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Nutritional and Antinutritional Composition of *Sclerocarya birrea* Fruit Juice

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ABSTRACT: The juice of *Sclerocarya birrea* fruit was evaluated for its nutritional and antinutritional compositions. The results show that the total solid, ash, crude protein, crude lipid, available carbohydrate and energy value are 12.32g/100cm^3, 5.05%, 3.31%, 1.30%, 90.35% and 386.34kcal/100g dry weight respectively. The results of minerals content indicate that, the juice is a good source of both macro and micro elements with calcium as predominant. The 100 cm^3 juice contained reasonable amount of pectin (2.10g), vitamin C (0.49g), glucose (0.21g) and sucrose (0.76g). Concentrations of hydrocyanic acid, nitrate, oxalate, and phytate are lower than the reference toxic standard level. The juice of the plant could have a potential nutritional uses.
Keywords: Nutritional, antinutritional, *Sclerocarya birrea*, fruit, Juice.

INTRODUCTION

Beside fresh fruits, one of the most common fruits products is fruit juice. Juice is a naturally unfermented or fermentable liquid product obtained from the edible part of one or more sound fruits and preserved exclusively by physical means (FAO, 1997). Most juices are free from skin, seed, and other coarse part of the fruit, it may be clear, turbid or pulpy, and also it may be concentrated or reconstituted with water. Fruit juice is a popular choice of beverage and the fruit juice market is one that has grown substantially over recent years. Recent research indicates that the market for fruit juice and juice drinks increased by 43% from 1999 to 2009 (Caswell, 2009). Its rise in popularity may be due to an increased in interest in health and nutrition among consumers and also due to the fact that the ever expanding fruit juice market now provides a range of different juice varieties catering for all tastes and needs (Caswell, 2009).

Considering the market prospect of fruit juice worldwide, research in finding out new fruits from the wild is desirable due to the fact that most of the fruits currently used are the conventional type. Africa and Nigeria in particular is blessed with abundant fruits bearing tress which could be utilised in this respect. Among them is *Sclerocarya birrea* commonly known as "*Nunu*" or "*Loda*" or "*Daniya*" among the Hausa speaking community of West Africa (Glew *et al.*, 2004). Details of botanical profiled of the tree is given by Kokwaro and Gillet (1980); Kokwaro (1986); FAO (1988) and Palgrave (1988). The mature fruits (3-3.5cm in diameter) of *Sclerocarya birrea* are green but change to yellow ripens. The fruit contain a large stone and a white clinging flesh from which the juice can be extracted. Plate 1show the ripe fruits of *Sclerocarya birrea*.

Nutritional information about the plant in this region (North-West) is scarce and efforts are needed in order to preserve this plant as well as to use it as an agent to recover perturbed ecosystems. Furthermore, the research aimed to determine the nutritional and antinutritional composition of *S. birrea* fruit juice in order to establish it as a potential raw material in making fruit juice.

MATERIALS AND METHODS

Sampling and sample treatment

One kilogramme (1 kg) of matured and ripe *Sclerocarya birrea* fruits were collected in June, 2009 from More, Kware local government area of Sokoto State, Nigeria. Five trees were randomly selected and the fruits collected from different branches of the selected tree, as described in the method of Hassan and Umar (2004). Representative sample was taken using alternate shovel method (Alan, 1996). The representative sample was thoroughly washed with distilled water and the residual moisture evaporated at room temperature. The juice was manually squeezed and subjected to the nutritional analyses.

Plate 1: Ripe fruits of *Sclerocarya birrea*

Proximate analysis: Standard methods of AOAC (1990) were used for the proximate analysis. Total solid (TS) was determined by evaporating 100cm^3 of the juice in an oven at 105^{0}C to a constant weight for 24 hrs. The ash content was determined by the incineration of 2g dried sample in a muffle furnace at 55^{0}C for 2 hrs. Crude lipid (CL) was Soxhlet extracted from 2g dried sample with n-hexane for 8 hrs. The nitrogen (N) content was estimated by micro-Kjeldahl method and crude protein (CP) content calculated as N% x 6.25. Crude fibre (CF) content was determined by treating 2g dried 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:

$$CV(kcal/100g) = (CHO \times 4) \times (CL \times 9) \times (CP \times 4)$$

(Hassan *et al*., 2008)

Minerals analysis: Mineral analysis was carried out after sample digestion of 1g of the dried sample with 12 cm^3 mixture of nitric/perchloric/sulphuric acids in the ratio of 9:2:1 respectively. Ca, Mg, Fe, Co, Mn, Cr, Ni, Cu and Zn were determined by atomic absorption spectrophotometry, Na and K by atomic emission spectrometry (AOAC, 1990), and P by the molybdenum blue colorimetric method (James, 1995).

Glucose, Sucrose, Pectin and Vitamin C and pH analysis: The method of Chopra and Kanwar (1991) was used for determination of glucose and sucrose. The method of Izuagie and Izuagie (2007) was used for determination of vitamin C, while pH and pectin were determined using the method of Belitz and Grosch (2004).

Antinutritional analysis: The method of Ola and Oboh (2000) was adopted for determination of phytate. Hydrocyanic acid was determined by the AOAC (1990) method. Oxalate and nitrate were determined by the methods of Krishna and Ranjhan (1980). For determination of tannins the method of van-Burden and Robinson (1981) was employed.

Statistical Analysis: Data generated in triplicates were expressed as mean ± standard deviation using SPSS version 10 statistical packages.

RESULTS AND DISCUSSION

Proximate composition: The result of proximate analysis is presented in Table 1. The fruit juice had total soluble solids (TS) of 12.3g/100cm^3, which is higher than

3.0g/100cm^3 reported in the juice of *S. birrea* fruit and 3.4g/100cm^3 in the juice of shea nut fruit (Steven *et al.*, 2004). The juice also had low total solid content when compared with some fruit juices such as 15g/100cm^3 reported in mango (Steven *et al.*, 2004), 21.40g/100cm^3 in *Uapaca kirkiana*, and 14.30g/100cm^3 in *Adansonia digitata* (John *et al.*, 2007). The TS in fruits juice is an index of sugar content (Steven *et al.*, 2004), thus juice is an important source of soluble sugars.

The ash content of the juice was relatively low (5.05% DW) than that of mango fruit juice (8.5% DW) but higher than 1.6% dry weight reported in apple fruit juice (Steven *et al.*, 2004). This is an indication that the juice of *S. birrea* fruit contains nutritionally important mineral elements.

The juice crude protein content was low (3.31% DW) but within the range of 2.4-10.30% (DW) reported in shea fruit juice (Steven *et al.*, 2004). Low protein content is a general characteristic of fruit juice. Like CP, the CL ontent was low (1.30% DW) which is much higher than 0.1% reported in orange fruit juice (Al-jedah and Robinson, 2002). Thus, the fruit juice can only contribute about 11.7 kcal/100g (DW), which is low below the daily limit of 30 calories and higher value may cause obesity (Hassan *et al.*, 2008).

Crude fibre was not detected in the juice and this is in agreement with the findings of Al-jedah and Robinson (2002) and Steven *et al.* (2004) on orange, shea and mango fruit juices. *S. birrea* fruit juice have high CHO content (90.35% DW). The value was higher than 8.5% and 37.5% DW reported for orange and mango fruit juice respectively (Al-jedah and Robinson, 2002); Jadele *et al.*, 2003). High CHO content justify the energy providing ability of fruit juice. The calculated CV of the juice was 386.34kcal/100g DW which is lower than 1274 kcal/100g DW for baobab fruit pulp (Chadare *et al.* 2009) and 1378 kcal/100g DW for Zizyphus *sonorensis* fruit pulp (Marcelino *et al.*, 2005).

Minerals composition: The minerals profile of the juice is reported per 100cm^3 juice content and result presented in Table 2. Calcium was the most abundant (51.73mg) element followed by potassium (44.54mg) and then magnesium (24.53mg). The calcium content is higher when compared with that of shea (35mg) and mango (10mg) (Steven *et al.*, 2004). The contents of sodium and iron were 14.88mg and 8.83mg and were higher than respective values reported in mango juice (20.32mg and 6.10mg) (Steven *et al.*, 2004). The juice also contains a reasonable amount of copper (1.07mg), manganese (6.60mg), nickel (0.21mg), zinc (2.96mg) and chromium (0.19mg). This is an indication that, the juice could supplement the body with both macro and microelements.

Table 1: Proximate compositions of *Sclerocarya birrea* fruit juice.

Parameter	Concentration (g/100g DW)
Total solid*	12.32±1.02
Ash	5.05±0.61
Crude Protein	3.31±0.10
Crude Lipid	1.30±0.15
Crude Fibre	ND
CHO	90.35±0.77
CV (kcal/100g)	386.34±1.90

* g/100cm^3 wet weight DW = Dry weight
ND = Not detected CV =Calorific value
CHO = Available Carbohydrate

Table 2: Minerals compositions of *Sclerocarya birrea* fruit juice.

Element	Concentration (mg/100cm^3)
Na	14.88±6.00
K	44.54±0.41
P	0.18±0.02
Ca	51.73±6.0
Mg	24.53±2.06
Cu	1.07±0.10
Mn	6.60±4.10
Co	0.09±0.01
Cd	0.01±0.00
Ni	0.21±0.10
Fe	8.83±0.15
Cr	0.19±0.10
Pb	0.04±0.02
Zn	2.96±1.0

Pectin, glucose, sucrose and vitamin C content: The content of pectin, glucose, sucrose, vitamin C and pH of the juice were presented in Table 3. The pectin content of the juice was 2.10g/100cm^3 (17.0g/100g dry weight). The value was higher than 1.5g/100cm^3 in apple fruit juice, 1.4g/100cm^3 in carrots fruit juice, lower than 4.0g/100cm^3 in citrus fruit juice and is within the range of 0.5-3.5g/100cm^3 in orange fruit juice as reported by Belitz and Grosch (2004). The high pectin content of the juice could be the reason for its thickness, which makes it to stay for long with out drying out. Pectin is not digestible but is considered a beneficial dietary fibre (Willats *et al.*, 2006).

The respective glucose and sucrose content of the juice are 0.21g/100cm^3 (1.70g/100g DW) and 0.76g/100cm^3 (6.16g/100g DW). The concentration of glucose was low when compared with 4.1g/100g DW in *Uapaca kirkiana* fruit juice but that of sucrose was higher than 1.5g/100g DW for *Uapaca kirkiana* fruit juice as reported by Leakey (1999). The sweetness of the juice could be attributed to the glucose and sucrose content, which are important macronutrient that provides quick source of energy to the body (Gailliot *et al.*, 2007).

The vitamin C content of the juice was 0.49g/100cm^3 (3.97g/100g DW). The value recorded was lower than 27.70mg/100g DW in mango juice, 44.10g/100g dry weight in apple fruit juice and 41.82g/100g DW in pine apple fruit juice reported by (Marcelino *et al*., 2005). The value recorded indicates that, the juice is a good source of vitamin C which is essential for collagen formation, and aids iron to stay in reduced state (Banerja, 1976).

The pH of the juice was 4.30. This indicated lower acidic value when compared with 3.58 for *Mangifera indica* fruit juce reported by John *et al.* (2007). The result obtained indicates the acidic nature of the juice which could be due to the presence of organic acids in the juice (Grivetti, 1981).

Table 3: pH , pectin, glucose, sucrose and vitamin C content of the juice (g/100cm^3).

pH	Pectin	Glucose	Sucrose	Vitamin C
4.30 ± 0.20	2.10 ± 0.10	0.21 ± 0.01	0.76 ± 0.21	0.49 ± 0.13

Antinutritional composition: The result of antinutritional factors was presented in Table 4. The phytate content of the juice was 42.80mg/100cm^3 (346.68mg/100g DW). The value is higher compared to 2.88mg/100g DW in Banana fruit juice, 4.08mg/100g DW in Apple fruit juice as reported by Onibon *et al.* (2007). Phytate chelates with mineral elements and protein in monogastic animals and render them not bioavailable (Fergusin *et al*., 1993).

The juice has high tannin content of 338.80mg/100cm^3 (2,744.28mg/100g DW). The value was higher compared to 3.40mg/100g DW for Banana fruit juice, 8.5mg/100g DW for Apple fruit juice reported by Onibon *et al.* (2007). The astringent flavour of the juice could be associated with the high tannin content; tannin in the biological system have the ability to chelate protein making it impossible or difficult to digest (Alerto, 1993).

Table 4: Antinutritional compositions of *Sclerocarya birrea* fruit juice (mg/100cm^3).

Phytates	Tannins	Oxalates	Cyanides	Nitrates
42.80 ± 0.96	338.80 ± 5.40	0.42 ± 0.20	0.79 ± 0.12	0.21 ± 0.11

The total oxalate content of the juice was 0.42mg/100cm^3 (3.40mg/100g DW). The value was relatively lower than 4.50mg/100g DW for Banana fruit juice, but higher than 3.15mg/100 DWs for Apple fruit juice (Onibon *et al*., 2007). Presence of oxalate in food causes irritation in the mouth and interfere with absorption of divalent minerals particularly calcium by forming insoluble salt with them (Hassan and Umar, 2004). Consumption of oxalates may results in kidney disease (Onibon *et al*., 2007).

The amount of hydrocyanic acid of the juice was 0.79mg/100cm^3 (6.40mg/100g DW). This value was relatively higher than 4.9mg/100g DW in banana fruit juice (Onibon *et al*., 2007). The concentration of hydrocyanic acid in the juice is within the permissible level of 200mg

HCN/100g for human consumption (Umar, 2005).

The nitrate content of the juice 0.21mg/100cm^3 (1.70mg/100g) was high compared to 0.13mg/100g DW for apples fruit juice but lower than 5.87mg/100g DW for straw berries fruit juice reported by Nabrzysky and Gajewska (2009).

To predict the bioavailability of some divalent elements especially calcium, iron and zinc, antinutrients ratios were calculated. From the result (Table 5), it was observed that [oxalate]/[Ca], [oxalate]/[Ca+Mg] ratio are below the critical level known to impair calcium bioavailability (Umar, 2005). Similarly, [Ca] [phytate]/[Zn] and [phytate]/[Zn] ratios were below the critical level known to impaired zinc bioavailability (Umar, 2005). Also, [phytate]/[Ca] are also low compared to the critical value known to cause calcium deficiency by the phytate. Mitchikpe *et al.* (2008) reported that, for iron bioavailability, [phytate]/[Fe] should not exceed 0.4; the result obtained was slightly above the critical value which called for consumption of iron enhancers such as vitamin C and meat together with the juice.

Table 5: Antinutrients to Nutrients molar ratio of *Sclerocarya birrea* fruit juice

Antinutrients to Nutrients Ratio	Ratio	Critical level
[Oxalate]/[ca]	$4.69x10^{-3}$	2.5
[Oxalate]/[ca+ Mg]	0.18	2.5
[Ca][Phytate]/[Zn]	$1.49X10^{-2}$	0.5
[Phytate]/[Ca]	$4.95X10^{-2}$	0.2
[Phytate]/[Fe]	0.41	0.4
[Phytate]/[Zn]	1.42	10

Conclusion: The analytical results revealed that, the juice is potentially a good source of carbohydrate, vitamin C and some essential mineral elements especially calcium, magnesium and potassium which are found in high concentration. Due to its pectin content the juice could be use as a raw material in some beverage industries. The antinutrients to nutrients molar ratio indicate that the juice is safe for consumption.

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