ISSN 2201-2796

Proximate and Mineral Composition of Synsepalum Dulcificum Seed

Olaitan J. Jeremiah
Department of Pharmacology,
Obafemi Awolowo University
Ile-Ife, Osun State,Nigeria
ola_tan@yahoo.com

Olapade R. Ilesanmi
Department of Pharmacology,
Obafemi Awolowo University
Ile-Ife, Osun State,Nigeria
padsanmi@yahoo.com

Morakinyo M. Ige
Department of Food Science and Technology,
Obafemi Awolowo University,
Ile-Ife, Osun State, Nigeria.
mmige@oauife.edu.ng

***Abstract*- In this study, the proximate analysis of Synsepalum dulcificum seed was investigated and results showed that it has moisture content (38.08%), crude protein (19.47%), crude fat (11.94%), total carbohydrate (29.08%), crude fibre (0.66%) and ash (1.43%). The mineral content was also determined. It contains 569.500 ± 2.820, 72.170 ± 5.340, 25.000 ± 0.000 and 17.630 ± 0.390 mg/100 g of Potassium, Calcium, Sodium and Magnesium respectively. Other mineral elements found (in mg/ 100 g) were Iron (3.050 ± 0.490), Zinc (2.710 ± 0.009), Copper (2.420 ± 0.008), Manganese (2.380 ± 0.004), Nickel (0.240 ± 0.028) and Cadmium (0.013 ± 0.002).**

***Index Terms*— Synsepalum dulcificum, Proximate, Mineral.**

I. Introduction

The plant, *Synsepalum dulcificum* (family Sapotaceae) also known as the miracle fruit is a large shrub about 2 to 5 m high with dense foliage (the leaves measuring up to 5-10 cm in length, 2-3.7 cm in width and are glabrous below). Its many slender branches are clustered at the tip and it possesses brown flowers. The fruits (about 2 cm long) are red when ripe and each fruit contains one seed [1]. It originates from West and West-Central tropical Africa. This species and its berry are commonly known as miracle fruit,http://en.wikipedia.org/wiki/Synsepalum_dulcificum - cite_note-WEP-1 miracle berry, miraculous berry [2], sweet berry [1][3] and in West Africa, agbayun (Yoruba, Nigeria) (U.S Plant inventory), asowa (Twi, Ghana) and ele (Ewe, Ghana).

This plant is best known for its red berries, which contain a glycoprotein called miraculin [4]. When the fruit pulp is sucked, sour foods subsequently consumed taste sweet because miraculin binds to some receptors on the taste buds to activate the sweet receptors hence resulting in perception of sweet taste. This action of miraculin is usually favoured at a low pH (acidic) like that resulting from ingestion of sour food [5]. This effect lasts until the protein is washed away by saliva (up to about 60 minutes). Miraculin is commercially used as a sugar substitute [2]. It has also been found useful among diabetics and dieters possibly because research has shown that the fruit has the ability to improve insulin sensitivity [6] and also because of its characteristic of being a low-calorie sweetness enhancer, limiting energy intake [7]. In addition to the value of the fruit as a taste modifier, the skin, pulp and seeds of miracle berries have been shown to have antioxidant properties, hence of possible benefits to human health [8].

II. MATERIALS AND METHODS

Collection and Processing of Plant materials

The plant was identified and authenticated in the Department of Botany (Ife herbarium) of Obafemi Awolowo University, Ile-Ife by Mr. B.E. Omomoh and deposited with the number: 17218. The curator of the herbarium is Mr. G. Ibhanesehbor. The fruits were collected from the plant domiciled at the Parks and Gardens of Obafemi Awolowo University, Ile-Ife, in its fruiting season (March, 2013). These were washed and squeezed inside water to remove the skin from the pulp and the water was allowed to drain off the seeds. The seeds were decoated and subjected to proximate and mineral analysis.

Determination of Proximate and Mineral Composition

The proximate analysis of *S. dulcificum* seed for percentage moisture content, crude protein, ether extract (crude fat), ash content and crude fibre were determined using the standard Association of Official Analytical Chemists (AOAC), 1990 methods [9]. The carbohydrate content was determined by difference, also according to AOAC (1990) method [9]. The mineral analysis was carried out with the aid of atomic absorption spectrophotometer (AAS).

III. RESULTS AND DISCUSSION

Foods and Feed samples can be considered nutritious only if they contain good amounts of food macronutrients and/or micronutrients. Proximate analysis is a quantitative method used in determining the macronutrient content of foods or potential feeds. In this method, the compounds in a feed sample are partitioned into six categories based on their chemical properties. These include: Moisture, Crude protein, Crude fat, Ash, Crude fibre and Nitrogen-Free extracts (digestible carbohydrates). The result of the proximate analysis of *S. dulcificum* seed is presented in Table 1 below. The moisture content was found to be 38.08 %. This is high compared to that of some common food seeds: groundnut (*Arachis hypogea*) [10] and Egusi-melon (*Citrullus lanatus*) [11] seeds which have been reported as 7.48 % and 4.6 ± 0.3 % respectively. It is lower than 48.7 % reported for African walnut (*Tetracarpidium conophorum*) seed [12]. The moisture content of *S. dulcificum* seed is also lower than that of its fruit pulp (59.55 %) [13].

Moisture content of a feed sample is related to the shelf life of the sample. High moisture content in feed samples often leads to spoilage from increasing microbial action when stored [14]. However, low-moisture content may imply higher shelf life. Therefore, the moisture content is considered in determining the storage conditions for such samples. Thus, the seed is expected to last longer on storage than the pulp.The crude protein of the seed was found to be high (19.47 %). This is similar to that of baobab seed (19.5 %) [15] and comparable to that of sesame seeds (20.00 ± 0.12 %) [16]; though also lower than that of groundnut (24.70 %) [10] and Egusi-melon (23.4 %) [11] but higher than the values reported for the seeds of black nightshade (*Solanum nigrum*) (17.04 ± 0.67 %), Spinach (*Amarenthus hybrid)* (17.19 ±1 .47 %) [17]; sour sop (*Annona muricata*) (8.5 ± 0.52 %) [18] and *Cyperus esculentus* L commonly called tiger nuts (8.07 ± 0.37 %) [19]. The crude protein content of this seed is also considerably higher than 7.75 % reported for its pulp [13]. Proteins perform critical roles in the biological systems; hence they are essential components of human and animal diet. They perform structural, transport and body-building functions among others [20]. The high crude protein content of *S. dulcificum* seeds suggests that the seed is a potential source of protein, hence could be processed and used as protein supplement and food additive.

The crude fat content of the seed was found to be relatively high (11.97 %), suggesting that the seed can be potentially useful as oilseeds. This value is higher than that of walnut (6.21%) [12] and dehulled bambara groundnut (6.99 %) [21]. It is also much higher than the 3.26 % reported by for *S. dulcificum* fruit pulp [14]. However, it is lower than that of some common oil seeds like groundnut (46.10%) [10], *Annona muricata*- sour sop (40 ± 0.82 %) [18] and castor seeds (55.50 ± 2.66 %) [22].

The ash content is a measure of the amount of minerals contained in a feed while the crude fibre is a measure of indigestible components, majorly polysaccharides (e.g. cellulose) and lignin contained in such feeds [23]. The ash and crude fibre contents were relatively low, having values of 1.43 and 0.66 % respectively. The ash content compares favorably with 1.48 % reported for groundnut [10] but lower than 3.7 ± 0.03 and 2.03 % reported for Egusi-melon [11] and walnut [12] respectively. The ash is however higher than 0.81 % reported for custard apple (*Annona cherimoya*) [24].

The crude fibre content (0.66 %) is lower than that in the seeds of baobab (15.6 ± 0.5%) [15] and Egusi-melon (12.0 ± 0.1 %) [11]; it is much lower than 32.46 ± 0.85 % found in custard apple (*Annona cherimoya*) [24]. The low fibre content (0.66) of the seeds implies that it might not be useful in making digestibility preparations [25], though might still aid digestion in humans.

The Nitrogen Free Extract (NFE) represents the easily digestible carbohydrates e.g. sugars and digestible polysaccharides like starch. NFE is used in calculating the total carbohydrate as the addition of crude fibre content to NFE gives the total carbohydrate [9]. The NFE of *S. dulcificum* seeds was found to be 28.42 % and the total carbohydrate was calculated as 29.08 %. This shows that the seeds contain appreciable amount of total carbohydrates and a large percentage of the carbohydrate content is digestible. The digestible carbohydrates (NFE) found in this seed (28.42 %) is higher than that found in seeds of Egusi-melon (10.6 ± 0.2 %) [12], custard apple (10.32 ± 0.43) [24] and castor (8.86 ± 0.00 %) [22]. The NFE (digestible carbohydrate) obtained for this seed is similar to that of sour sop (28.9 %, calculated from the total carbohydrate and crude fiber values of 34.1 % and 5.2 % respectively) [18] but lower than that of, baobab (44.6 ± 0.2 %) [15] and African walnut (53.20 %) [12].

The total carbohydrate (29.08 %) is lower than that of the seeds of *Amarenthus hybridus* (58.3 %), *Abelmoschus esculentus* (36.58 %) and *Solanum nigrum* (32.81 %) but higher than that of *Morienga oleifera* (13.6 %), *Sesamum indicum* L. (16.6) and *Jatropha curcas* L. (17.18 %) which are all common Congo oilseeds [17]. The high carbohydrate content suggests that it might be a potential source of energy-giving food.

The result of the determination of mineral content of *S. dulcificum* seed is shown in Table 2. The mineral analysis showed that the seed is rich in some minerals. Potassium (K) has the highest value (569.500 ± 2.820 mg/100 g). This is higher than that found in groundnut (470 mg/100 g) [10], sour sop (357.14 ±1.84 mg/100 g) [18], Egusi-melon (96.1± 0.4 mg/100 g) [11], dehulled bambara groundnut (49.3 mg/100 g) [21] and castor (19.62) [22] seeds. However, it is lower than the postassium content of custard apple (21340 mg/100 g, i.e. 21.34 g/100 g) [23], baobab (875.15 ± 0.05 mg/100 g) [15]. Potassium is important for the maintenance of body fluid and electrolyte balance and is involved in the proper functioning of the heart muscles. It also plays a major role in carbohydrate metabolism and protein synthesis [26]. The high potassium content of these seed suggests that it could be a potential source of potassium supplements for humans and animals (livestock).

The seeds were also found to contain 72.170 ± 5.340 mg/100 g of calcium (Ca). This is higher than 33.00, 30.34 and 28.20 ± 0.20 mg /100 g reported for Guna seed (*Citrullus vulgaris*), a variety of melon commonly called pumpkin [27], castor [22] and Egusi-melon [11] seeds respectively. However, it was found to be lower in Ca content compared with baobab [15], sour sop [18] and dehulled bambara groundnut [21] which are 521.10 + 0.25, 149.10 ± 2.10 and 82.2 mg/100 g respectively. Calcium is essential for the formation and maintenance of strong bones and teeth. It is also involved in regulation of nerve function, muscle contraction and blood clotting [26]. It is thus essential in diet.

The sodium (Na) content of *S. dulcificum* seeds was found to be 25.000 ± 0.000 mg/100 g. This value compares that reported for dehulled bambara groundnut (24.9 mg/100 g) [21]; higher than Na content of *Moringa oleifera* [17], sour sop [18] and Egusi-melon [11] which are 22.50 ± 0.01, 17.35 ± 2.47 and 13.0 ± 0.2 mg/100 g respectively. However, this seed has a lower Na content when compared with groundnut (710 mg/100 g) [10], guna (207 mg/ 100 g) [27], castor (73.45 mg/100 g) [22] and baobab (40.72 ± 0.2 mg/100 g) [15] seeds. Sodium is also an important component of human and animal diet as it helps in maintaining homeostasis within the body system and it also performs structural functions (in skeleton) [26].

The magnesium (Mg) content was 17.630 ± 0.390 mg/100 g. This value is higher than that found in sour sop (12.57 ± 1.42 mg/100 g) [18] but lower than that found in most oilseeds e.g. *Amaranthus hybridus* (596.73 ± 0.31 mg/100 g), Sesame (579.53 ± 0.42 mg/100 g), *Moringa oleifera* (251.30 ± 0.02 mg/100 g) [17]; Groundnut (180 mg/100 g) [10], Guna (81.00 mg/100 g) [27] and Egusi-melon (31.4 ± 0.2 mg/100 g) [11]. Magnesium is found in every cell and it plays a role in carbohydrate and protein metabolism, smooth muscle function and cell reproduction [28].

The other elements determined in *S. dulcificum* seeds were iron (Fe), Zinc (Zn), Copper (Cu), Manganese (Mn), Nickel (Ni) and Cadmium (Cd). Their values were found to be 3.050 ± 0.490, 2.710 ± 0.009, 2.42 ± 0.008, 2.380 ± 0.004, 0.24 ± 0.028 and 0.013 ± 0.002 mg/100 g, respectively. Chromium was not detected.

Iron is an essential trace element and it is a component of heamoglobin [26]. According to food drug administration (FDA), USA, the Recommended Daily Intake (RDI) for both iron and Zinc is 15 mg. Hence, these seeds may represent a potential source of food to contribute to the RDI of these essential trace elements. The RDI for Copper by FDA is 2 mg. Comparing this with the Cu content determined for *S. dulcificum* seeds (2.42 ± 0.008), it can be said that the value in 100 g of the seeds is more than the RDI. Hence, the seeds could be a potentially good source of Cu if included in human and animal diets. These seeds could also contribute to the RDI of Mn and Ni which are 5 mg and < 1mg respectively.

In conclusion, the proximate and mineral analyses of *Synsepalum dulcificum* seed showed that the seed is highly nutritious, hence could be a readily available and affordable source of macro-nutrients and minerals in both humans and animals.

TABLE I. PROXIMATE COMPOSITION OF S. DULCIFICUM SEED

Nutrient	Composition (%)
Moisture	38.08
Crude Protein	19.47
Ether extract/Crude Fat	11.94
Ash	1.43
Crude Fibre	0.66
Nitrogen free extract (NFE)	28.42
Total Carbohydrate	29.08

TABLE II. MINERAL COMPOSITION OF S. DULCIFICUM SEED

Mineral elements	Mean composition (± SD) (mg/100 g)
Potassium (K)	569.500 ± 2.820
Calcium (Ca)	72.170 ± 5.340
Sodium (Na)	25.000 ± 0.000
Magenesium (Mg)	17.630 ± 0.390
Iron (Fe)	3.050 ± 0.490
Zinc (Zn)	2.710 ± 0.009
Copper (Cu)	2.420 ± 0.008
Manganese (Mn)	2.380 ± 0.004
Nickel (Ni)	0.240 ± 0.028
Cadmium (Cd)	0.013 ± 0.002
Chromium	ND

ND = Not detected.

REFERENCES

[1] Duke J.A.and DuCellier J. L., ed. (1993). CRC handbook of alternative cash crops, CRC Press. 433–434.

[2] Wiersema J. H. and León B: (1999). World Economic Plants: A Standard Reference. CRC Press: 661.

[3] Hanelt P., ed. (2001). Mansfeld's encyclopedia of agricultural and horticultural crops. Springer. 2: 1660

[4] McCurry J. (2005): Miracle berry lets Japanese dieters get sweet from sour. London: The Guardian. http://www.guardian.co.uk/world/2005/nov/25/japan.foodanddrink.

[5] Koizumi A. (2011): Human Sweet Taste Receptor Mediates Acid-induced Sweetness of Miraculin. Proceedings of the National Academy of Sciences. http://www.pnas.org/content/early/2011/09/16/1016644108.

[6] Chen C. C., Liu I. M. and Cheng J. T. (2006): Improvement of insulin resistance by miracle fruit (Synsepalum dulcificum) in fructose-rich chow-fed rats. Phytotherapy Research; 20(11): 987-992.

[7] Wong J. M. and Kern M. (2011): Miracle fruit improves sweetness of a low-calorie dessert without promoting subsequent energy compensation. Appetite; 56(1): 163-166.

[8] Inglett G. E., Chen D. (2011): Contents of phenolics and flavonods and antioxidant activities in Skin, Pulp, and Seeds of Miracle Fruit. Journal of Food Sciences; 76(3): 479-481.

[9] AOAC (1990): Official Methods of Analysis, 15th Edition, Association of Official Analytical Chemists, Arlington, VA.

[10] Ayoola P. B., Adeyeye A. and Onawumi O. O. (2012): Chemical evaluation of food value of groundnut (Arachis hypogaea) seeds. America Journal of Food and Nutrition; 2(3): 55-57.

[11] Ojieh G. C., Oluba O. M., Ogunlowo Y. R., Adebisi K. E., Eidangbe G. O. and Orole R. T. (2007): Compositional Studies of Citrullus lanatus (Egusi melon) Seed. The Internet Journal of Nutrition and Wellness; 6(1): ISSN: 1937-8297.

[12] Edem C. A., Dosunmu M. I. and Bassey F. I. (2009): Determination of Proximate Composition, Ascorbic Acid and Heavy Metal Content of African Walnut (Tetracarpidium conophorum). Pakistan Journal of Nutrition; 8: 225-226.

[13] Nkwocha C., Njoku O. and Ekwueme F. (2014): Proximate and Micronutrient Analyses of Synsepalum dulcificum Pulp. Scientific Research Journal; (2)1: 2201-2796.

[14] Onyeike E. N., Olungwe T. and Uwakwe A. A. (1995): Effect of heat treatment and defatting on the proximate composition of some Nigerian local soup thickeners. Food Chemistry; 53: 173-175.

[15] Oyeleke G. O., Salamand M. A. and Adetoro R. O. (2012): Some Aspects of Nutrient Analysis of Seed, Pulp and Oil J.M of Baobab (Adansonia digitata L.). IOSR-JESTFT; 1(4): 32-35.

[16] Nzikou J. M ., Matos L., Bouanga -Kalou G., Ndangui C. B., Pambou -To bi N. P. G., Kimbonguila A., Silou Th., Linder M. and Desobry S. (2009): Chemical Composition on the Seeds and Oil of Sesame (Sesamum indicum L.) Grown in Congo-Brazzaville. Advance Journal of Food Science and Technology; 1(1): 6-11.

[17] Kimbonguila A., Nzikou J. M., Matos L., Loumouamou B., Ndangui C.B., Pambou -Tobi N. P .G. Abena A. A ., Silou Th ., Scher J. and Desobry S. (2010): Proximate Composition of Selected Congo Oil Seeds and Physicochemical Properties of the Oil Extracts. Res. Journal of Applied Science and Engineering Technology; 2(1): 60-66.

[18] Kimbonguila A., Nzikou J. M., Matos L., Loumouamou B., Ndangui C. B., Pambou -Tobi N. P .G. Abena A. A ., Silou Th., Scher J. and Desobry S. (2010): Proximate Composition and Physicochemical Properties on the Seeds and Oil of Annona muricata grown In Congo-Brazzaville. Research Journal of Environmental and Earth Sciences; 2(1): 13-18.

[19] Ekeanyanwu R. C. and Ononogbu C. I. (2010): Nutritive Value of Nigerian Tigernut (Cyperus esculentus L.) Agricultural Journal; 5(5): 297-302.

[20] Rodwell V. W. and Kennelly P. J. (2003): Proteins: Determination of Primary Structure In: Harper's Illustrated Biochemistry, Twenty-Sixth Edition. McGraw-Hill.

[21] Olaleye A. A., Adeyeye E. I. and Adesina A. J. (2013): Chemical composition of bambara groundnut (V. subterranea L. Verdc) seed parts. Bangladesh Journal of Scientific and Industrial Research; 48(3): 167-178.

[22] Annongu A. A. and Joseph J. K. (2008): Proximate Analysis of Castor Seeds and Cake. Journal of Applied Sciences and Environmental Management; 12(1): 39 – 41.

[23] Matarese L. E. and Gottschlich M. M. (2003): Contemporary nutrition support practice: a clinical guide. 2nd Edition, USA: Saunders: 173-175.

[24] Amoo I. A., Emenike A. E. and Akpambang V. O. E. (2008): Compositional Evaluation of Annona cherimoya (Custard Apple) Fruit. Trends in Applied Sciences Research; 3: 216-220.

[25] Pearson D. (1976): The Chemical Analysis of Foods. 7th Edition, Churchill Livingstone, London: 7-11.

[26] Drewnowski A. (2010): The Nutrient Rich Foods Index helps to identify healthy, affordable foods. The American Journal of Clinical Nutrition; 91(4): 1095S–1101S.

[27] Penuel B. L., Khan E. M. and Maitera M. O. (2013): Properties of Proximate Composition and Elemental Analysis of Citrullus vulgaris (Guna) Seed. Bulletin of Environment, Pharmacology and Life Sciences; 2(2): 39- 46.

[28] Corbridge D. E. C. (1995): Phosphorus: An Outline of Its Chemistry, Biochemistry, and Technology. 5th Edition, Amsterdam: Elsevier Science Publishing Company: 1220.

APPENDICES

Appendix1

Determination of Moisture content				
Sample weight (a)(g)	Weight of empty crucible (b) (g)	Initial weight-before drying (a+b) (g)	Final weight-after drying (c) (g)	% moisture content [{(a+b)-c}/a]× 100
2.0000	27.1884	29.1884	28.4268	38.0800
Determination of Ash Content				
Sample weight (a)(g)	Weight of empty crucible (b) (g)	Weight of empty crucible +Ash (c)(g)	Weight of ash (c-b) (g)	% Ash content [{(c-b)/a} ×100]
2.0000	26.9127	26.9413	0.0286	1.4300
Determination of Crude fibre				
Sample weight-before digestion (a)(g)	Weight of empty crucible +digested sample (b)(g)	Final weight of 'b' after ashing the digested sample (c)[g]	Weight of Crude fibre (b-c) (g)	% Crude fibre [{(b-c)/a}× 100]
2.0000	26.2068	26.1936	0.0132	0.6600

Determination of Crude fat				
Sample weight (a) (g)	Weight of empty extraction flask (b) (g)	Final weight of flask after extraction (c) (g)	Weight of oil extracted (c-b) (g)	% Crude fat[{(c-b)/a} × 100]
2.0000	34.4096	34.6484	0.2388	11.9400

Appendix 2

Determination of Crude protein (Titration)

S/N	Sample Weight (a) (g)	Initial burette reading (ml)	Final burette reading (ml)	Titre value (b) (ml)	% Nitrogen [(b × 0.35)/a]	% Crude protein (% Nitrogen × 6.25)
i	0.50	0.00	4.20	4.20	2.94	18.38
ii	0.50	0.00	4.70	4.70	3.29	20.56
Average % Crude protein						19.47

Appendix 3

Determination of Nitrogen-Free Extract (NFE) and Total Carbohydrate
% Total carbohydrate = % Nitrogen Free Extract (N.F.E) + % Crude Fibre
% N.F.E = 100 – (% M.C + % A.C + % C.F + % F.C + % C.P)
% M.C = Percentage Moisture content
% A.C = Percentage Ash content
% C.F = Percentage Crude fibre
% F.C = Percentage Fat content (Crude Fat)
% C.P = Percentage Crude protein
% Nitrogen Free extract = 100 – (38.08 + 1.43 + 0.66 + 11.94 + 19.47)
% N.F.E = 100 – 71.58
% N.F.E = 28.42
% Total carbohydrate = % N.F.E + % Crude Fibre
% Total carbohydrate = 28. 42 + 0.66
% Total carbohydrate = 29.08