.01 ± 1.07
Crude protein	21.42 ± 0.34	10.90 ± 0.30	2.41 ± 0.71
Crude fibre	7.15 ± 0.01	6.21 ± 0.41	35.3 ± 0.47
Carbohydrate	37.16 ± 0.04	45.21 ± 0.17	21.68 ± 0.36
Ash	2.15 ± 0.70	1.98 ± 0.64	4.21 ± 0.31
Energy	760.41	820.47	590.21

Mean ± SD of the three dimensions

TABLE II - Percentage composition of carbohydrate in seed and pulp

Class of carbohydrate	Mean ± SD	
	Seed	Pulp
Sugars	6.41 ± 0.04	43.62 ± 0.17
Glucose	1.94 ± 0.16	8.47 ± 0.91
Fructose	4.32 ± 0.07	17.93 ± 0.78
Sucrose	0.31 ± 0.36	10.21 ± 0.34
Maltose	ND	ND
Soluble polysaccharide	12.36 ± 0.14	10.21 ± 0.17
Starch	62.48 ± 0.01	48.10 ± 0.22
Other polysaccharides	14.36 ± 0.00	ND

ND = not detectable (below detecting limit).

TABLE III - Physico-chemical characteristics of Baobab seed oil

Properties	Mean ± SD
Acid value	7.79 ± 0.33
Iodine value	82.41 ± 0.64
Peroxide value	5.14 ± 0.12
Saponification value	132.68 ± 2.14
Unsaponificable	3.27 ± 0.47
Free fatty acids	6.48 ± 0.18
Specific gravity	0.937 ± 0.00
Refractive index	1.4573
Colour	Light yellow
Free hydrocarbons	ND

Minerals were determined from the samples by accurately weighing 2 g of the samples into a crucible followed by dry ashing at 525°C for 5 hours. Two drops of conc. HNO_3 were added at the end of the drying treatment and returned into the furnace for a further 4 hours.

The residual white ash was dissolved in 5 cm³ conc.HNO_3. This was quantitatively transferred into a 100 ml standard flask, 5% of lanthanium chloride was added to suppress interferences and the solution made up to mark with distilled-deionised water. Sodium and potassium were determined with flame photometer (Corning model 45). Other metals were determined by atomic absorption spectrometer (Pye Unicam Sp-a).

The methods used for the physico-chemical analysis of the oil were those recommended by the official method of AOAC [3]. The characteristics determined are: iodine value, saponification value, free fatty acid, acid value, peroxide value, unsaponifiable matter, refractive index, and specific gravity.

The fatty acid composition of the oil was analysed by gas chromatography. 2 g of the oil after saponification with 0.5M ethanolic potassium hydroxide (30 ml) for 3 hours was reacted with 2MH_2SO_4 to liberate fatty acids after separation of unsaponifiable matter with diethylether. The fatty acids were converted to methyl ether by refluxing with dry methedol (5 ml) and 1% H_2SO_4 for 2 hours and subsequently analysed by Pye Unicam GLC, using diethylene glycol succinate (DEGS 15%) on 80-200 Chromosorb W solid support. The column injection, detector and oven temperature were 185, 200 and 205°C respectively. Nitrogen was used as carrier gas at a flow rate of 45 ml/min.

RESULTS AND DISCUSSION

Table I summarises the proximate chemical composition of the seed, pulp and husk of Baobab fruit. The moisture content of the seed pulp and husk are quite low, 6.12 ± 0.14, 6.23 ± 0.02 and 3.11 ± 0.17 respectively.

The moisture of the husk and pulp did not vary significantly with time compared to the moisture in the seed which steadily decreased over a period of time. This could be an advantage for the shelf life of the fruit. The ash content of the seed, pulp and husk are 2.15 ± 0.70, 1.98 ± 0.64 and 4.21 ± 0.31 respectively. The high ash content of the husk made it rather unsuitable for mixing with animal feed while the ash content of the seed and pulp was still within the limits recommended for poultry and cattle feeding.

This is further enhanced by the high carbohydrate content of between 37.16 ± 0.04 to 45.21 ± 0.17. Carbohydrates make up more than 82% of the starch content as shown in the table II. This means that it could be good source of starch for human consumption and/or industrial starch. Table II also reveals that between 10.12 and 12.36 of the seed and pulp are water-soluble polysaccharide and between 48.10 and 62.48 of the carbohydrate are reducing sugars. Fructose, glucose and sucrose which are detected in the free sugar fraction of the carbohydrate, particularly in the pulp, constitute the sweet taste of the pulp.

Soxhlet extraction of the seed with petroleum ether (Bp 40-60°) gave a light yellow oil of about 17.51 ± 0.13. This compared well with some of the oil seeds [9, 10]. The oil from the husk and pulp was very low and could not be of any commercial importance. The physico-chemical characteristics of the seed oil are presented in table III.

The iodine value of the seed oil 82.41 ± 0.64 is an indication of the high concentration of unsaturated fatty acids and is similar to that of olive oil (81.1). The free fatty acids were 6.48 ± 0.18 while the acid value was 7.79 ± 0.33 mg/KOH g^{-1}. The free acid and acid value were higher than the limit recommended for virgin or non virgin edible oils and fats by C standard (0.8% for free fatty acid and 4.0 mg/KOH g^{-1} for acid value). It is these two parameters that determine the suitability of an oil for edibility or industrial use. Like other oils from Monkey Pod [10] and *Bliphia sapida* seeds [5], oleic acid was the major fatty acid (58.71) followed by linoleic acid (23.25). Palmitic acid was the most abundant saturated fatty acid. Linoleic and oleic acids could be useful in the production of certain chemicals [11].

The crude protein content of the seed was 21.42 ± 0.34 while that of the pulp and husk were 10.90 ± 0.30 and 2.41 ± 0.17 respectively. The seed compared favourably with cowpea, chick bean and lima bean [10, 11] but lower than soybean, 35.1%, FAO-WHO 1973 [12].

Table IV showed the thirteen amino acids that were detected by two dimentional paper chromatographies. Valine and proline were the most limiting amino acids while the most abundant were lysine (17.36), cystein (12.63), arginine (8.62), leucine (7.48) and isoleucine (7.10) in the seed. The amino acid in the pulp followed a similar pattern. This result is of immense importance as the seed and the pulp could be used as an ef-

TABLE IV - Fatty acid composition of Baobab seed oil

Fatty acids	Composition, %
Oleic (C18:1)	58.71
Linoleic (C18:2)	23.25
Linolenic (C18:3)	8.17
Gadoleic (C20:1)	3.64
Palmitoleic (C16:1)	1.65
Myristic (C14:0)	1.46
Palmitic (C16:0)	2.22
Lauric (C12:0)	0.34

TABLE V - Amino acid distribution in the protein concentrate of seed and pulp

Amino acids	Concentration g/100 g Seed	Pulp
Proline (PRO)	0.62	0.92
Histidine (HIS)	1.43	2.71
Leucine (LEU)	7.48	8.41
Lysine (LYS)	17.36	14.62
Arginine (ARG)	8.62	6.04
Isoleucine (ILE)	7.10	10.73
Methionine (MET)	5.94	4.92
Cystine (CYS)	12.63	11.23
Phenylalanine (PHE)	5.18	4.11
Glutamic acid (GLU)	2.10	4.02
Valine (VAL)	0.76	0.43
Threonine (THR)	1.64	2.96
Tyrosine (TYR)	3.62	4.21
Tryptophan (TRP)	2.64	1.49

TABLE VI - Nutritionally valuable minerals of ash in the seed, pulp and husk

Element	Mean ± SD Seed	Pulp	Husk
Potassium	1.74 ± 0.41	2.31 ± 0.03	3.42 ± 0.17
Sodium	1.64 ± 0.18	1.86 ± 0.11	2.11 ± 0.71
Calcium	0.53 ± 0.02	0.06 ± 0.13	1.42 ± 0.41
Iron	1.89×10^{-4}	3.47×10^{-4}	4.64×10^{-4}
Magnesium	0.20 ± 0.04	0.10 ± 0.00	0.06 ± 0.01
Zinc	0.91 ± 0.01	$0.64 \pm$	0.43 ± 0.04
Manganese	2.84×10^{-3}	2.7×10^{-3}	4.36×10^{-3}
Copper	5.36×10^{-3}	7.14×10^{-3}	8.31×10^{-3}
Phosphorus	1.49×10^{-4}	3.18×10^{-4}	6.49×10^{-4}

ficient supplement to cereal protein. Cereal protein like sorghum and corn, that are deficient in some essential amino acids, could be used as a supplement particularly in animal feed.

The essential mineral composition of the seed and pulp calculated as mg/100 g of the dry weight are in table VI. Potassium and sodium were the most abundant with a concentration of 1.74 ± 0.41 and 1.64 ± 0.18 in the seed and a similar trended was recorded for the puld and husk.

Despite the fact that there is no RDA for potassium and sodium it is recommended that the intake should be the same to counteract tha effect of sodium in raising blood pressure (FAO 1986) [13]. Therefore the use of the pulp as a sugar concentrate must be subject to toxicological studies. However, the presence of valuable minerals in the fruit make it suitable as animal feed.

REFERENCES

1) F.R. IRVINE, «West African crops». Mac. Nig. Press, 1979, p. 187-188.

2) J.W. AIRAN, R.M. DESAI, «Acids and sugars of *Andasonia digitata*» J. Univ. Bombay Sc. Sect. A, no. 35, 23-27 (1954).

3) K. HOWTZ, «Official Methods of Analysis», Association of Official Analytical Chemistry (AOAC), 12th edition, 1980.

4) K.M. CLEGG, «Determination of starch in cereals». J. Ed. Sci. and Agric. *7*, 40-46 (1956).

5) K.O. ESUOSO, S.M. ODETOKUN, «Proximate chemical composition and possible industrial utilisation of *Bliphia sapida* seed and seed oils» Riv. Ital. Sostanze Grasse *75*, 311 (1995).

6) D.A. HEARTHERBELL, «Determination of sugars in grape fuit in New Zealand». J. Sci. and Ed. Agric. *26*, 8158 (1975).

7) G.L. MILLER, «Determination of sugars using dinitrosalicylic acid». Anal. Chem. *31*, 426-428 (1959).

8) S. MEERE, W.H. STEIN, «Acid hydrolysis method in enzymology». Academic Press, N.Y. 1963, p. 819-822.

9) A.A. OSHODI, «Proximate composition and nutritional valuable minerals and functional properties of *Andenopus breriflorus* benith flow and protein concentrate». Food Chemistry *45*, 79-83 (1992).

10) K.O. ESUOSO, «Nutritive value of Monkey pod». Riv. Ital. Sostanze Grasse *73* (4) 165-168 (1996).

11) R.R. ALLEN, M.W. FORMS, R.G. KRISHNAMMURTHY, G.N. MODERMOFF, F.A. NORRIS, N.O. SONNTAG, «Bailey industrial oil and fat products». John Wiley and Sons, vol. 2, Forth Ed., 1982.

12) FAO/WHO, «Energy and protein requirement». Technical report no. 252, Ad-Hoc Expert Committee UN, Rome, 1973.

13) FAO, «Food composition table for use in Africa». Development of Health Education and Welfare, Public Health Service and FAO Nutritional Division, 1968.