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Research Article

Comparative Assessment of Chemical Composition and Anti-Nutrient Components of Solenostemon Rotundifolius Tuber Pulp and Peel

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Abstract

This research work compared chemical composition and anti-nutritional components of *Solenostemon rotundifolius* tubers pulp and peel. The proximate analysis revealed that peels of *S. rotundifolius* have high crude protein, lipid and fiber whereas the pulps show high carbohydrates and energy content. The mineral elements in mg/100g for the peel and pulp were magnesium (811.52 ± 0.34 and 816.96 ± 0.58), calcium (716.59 ± 0.77 and 723.83 ± 0.24), potassium (73.33 ± 2.36 and 101.67 ± 6.24) and iron (10.83 ± 0.67 and 15.20 ± 0.51) respectively. The values of anti-nutritional properties analyzed for both the peels and the pulps were quite suitable and within the safe limit for consumption. Therefore, the results obtained from the analysis indicate that the peel and pulp may be a good raw material for nutritional and other industrial applications.

Keywords: Chemical, Composition, Anti-Nutritional, Solenostemon Rotundifolius.

INTRODUCTION

Over one billion people throughout the world are believed to make part of their entire livelihood from utilization of wild food. In Africa, studies indicate that a vast number of indigenous wild plants exist and play a significant role in the diet of the populace (Muhammad et al. 2011). Nigeria has abundant edible vegetables growing wild, which if properly utilized could supplement conventional food items, this calls for the need to search for more edible wild plants in Nigeria with the hope of using them to ease malnutrition problems (Abdulmumin et al., 2017). In Nigeria, wild fruits are consumed by both rural and urban dwellers especially during the dry season when most cultivated fruits are out of season. Some of these wild fruits have higher nutritional values compared with levels found in cultivated fruits (Muhammad et al. 2011).

Solenostentemon rotundifolius or Plectranthus rotundifolius (Spreng/Tumuku), commonly known as native or country potato in Africa and called Chinese potato in India is a perennial herbaceous plant of the mint family (Lamiaceae) and native to tropical Africa. It is cultivated for its edible tubers primarily in West Africa and more recently in parts of Asia, especially in India, Sri Lanka, Malaysia and Indonesia. P. rotundifolius is closely related to the coleus plant and as such, it is also called coleus potato which is widely cultivated as ornamentals. It is often classified as a member of the genus Solenostentemon rather than Plectranthus. It was formally placed in the now-defunct genus coleus specie most of whose members have now been reassigned to the genus Solenostentemon family (NRC, 2006).

S. rotundifolius is an erect, semi-succulent annual herb. It is bushy from the base up to 30cm in height, has a succulent stem and thick leaves. The flowers are blue pinkish white or pale violet in a distal inflorescence. The plant is highly tolerant of drought as well as rainfall (Priya and Anbuselvi, 2013). It grows well in loose or sandy soil and in direct sunlight. The tubers are harvested at about four to five months of planting, after the flowering and aerial parts of the plant have died. Tubers of S. rotundifolius can be used as edible potatoes in Tamil Nadu. This tuber is oval-shaped and smaller than commercial potatoes. They are usually cooked by baking and frying. The taste of potato is fairly blander than sweet potato (Manikandan et al., 2016) The nutritional composition of S. rotundifolius tuber has not been investigated despite its consumption by the rural people where it is cultivated. Therefore, this research work is to investigate the mineral and anti-nutritional composition of S. rotundifolius tuber.

MATERIALS AND METHODS

Sample Collection and Identification

Matured tubers of S. rotundifolius were obtained from different plants of various locations in Zuru Local Government area of Kebbi State in Nigeria. The fresh tuber samples were authenticated at the Herbarium of the Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto, Nigeria with voucher No. UDUSH/ANS/0235.

Sample Treatment

The sample tubers were washed with distilled water to avoid surface contamination (Ahmed and Birnin Yauri, 2008). The pulp and peel were separated manually using mechanical filler. The sample was dried at room temperature for three (3) weeks and crushed into fine powder mechanically using a blender. It was then sieved through 20mm–mesh and stored in room condition in an air tight plastic container for analysis.

Proximate Analysis

Recommended methods of the Association of Official Analytical Chemists, (AOAC 2005) were used for determination of moisture, ash, crude lipid, crude fiber and crude protein content. Available carbohydrate was estimated (by difference) and 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. The product was summed up using the method adopted by James, (1995). All analysis were carried out in triplicate.

Mineral Analysis

Samples of 0.5 g each of the pulp and peel were put into Kjeldahl digestion flask to which 24cm3 of a mixture of concentrated nitric acid (HNO3), concentrated sulphuric acid (H2SO4) and 60% perchloric acid (HClO4) (9:2:1v/v) were added. The flasks were allowed to stand over-night to prevent excess foaming. The flasks were put on a heating block and digested to a clear solution. They were then cooled and the contents filtered into 50 cm3 volumetric flasks. The solutions were then diluted to the volume with distilled water. A blank solution was prepared in a similar manner without the samples 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 determined using AAS. Sodium and potassium were determined using atomic emission spectrometry and phosphorus was determined by colorimetry using Vanadium molybdate (blue) method (Hassan et. al., 2014).

Anti-nutritional Analysis

The method reported by Bradbury et al., (1991) was used for the determination of total oxalates. The method described by IITA (1988) was adopted in the determination of nitrates. The method reported by Ola and Obah (2000) was used for the determination of phytate. Hydrogen cyanide (HCN) was determined using AOAC (2005) method. Tannins were determined using spectrometer.

Statistical Analysis

Data generated in triplicates were expressed using T-test.

Proximate Analysis

The results of the proximate composition of S. rotundifolius tuber (pulp and peel) are represented in Table1. The moisture content of S. rotundifolius is high when compared with the value of 62.58±0.42 as reported for sweet potato (Ingabire and Hilda, 2011). High moisture content results in low shell life during storage (Hassan et al. 2014).

The ash content of the pulp is low when compared with the peel of 1.33 ± 0.24 and 5.17 ± 0.24 respectively. That gives insight that the peel contains some nutritionally important minerals than the pulp. The ash content of the pulp, is however, higher than 0.87±0.06 and 1.00 ± 0.05 as reported for cassava pulp and peel respectively (Somendrika et. al., 2017). The low ash content indicates that the fruits may possess low concentration of mineral elements which are expected to speed up metabolic processes, and improve growth and development (Hassan et al., 2011). The crude lipid content for the pulp is 0.50 ± 0.00 % which is lower compared with that of the peel 2.67 ± 0.24 %. This indicates that, the tuber can be recommended as a weight reducing diet since low fat foods reduce the level of cholesterol and obesity (Muhammad et. al., 2011).

The protein content for pulp and peel are 2.22 ± 0.12 and 2.77 ± 0.08 respectively. The results of this research are high in comparison with 0.71 ± 0.03 and 0.80 ± 0.02 as reported for sweet potatoes by Ingabire and Hilda (2011). Protein

Table 1: Proximate Compositions of S. *rotundifolius* Tuber (%).

Parameter	Pulp	Peel
Moisture (% wet weight)	78.17 ± 0.63	75.50 ± 0.82
Ash	1.33 ± 0.24	5.17 ± 0.24
Crude Protein	2.22 ± 0.12	2.77 ± 0.08
Crude Lipid	0.50 ± 0.00	2.67 ± 0.24
Crude Fibre	0.50 ± 0.00	1.83 ± 0.24
Available Carbohydrate	95.45 ± 0.33	87.56 ± 0.56
Calorific Value (kcal/100g)	395.18±2.03	385.35±1.01

The data are mean ± standard deviation of three replicate determinations.

is an important source of amino acids and an essential component of diet which is required for body development and maintenance (Hassan et. al., 2014, Pugalenthi, 2004). Deficiency of protein may cause growth retardation, muscles wasting, abnormal swelling of the belly and collection of fluids in the body (Zarkada et. al., 1997).

The fibre content for the peel of S. rotundifolius tuber 1.83 ± 0.24 is high in comparison with value of 1.10 ± 0.00 as reported by Enyiukwu et al., (2014), and higher than the value for S. rotundifolius pulp 0.50 ± 0.00. It was reported that fibre in diet reduces serum cholesterol levels and if in very high amounts absorb essential trace elements in the gut (Hassan et. al., 2014). Available carbohydrate content of the pulp and peel are 95.45 ± 0.33 and 87.56 ± 0.56 respectively. The value reported for the pulp is higher when compared with 89.45±0.64 reported for Gardenia Aqualab pulp (Muhammad et. al., 2011). The major function of carbohydrates is to provide the body with energy (Abdulmumin et. al., 2017). The calorific values for both pulp and peel of 395.18±2.03 and 385.35±1.01 respectively is an appreciable amount. This is an indication that it could be an important source of dietary calories.

Mineral Analysis

The mineral composition of S. rotundifolius tuber are presented in Table 2. The mineral elements determined were Ca, Mg, Na, K, P, Cu, Fe, Zn, Mn, Cr and Cd. High potassium values were observed for both peel (101.67 ± 6.24 mg/kg) and pulp (73.33 ± 2.36mg/kg) The potassium content for the peel is higher than that of the pulp. The potassium content of the peel is favorably comparable with 98.51 as reported for cassava peels from Otukpo (Otache et. al., 2017). Potassium is essential in the maintenance of cellular water balance, pH regulation in the body and is also associated with protein and carbohydrate metabolism (Onibon et. al., 2007; Hassan et. al., 2014). High amounts of potassium in the body is reported to increase iron utilization (Muhammad et. al., 2011). The Sodium content for the pulp and peel are reported as 4.33 ± 0.12 and 4.42 ± 0.12 respectively. The values obtained from this analysis are lower as compared with reported values of 14.04 mg/100g and 8.88 mg/100g respectively (Otache et. al., 2017). Calcium is very essential in blood clotting, muscle contraction and for the activity of certain enzymes in metabolic processes (Hassan et. al., 2014). Calcium content reported for the pulp (716.59 ± 0.77) is much higher when compared with 30.27 ± 0.30 as reported for Vitex doniana fruit Pulp (Vunchi et al., 2011). Magnesium and iron content in S. rotundifolius peel and pulp (811.52 ± 0.34 mg/kg, 816.96 ± 0.58 mg/kg respectively) and (15.20 ± 0.51 mg/kg, 10.83 ± 0.67 respectively) are quite high. Magnesium plays a major role in relaxing muscles along the air ways to the lungs which allows asthma patients to breathe easily (Muhammad et. al., 2011). The iron content reported for S. rotundifolius pulp and peel indicates that, the tuber could be a good source of iron. Iron is an important element in the diet of pregnant women, nursing mothers and infants to prevent anaemia (Oluyemi et. al., 2006; Hassan et. al., 2014). The manganese content reported for pulp and peel of S. rotundifolius tubers (10.83 ± 0.67 mg/100g and 5.34 ± 0.64 mg/100g) respectively. 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 (Abdulmumin et. al., 2017). Recommended dietary allowance for manganese is 2 – 5 mg/100g (Hassan et. al., 2006). The values reported are indications that S. rotundifolius could be a good source of manganese. Chromium in trivalent state is an essential trace element that

Table 2: Concentrations of Mineral Elements in S. *rotundifolius* Tuber (mg/100g dry weight).

Mineral Element	Pulp	Peel
Mg	811.52 ± 0.34	816.96 ± 0.58
Ca	716.59 ± 0.77	723.83 ± 0.24
K	73.33 ± 2.36	101.67 ± 6.24
Fe	10.83 ± 0.67	15.20 ± 0.51
Na	4.33 ± 0.12	4.42 ± 0.12
Zn	0.38 ± 0.03	0.52 ± 0.04
Cu	0.32 ± 0.06	0.59 ± 0.09
Mn	5.13 ± 0.36	5.34 ± 0.64
P	0.27 ± 0.00	0.44 ± 0.00
Cr	1.01 ± 0.01	1.24 ± 0.19
Cd	0.13 ± 0.03	0.15 ± 0.03

The data are mean ± standard deviation of three replicate determinations

Table 3: Anti–Nutritional Compositions of S. *rotundifolius* Tuber (mg/100g dry weight).

Anti-nutritional Factors	Pulp	Peel
Nitrate	147.62 ± 1.11	172.91 ± 0.42
Tannins	12.29 ± 0.11	33.27 ± 0.04
Cyanide	9.30 ± 1.27	64.08 ± 1.32
Phytate	2.68 ± 0.54	3.39 ± 0.34
Oxalate	Trace	Trace

The data are Mean ± standard deviation of three replicates

Figure 1: *Solenostentemon rotundifolius* plant.

Figure 2: *Solenostentemon rotundifolius* tubers.

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 which interferes with the metabolism of some metals like calcium, zinc and iron (Abdulmumin et. al., 2017).

Anti-nutritional Factors

Phytate, tannins, cyanide and nitrate for the peel are higher than that of the pulp, while both revealed trace of oxalate as shown in table 3. The anti-nutrient factor interferes with metabolic processes so that growth and bio availability of nutrients are negatively influenced. These factor stands as indices for judging the nutritional value of any given food substance (Binita and Khetarpual, 1997). The value obtained for phytate in peel and pulp were found to be 3.39 ± 0.34 mg/100g and 2.68 ± 0.54 mg/100g respectively which were lower than that reported for Strychno sinnocus pulps (242.9 ± 8.62 mg/100g) by Hassan et al., (2014) but higher than Gardenia sokotensis seeds and pulp of 1.97 ± 0.00 mg/100g and 1.10 ± 0.02 mg/100g respectively (Muhammad et al., 2017). Phytate can bind some essential mineral nutrients in the digestive tract and result in mineral deficiencies (Bello et al., 2008).

The tannins content of S. rotundifolius peel and pulp (33.27 ± 0.34 mg/100g and 12.29 ± 0.11 mg/100g) respectively are higher than those of seeds and pulp of Gardenia sokotensis (0.27 ± 0.00mg/100g and 0.38 ± 0.00mg/100g) as reported by (Muhammad et al., 2017). The concentration of cyanide content of S. rotundifolius peel and pulp are 64.08 ± 1.32mg/100g and 9.30 ± 1.27mg/100g which is higher than Gardenia sokotensis seeds and pulp (0.21 ± 0.00mg/100g and 0.12 ± 0.00mg/100g) respectively as reported by (Muhammad et al., (2017). On the other hand it is higher than 0.08 ±0.00mg/100g as reported by Hassan et al.,

(2014) for Strychno sinnocua Del pulp. In spite of the high cyanide content of S. rotundifolius peel and pulp when compared with Gardenia sokotensis and Strychno sinnocua it is still below the toxic level of 35mg/100g dry weight and 20mg HCN as recommended by Standards Organization of Nigeria (Edijala et al.,1999). This also shows that the level of the acid in the sample is within the acceptable range for human consumption. Only plants with more than 200mg of hydrocyanic acid equivalent per 100mg fresh weight are considered dangerous (Betancur-Ancona et al., 2008). The concentration of nitrate in S. rotundifolius peel and pulp (172.91 ± 0.42mg/100g and 147.62 ± 1.11mg/100g) respectively are very much higher than the Gardenia sokotensis pulp and seeds (0.004 ± 0.00mg/100g and 0.14 ±0.00mg/100g) respectively. It is also higher than that of Strychnoc innocua Dell pulp of 0.56 ± 0 03mg/100g (Muhammad et al., 2017, Hassan et al., 2014). Higher concentration of nitrate in the food can lead to a disease called methmoglobinaemia which is known to reduce the ability of red blood cells to carry oxygen (Kim-Shapiro et al., 2005). The value obtained is within consumable range. According to DASH (Dietary Approach to Stop Hypertension) diet, the nitrate intake could vary between 174 and 1222 mg per day considering 4-to-5 daily servings of vegetables and fruits, depending on the food choices (Jones, 2011). Normal dietary nitrate showed no harm to human health and no confirmed evidence stated explicit association of dietary nitrate and cancer, most existing research on nitrite and tumors therefore ignored the complicated compounds in target foods, resulting in contradictory conclusions among researchers. Considering the various protective effects other than the formal harmful suspects, dietary nitrate play an important role in physiological functions through the provision of non-enzymatic NO. With a new understanding of nitrates, their biological functions and applications need further investigation in the future (Ma et al., 2018). The variation in nutritional, anti-nutrients and minerals content of the sample under study with other tubers may be due to regional and species of the plant.

CONCLUSION

The results reported show that, the peel of S. rotundifolius contains higher amounts of crude protein, crude lipid and crude fiber as compared to the pulp. On the other hand, moisture content, carbohydrates and energy value of the pulp are higher than those of the peel. The mineral element contents obtained showed that, the peel contains significantly high levels of magnesium, calcium, potassium and iron than contained in the pulp. The pulp contains significantly low amounts of anti-nutritional components. The pulp and peel could therefore be good sources of food for human consumption and animal feed formulation.

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CONFLICT OF INTEREST

The authors have no declared conflict of interest.

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