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Comparative Study on the Proximate and Mineral Contents of the Seed and Pulp of Sugar Apple (*Annona squamosa*)

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Abstract: Proximate composition and mineral content of the seed and pulp of sugar apple (*Annona squaumosa*) was investigated. On dry weight (DW) bases, the pulp contain significantly ($p < 0.05$) higher amount of moisture (70 ± 1.83%), ash (7.5 ± 1.29%), crude fibre (46 ± 2.5%) and soluble carbohydrate (30.30 ± 2.02%) compared to the respective values of 42.50 ± 1.29%, 2.50 ± 0.20%, 36.30 ± 2.00% and 12.60 ± 1.80% for seeds. The crude protein contents did not differ significantly ($p > 0.05$) difference between the seeds (4.4 ± 0.72%) and the pulp (4.4 ± 1.03%). On the other hand, crude lipid (44 ± 3.06%) and calculated energy (464 kcal/100g) were significantly ($P < 0.05$) higher for the seeds than the corresponding values (11.5 ± 2.08%; 246 kcal/100g) for pulp. Mineral elements concentrations were low except for Ca in both samples and Mg for pulp. Nutrient densities were low for most elements other than Ca, Mg (for pulp), Fe and Zn, which were > 100%.

Key words: *Annona squamosa*, Fruits, Proximate, Minerals, nutrient density.

INTRODUCTION

Sugar apple (*Annona squamosa*) also called "Gwanda masar" in Hausa belong to the family *Annonacae*. The most widely grown of all the species are *A. muricata, A. cherimola, A reticulata, A. senegalensis* and *A. Taglabra, A. squamose* (Morton 1987).

The sugar apple tree ranges from 3 – 6 m in height with open crown of irregular branches and somewhat zigzag twigs. Deciduous leaves, alternately arranged on short, hairy petioles are lanceolate or oblong, blunt tipped, 5 – 15 cm and 2 – 5 cm wide; dull green on the upper side, pale with a bloom, below; slightly hairy when young; aromatic when crushed. Along the branches tips, opposite the leaves, the fragrant flowers are born single or in group 2 to 4. They are oblong 2.5 to 3.8 cm long, never fully open; with 2.5 cm long dropping stalks, and 3 fleshy outer petals, yellow green on the outside and pale yellow inside with a purple at the base. The compound fruits (Fig.1) are nearly round, ovoid or conical 6 – 10 cm long; thick peel composed of knobbly segment, pale green, grey-green, bluish – green or in one form. When the fruits ripen, it reveal the mass of conically segmented creamy – white, glistening, delightfully fragrant, juices, sweet and delicious flesh (Mortan, 1987).

The objective of this work is to conduct comparative study of nutrient composition of seed and pulp of *Annona squamosa* fruit .

Fig.1: Sugar apple (*Annona squamosa*)
Source: Morton (1987)

MATERIALS AND METHODS

Sample collection

Fresh sample of *A. squamosa* was obtained from individual houses within Sokoto metropolis at (Gawon Nama and Gwiwa Low-cost areas). The sample was identified as *A. squamosa* at the Botany unit, Usmanu Danfodiyo University Sokoto.

Sample Treatment
The fruits were split manually with knife in the laboratory and the seeds separated from the "flesh". The seeds were washed and air-dried to constant weight. The seeds and flesh were oven dried at 55^oC, ground using ceramic mortar and pestle, sieved with 20 mesh sieve and stored in air-tight polyethylene bags in a desiccator. The dried powdered samples were used for the analysis. All determinations were carried out in triplicates.

Proximate analysis
Standard methods (AOAC, 1990) were employed for the proximate analysis. The moisture content was determined by drying two grams of the fresh sample in an oven at 105^oC to constant weight ($\approx$ 24 hours). The ash content was determined by the incineration of 2g sample in a muffle furnace at 550^oC for 3 hours. Crude lipid (CL) was exhaustively Soxhlet extracted from 2g sample with n-hexane for 8 hours. The nitrogen (N) content was estimated by micro-Kjeldahl method and crude protein (CP) content calculated as N% *x* 6.25. Crude fibre content was determined by treating 2g sample with 1.25% (W/V) H_2SO_4 and 1.25% (W/V) NaOH. The available carbohydrate (CHO) was calculated by difference. Calorific value (CV) was determined using the following equation:

CV (kcal/100g) = (CHO x 4) + (CL x 9) + (CP x 4)

Minerals analysis Mineral analysis was carried out after sample digestion using the double acid digestion method (James, 1995). Cu, Fe and Zn were determined by atomic absorption spectrophotometric (AAS) method, while Na and K were determined by atomic emission spectrometry (AES) (AOAC, 1990). Ca and Mg were determined by complexo- metric titration method using EDTA (AOAC, 1990), and P by the molybdenum blue colorimetric method (James, 1995).

Nutrient density (ND)
The samples nutrient densities were calculated using the equation reported in Hassan and Umar (2004), which is:

$$ND(\%) = \frac{[NP/EP]}{[Nr/Er]} \times 100$$

Where:
Np = nutrient concentration (mineral element in the food),
Ep = energy supplied by food,
Nr = recommended daily intakes of nutrient and
Er = recommended energy intake (3000kcal/day for an adult male given by WHO/FAO (Cole, 1980).

Statistical analysis
Data generated were analysed using SPSS (version 10) statistical package and reported as mean ± standard error of mean. Means separation was done using paired t-test and considered significant at $p < 0.05$.

RESULTS AND DISCUSSION
The result of proximate analysis is presented in Table 1. The pulp has significantly ($p < 0.05$) higher moisture content than the seed, but lower than those of *A. muricata* (81%) and bush mango (90%) (Onimawo, 2002). Generally, fruits are known for their high moisture content which is responsible for their susceptibility to microbial attack during storage.

Ash content of the seeds was also significantly ($p < 0.05$) lower than that of pulp. The pulp ash content was higher than that of *A. muricata* (0.5%) (Onimawo, 2002). The ash content of the plant material is an index of total mineral content. This finding indicated that the fruit pulp may contain nutritionally important mineral elements.

The fruit pulp contain significantly ($p < 0.05$) higher amount of crude fibre compared to seeds. These values are high when compared with that reported for *A. municata* (8%) (Onimawo, 2002). Fruits and vegetables are known to contain high fibre which can be beneficial in human diet on the muscles of large and small intestine (Fisher and Bender, 1979; Lanza and Butrum, 1986). The recommended daily intake of fibre is 12-38g/day (FNB/IOM, 2002). This indicates that the fruit could be a source of daily required bulk roughage.

The seed crude lipid content was relatively high placing the seed in the group of oil seeds. The fat content of the seed is higher than that reported for *A. muricata* (20.5%) (Onimawo, 2002), but lower than that of benni seed (48.2%) (Egbekun and Ehieze, 1997). The pulp crude lipid content was significantly ($p < 0.05$) lower than that of the seeds, but higher than that reported in pulp of African locust bean (1.84%) (Hassan and Umar, 2004).

Crude protein content was not significantly ($p > 0.05$) different between the seeds and the pulp. The values were higher than 2.4% and 0.90% reported for seed and pulp of *A. muricata* respectively (Onimawo 2002).

The available carbohydrate content of the samples is low with pulp having significantly ($p < 0.05$) higher amount than the seeds. The seeds available carbohydrate is lower than the range of 32.93% to 34.38% reported as available carbohydrate content of African locust bean seeds (Lockett *et al*., 2000; Hassan and Umar, 2004). The pulp soluble carbohydrate (30.3%) was also lower than the value (51.70% to 72.10%) found in pulp of African locust bean (Ega *et al*., 1988; Hassan and Umar, 2004). Seeds of *A. squamosa* have significantly ($p < 0.05$) higher energy value than the pulp due to relatively higher crude lipid content of the seeds.

The result of mineral analysis of *A. squamosa* seed and pulp is presented in Table 2. The pulp contained significant ($p < 0.05$) amount of K, Mg and P compared to the seeds while the seeds had significant ($p < 0.05$) amount of Na, Ca and Fe. Cu and Zn were not significant ($p > 0.05$) different between the pulp and the seeds. The sample, by and large, contained low amount of mineral elements except for Ca which is found in high amount in both the seeds and the pulp; and Mg in pulp. This is an indication that the fruit is not a good source of other macroelements. The concentration of microelements was also low, but compared favourably when their recommended dietary allowances were considered.

To measure their significant contribution as source of minerals nutrients, their nutrient densities (ND) were evaluated and the result presented in Table 3. Food materials with nutrient density of 100% supply the nutrient needed in the same proportion as the caloric needs. Those with ND below 100% will not provide proportionate amount of the nutrients. Thus, based on this *A. squamosa* is good source of Ca, Mg (in pulp), Fe and Zn.

Table 1: Proximate composition of seeds and pulp of *Annona squamosa* (% DW)

Parameter	Seeds	Pulp
Moisture (% wet weigh)	42.51 ± 0.74^{b}	70.00 ± 1.05^{a}
Ash content	2.78 ± 0.02^{b}	7.47 ± 0.72^{a}
Crude lipid	44.00 ± 1.76^{a}	11.50 ± 1.15^{b}
Crude protein	4.43 ± 0.15	4.40 ± 0.59
Crude fibre	36.33 ± 1.17^{b}	46.30 ± 1.17^{a}
Available Carbohydrate	12.45 ± 2.76^{b}	30.33 ± 1.85^{a}
Energy value Kcal/100g	463.55 ± 4.50^{a}	242.42 ± 5.85^{b}

Values are mean ± Standard Error of mean of triplicate determinations DW = Dry Weight
Values with different superscript are significantly different at $p < 0.05$.

Table 2: Mineral composition in seeds and pulp of *Annona squamosa* (mg/100g DW).

Element	Seeds	Pulp
Potassium (K)	22.00 ± 0.58^{b}	45.00 ± 0.49^{a}
Sodium (Na)	30.00 ± 1.15^{a}	10.00 ± 1.06^{b}
Calcium (Ca)	650.00 ± 4.36^{a}	450.00 ± 1.73^{b}
Magnesium (Mg)	50.00 ± 1.53^{a}	400.00 ± 2.65^{a}
Phosphorus (P)	21.00 ± 0.05^{b}	26.88 ± 0.13^{a}
Copper (Cu)	0.03 ± 0.01	0.02 ± 0.00
Iron(Fe)	2.05 ± 0.02^{a}	1.70 ± 0.05^{b}
Zinc (Zn)	0.32 ± 0.01	0.30 ± 0.02

Values are mean ± Standard Error of mean of triplicate determinations
Values with different superscript are significantly different at $p < 0.05$.

Table 3: Nutrient density of Sugar apple

Minerals	RDA*	Seed	Pulp
K	2000	7	28
Na	500	39	25
Ca	1200	351	464
Mg	350	92	1414
P	800	17	42
Cu	1.5-3	6	8
Fe	10-15	88-133	140-210
Zn	2-5	41-104	74-186

***Source:** NRC (1989).

CONCLUSION

In conclusion, the above analytical data revealed that the pulp of *A. squamose* is potentially good source of carbohydrate and fibre while the seeds could be a good source of lipids. The fruit is generally low in minerals except Ca and Mg. However, further research should be carried out to study the nutrients' bioavailability. Also there is a need to evaluate the physicochemical properties of the oil in order to ascertain its edible and industrial purpose.

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