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Nutritional and Anti-nutritional Composition of *Strychnos innocua* Del. (Monkey Orange) Fruit Pulp Grown in Zuru, Nigeria

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ABSTRACT: The *Strychnos innocua* (Monkey Orange) fruits pulp were analysed to establish its proximate, minerals, anti-nutritional and ascorbic acid compositions using standard analytical methods. The pulp, on dry weight basis (DW), contains crude protein (3.97%), crude lipid (20.0%), ash (0. 05%), available carbohydrates (75.53%), calorific value (498.0kcal/100g) and moisture (60.17%Wet Weight). The pulp is rich in, potassium (256.33mg/100g), magnesium (10.67mg/100g), iron (9.77mg/100g), zinc (28.73 mg/100g) and manganese (2.50mg/100g). The pulp contains appreciable concentration of ascorbic acid (17.97 91mg/100g DW). But the pulp also has high content of total oxalate (48.75 % DW) and phytic acid (242.91mg/100g). The levels of various nutrient and mineral elements varied significantly, which indicates the potential of the pulp to be harnessed for diverse application for value addition as health food provided that the anti-nutritional factors are tackled appropriately.
Keywords: *Strychnos innocua,* Fruits, Nutrition, Antinutritional factors, Minerals, Proximate composition

INTRODUCTION

Fruits are important sources of minerals, fibre and vitamins, which provide essential nutrients to the human body. But it is known that some fruits have so-called antinutritional factors (e.g. phytic acid and tannins) that diminish nutrient bioavailability, especially if they are present at high levels (Aberoumand, 2011). In most developing nations, numerous types of edible wild plants are exploited as sources of food to provide supplementary nutrition to the inhabitants (Vunchi *et al*., 2011).

Strychnos. innocua Del. (Monkey orange), belongs to the family Loganiaceae, a genus of *Strychnos,* commonly called '*Kokiyar Biri*' in Hausa. It is a small, straight-stemmed tree 3-14 m height, with a smooth, green or yellowish-white, powdery bark. Leaves are simple, alternate, leathery and elliptic in appearance. It flowers are greenish-white or yellowish and up to 8 mm long (Hutchinson, 1973; Orwa *et al*., 2009). Fruits are globose up to 6-10 cm in diameter, with a hard rind, bluish-green when young, yellowish or orange when ripe, with a thick woody shell, containing many seeds embedded in a yellowish pulp. Seeds are yellowish-white, tetrahedral, stony hard, 1.5–1.8 cm in diameter (Hutchinson, 1973; Orwa *et al*., 2009).

S. innocua tree occurs in savannah forests all over tropical Africa, in open woodland and rocky hills. The tree is found in Angola, Cameroon, Ethiopia, Ghana, Kenya, Nigeria, Senegal, Tanzania and Zimbabwe (Orwa *et al*., 2009).

Information on the nutritional contents of *S. innocua* fruit is not well known to the people eating it in the northern part of Nigeria. The aim of this work was to evaluate the nutritional and antinutritional compositions of *S. innocua* fruit pulp with hope the information would be of use to those concerned with plant food for human nutrition.

MATERIALS AND METHODS

Samples Collection and Preparation

The matured fruits of *S. innocua* were randomly collected from different branches of ten trees from various locations in Zuru, Kebbi State, Nigeria. The fruit was authenticated at the Herbarium of the Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto, Nigeria.

At the laboratory, the fruits were broken with a knife and the content oven dried at 70^{o}C for 24 h. The seeds were removed from the dried pulp manually by picking with hand. The pulp was pulverised to powder using pestle and mortar. The powdered sample was used for the analyses, other than moisture content for which fresh samples were used.

Proximate Analysis

The recommended methods of the Association of Official Analytical Chemists, AOAC (1990) were used for the determinations of moisture, ash, crude lipid, crude fibre and crude protein content. Available carbohydrate was estimated (by difference) using method described by James (1995). Calorific value (in kcal/100g) was estimated by multiplying the percentages of crude protein, crude lipid and available carbohydrate by factors of 4, 9 and 4 respectively and the product summed up (James, 1995). Vitamin C (ascorbic acid) was determined by titration with 2,6-dichloro-phenolindophenol dye as described by James (1995).

Mineral Analysis

Sample Digestion

The sample (0.5 g each) was put into Kjeldahl digestion flask to which 24cm^3 of a mixture of concentrated nitric acid (HNO_3), conc. H_2SO_4 and 60% $HClO_4$ (9:2:1v/v) was added. The flask was allowed to stand over-night to prevent excess foaming (Sahrawat *et al*., 2002). The flask was put on a heating block and digested to a clear solution, cooled and the content filtered into a 50 cm^3 volumetric flask. The solution was then diluted to the volume with distilled water. Blank solution was prepared in similar manner without sample being added. The solution was used for the mineral analysis.

The mineral contents (calcium, magnesium, iron, zinc, copper, manganese, lead, chromium, cobalt and cadmium) were analysed using AAS. Sodium and potassium were analysed using atomic emission spectrometry and phosphorus was determined by colorimetry using Vanadomolybdate (blue) method (AOAC, 1990).

Anti-Nutritional Analysis

The method reported by Krishna and Ranjhan (1980) was used for the determination of total oxalates. The method described by IITA (1988) was adopted in the determination of nitrate. The method reported by Ola and Obah (2000) was used for the determination of phytate. Hydrogen cyanide (HCN) was determined using AOAC, 1990 method. The method described by El-Olemy *et al*. (1994) was used for the determination of saponin content.

Statistical Analysis

Data generated in triplicates were expressed as mean ± standard deviation using SPSS version 16 statistical packages.

RESULTS AND DISCUSSION

The results of the proximate composition and vitamin C content of *S. innocua* fruit pulp investigated are shown in Table 1. The moisture content of the pulp is 60.17±0.62%. The value reported is low compared to 90.96g/100g and 71.50±2.10% for *S. Innocua* and *Mordii whytii* pulp (Bello *et al*., 2008; Adepoju, 2009) respectively. The moisture content of *S. innocua* fruit pulp is within the range of moisture content for fruits and vegetables (Adepoju, 2009). High moisture content results in low shelf life during storage (Hassan *et al.,* 2008).

Table 1: Proximate Compositions and Vitamin C content of *S. innocua* fruit pulp (g/100g) dry weight (DW).

Parameter	Pulp
Moisture*	60.17 ± 0.62
Ash	0.50 ± 0.01
Crude Protein	3.97 ± 0.11
Crude Lipid	20.00 ± 0.50
Crude Fibre	Trace
Available Carbohydrate	75.53 ±0.37
Calorific Value (kcal/100g)	498.00 ±2.50
Vitamin C (mg/100g wet weight)	17.97 ±0.09

The data are Mean± standard deviation of three replicates
* Wet weight

The ash content is 0.50% which is less than 4.65±0.33g/100g for *S. innocua* juice (Bello *et al*., 2008) or 11.50±1.10% DW for *Vitex doniana* fruit pulp (Vunchi *et al*., 2011). The ash content is an index of mineral content (Aberoumand and Deokule, 2009). This shows that, *S. innocua* fruit pulp contains low levels of minerals.

Protein deficiency may cause growth retardation, muscle wasting, abnormal swelling of the belly and collection of fluids in the body (Zarkada *et al*., 1997). The crude protein content of 3.97 ± 0.11% DW found in the pulp of monkey orange (*S. innocua)* fruit pulp can be compared to 4.65 ± 0.33% for *S. innocua* juice and 4.00 ± 0.10% for *P. biglobosa* pulp reported by Bello *et al*. (2008). Protein is an important source of amino acids and is required for body development and maintenance (Pugalenthi *et al*., 2004).

The crude lipid content of *S. innocua* pulp is 20.00 ± 0.50% which is higher than 0.78±0.08% and 4.7±0.50% for *S. innocua* juice and *Momordica dioica* fruit (Bello *et al*., 2008; Aberoumand, 2010) respectively. However, since the fruit is high in crude lipid, it could be a good source of edible vegetable oil if well harnessed, and could complement the conventional sources. Lipids provide the body with more energy; approximately twice that of protein and carbohydrate and facilitate intestinal absorption and transportation of fat soluble vitamins (Dreon *et al*., 1990).

The crude fibre content for the pulp is trace. It was reported that fibre in the diet reduces serum cholesterol level (Abolaji, 2007) and if in very high amount absorbs essential trace elements in the gut (Abolaji, 2007).

The available carbohydrate content of the pulp is 75.53 ± 0.37% DW, hence is comparable to 68.75 ± 0.89% reported for *Parkia biglobosa* pulp (Bello *et al*., 2008) and 79.00±0.01%DW for *Dialium guineense* pulp (Adepoju, 2009). The calorific value of *S. Innocua* pulp is 498.00±2.50Kcal/100gDW, which is an indication that it could be an important source of dietary calories.

The vitamin C content (17.97 ± 0.09 mg/100g DW) is higher than 10.83 ± 0.25 mg/100g DW reported by Sood *et al*. (2010) for *Kasmal* fruit and 10mg/100g DW for *Diospyros mespiliformis* (Hassan *et al*., 2004); but lower (30.48 mg/100g) than that reported for mango-olomi pulp (Ngi and Onajobi, 2002). The Recommended Dietary Allowance (RDA) of vitamin C is 60 mg/day for a male adult (Ganong, 2003). Thus, *S. innocua* pulp can satisfy the daily vitamin C requirement.

Table 2 presents the mineral composition of *S. innocua* fruit pulp. The fruit pulp is rich in potassium, sodium, manganese, iron, copper and zinc and calcium. It was reported that, plant based foods are usually high in potassium (Hassan *et al*., 2008). High amount of potassium in the body increases iron utilization (Adeyeye, 2002). Potassium is essential in the maintenance of cellular water balance, pH regulation in the body and it is also associated with protein and carbohydrate metabolism (Onibon *et al*., 2007). Calcium is very essential in blood clotting, muscle contraction and for the activity of certain enzymes metabolic processes (Atasie *et al*., 2009). Manganese is desirable in the body as it supports the immune system, regulates blood sugar levels and is involved in the production of energy and cell and works with vitamin K to support blood clotting, and also helps to mitigate the effect of stress (Anhawange, 2004). Birth defects can possibly result when a mother does not get enough of this important element (Anhawange, 2004; Abitogun *et al*., 2010) hence the pulp could be a good source of manganese. Iron is an important element in the diet of pregnant women, nursing mothers and infants to prevent aneaemia (Oluyemi *et al.,* 2006). The iron content indicates that, the fruits could be a good source of iron. Deficiency of copper causes cardiovascular disorders as well as anaemia and disorders of the bone and nervous systems (Mielcarz *et al*., 1997). Cobalt is an essential trace element by virture of its function as component of vitamin B_{12} (cyanocobaltamin). This indicates that *S. innocua* fruit could be a source of vitamin B_{12}. Abolaji *et al*., (2007) reported that, lead is a highly toxic mineral element even at low concentration, for that consumption of the fruit should be with caution. Chromium in trivalent state is an essential trace element that potentiates insulin action and influences carbohydrate, lipid and protein metabolism (Duran *et al*., 2007). The maximum acceptable concentration of cadmium in plant food is 0.8 mg/100g (WHO, 1996). It is a non-essential toxic element and interferes with the metabolism of some metals such as calcium, zinc and iron

Table 2: Minerals Composition of *S. innocua* fruit pulp (mg/100g DW)

Mineral	Pulp
K	256.33 ± 12.47
Na	153.33 ± 12.47
Ca	6.67 ± 0.47
Mg	10.67 ± 0.47
P	2.60 ± 0.01
Fe	9.77 ± 0.05
Zn	28.73 ± 0.06
Mn	2.50 ± 0.01
Cu	2.37 ± 0.09
Cr	0.60 ± 0.01
Co	1.20 ± 0.01
Cd	1.63 ± 0.05
Pb	0.50 ± 0.01

The data are Mean ± standard deviation of three replicates.

Table 3 shows the antinutritional factors present in the pulp. The fruit pulp was very low in antinutritional factors such as cyanogenic glycoside (hydrocyanic acid), nitrate and saponin, which are below the established toxic level. However, it is known that high content of these antinutrients exert negative effects on the bioavailability of some mineral nutrient (Agbaire, and Emoyan, 2012). Therefore, the consumption of the pulp cannot be considered safe since the toxicity level is yet to be established.

Table 3: Antinutritional Composition of *S. innocua* fruit pulp (mg/100g DW)

Ant-nutritional Factor	Pulp
Cyanogenic glycoside	0.08 ± 0.00
Nitrate	0.56 ± 0.03
Oxalate	48.75 ± 5.30
Phytate	242.91 ± 8.62
Saponin	2.60 ± 0.35

The data are Mean ± standard deviation of three replicates.

Table 4 shows the anti-nutrients to nutrients molar ratio. To predict the effect of oxalate on the bioavailability of Ca and Mg, the oxalate to nutrients ratios were calculated. The calculated molar ratios of [oxalate]/[Ca] is above the critical level of 2.5 and the value for [oxalate]/[Ca + Mg] is lower than the critical level. This indicates poor bioavailability of Ca due to oxalate. To predict the effect of phytate on the bioavailability of Ca, Fe, and Zn, phytate to nutrients ratios were calculated. The calculated molar ratios of [Ca] [Phytate] / [Zn] and [Phytate] / [Zn] are below the critical level of 0.5, and 10 respectively (Hassan *et al*., 2011), but the calculated molar ratios of [Phytate] / [Ca] and [Phytate] / [Fe] are above the molar ratios of 0.2 and 0.4 respectively and this indicate poor bioavailability of calcium and iron (Hassan *et al*., 2008).

Table 4: Anti-nutrients to Nutrients Molar Ratios

Molar Ratio	Value	Critical level*
[Oxalate]/[Ca]	3.24	2.5
[Oxalate /[Ca + Mg]	8.86×10^{-5}	2.5
[Ca] [Phytate]/[Zn]	1.39×10^{-4}	0.5
[Phytate]/[Ca]	2.20	0.2
[Phytate]/[Fe]	2.11	0.4
[Phytate]/[Zn]	0.83	10

***source:** Hassan *et al*., 2008; Hassan *et al*., 2011

CONCLUSION

The *S. innocua* fruit pulp can be considered a good source of lipid, carbohydrates and mineral elements such as potassium, sodium, magnesium, zinc and calcium and is also rich in vitamin C (ascorbate). But the fruit also contains substances that may be harmful to health when ingested in high quantity. The non-essential substances are low indicating that little processing is needed before they are consumed.

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