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Nutrient potentials of two lesser known leafy vegetables (*Vitex doniana* L. and *Sesamum indicum* L.)

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Abstract

Two lesser known vegetables, *Vitex doniana* L. and *Sesamum indicum* L. consumed by the rural dwellers in Savannah region of Nigeria were subjected to chemical analyses in an effort to determine their nutrient potentials. Results showed that *V. doniana* and *S. indicum* contained (g/100 g dry weight) moisture (8.04, 10.26), crude protein (8.75, 18.37), crude fiber (15.58, 11.75), crude fat (5.10, 6.14), ash (7.92, 11.04) and carbohydrate (70.20, 54.21), respectively. Ascorbic acid contents (mg/100 g) of the vegetables were 24.60 and 53.80 while nutritive values (Kcal/g) were 361.70 and 345.55, respectively. Both vegetables were also good sources of calcium (3.36, 2.00 g/100 g), potassium (1.13, 2.04 g/100 g) and iron (0.12, 0.67 mg/kg). Copper, chromium, nickel and zinc were found in trace amount for *S. indicum* whereas these elements were present below the detection limit for *V. doniana* leaves. The levels of anti -nutrients in the leaves were found lower than the permissible limits and could not have any adverse nutritional effect on human. Thus, the vegetables could complement the conventional ones in enhancing food security and sustainable livelihood.

Introduction

There had been no worry about food security since 1930 in United States; the thriving food export has even returned a positive effect on the economy. Many nations cannot make claim to this because over 870 million people are malnourished or hungry according to the United Nations Food and Agriculture Organization (Woteki, 2013). There is need for other countries to solve this fundamental issue of feeding their people in order to enhance food security. The reliance on few crop species (rice, maize, wheat and cassava) in the supply of calorie need requirement of man and high cost of commonly available fruits and vegetables are among the driving forces behind micronutrients deficiency prevailing in Africa. While there had been many interventions through food bio fortification, diet diversity is the most sustainable approach (Burchi *et al*., 2011).

Strategies based on nutrient-rich foods like vegetables are considered essential to be a basic goal in the fight against malnutrition and under-nourishment (Susane, 1996). In Nigeria like most other African nations, rural dwellers rely on leaves gathered from the wild as their main source of leafy vegetables. These vegetables include leaves of annuals and shrubs and also leaves of trees. Most of the times, the trees are considered as sources of fruits and seeds while their leaves are left to waste. Throughout the year these lesser known vegetables serve as sources of calories and nutrient especially when there is shortage of cultivated green vegetables and other food resources. The inclusion of these vegetables in the diet of most rural communities and urban people who purchased from traders who collected from the wild is important in the supply of various nutrients need. Two of these lesser known vegetables are Vitex doniana leaf (leaf of tree) and *Sesamum indicum* leaf that is highly prized for the oil of the seed.

Vitex doniana belong to the *Lamiaceae* family, the tree is found wildly in savannah region of Nigeria, due to their resistance to drought and ability for quick regeneration, the fruit is a dark brown drupe with succulent pulp. Young leaves are reported to be consumed by some local communities in the savannah regions of Africa especially during famine seasons (Umar *et al*., 2010). Sesamum indicum L. is familiar as Sesame and also known as “Beniseed” in West Africa, “Sim-sim” in East Africa. It is an oil crop belonging to the family Pedaliaceae grown in both tropical and sub-tropical regions of Africa, Asia and Latin America. It was reported to be the most important crop as a source of semi-drying vegetable oils. Though the leaves are used for vegetable soup, it perhaps remains the oldest crop cultivated for its oil (Onwueme and Sinha, 1991). In this study, the nutrients and anti-nutrients phytochemicals of the two lesser known leaves were quantified in an effort

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to search for diet sources that could complement the existing ones in enhancing food security.

Materials and Methods

Sample collection, identification and preparations

Samples were obtained from Ogbomoso North Local Government, Oyo state, South West, Nigeria. Young and fresh leaves of *Vitex doniana* L. were collected from Olagbemiro hostel premises, along old Ilorin road, Sesamum indicum were purchased from a local market called "Old Waso". Both samples were identified and authenticated by Dr. A.T.J. Ogunkunle of Pure and Applied Biology Department, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. The leaves were diced and air –dried at room temperature and ground to powder using Philips HR 2027 food blender. The powdered samples were placed in desiccators and stored in the refrigerator prior to analyses. Fresh samples were taken for ascorbic acid assay.

Proximate and nutritive values analyses

Proximate analyses were determined using the AOAC standard procedures (AOAC, 1990). Moisture content was determined by heating the samples to a constant weight in a thermostatically controlled oven at 105^{o}C. The ash content was determined by igniting a 0.5 g test sample in a muffle furnace at 550^{o}C, the percentage residue weight was expressed as ash content, nitrogen was determined using the Kjedhal method and crude protein was calculated by multiplying the percentage nitrogen by the conversion factor of 6.25. The dried pulverized sample was extracted with petroleum ether (boiling point 40-60^{o}C) using a Soxhlet apparatus to obtain the crude lipid content while crude fiber content was estimated by consecutive acid and alkali digestion of sample followed by washing, drying, ashing at 600^{o}C and calculating the weight of ash free fiber and carbohydrate was calculated by difference. Nutritive value (NV) of the leaves was calculated based on the energy value available per kg of the macronutrient. Proteins, carbohydrates and fats yield 4.0, 4.0 and 9.0 Kcal of energy per g respectively. The nutritive value (NV) was calculated as [(4 × g/100 g protein) + (4 × g/100 g carbohydrate) + (9 × g/100 g fat)] (Indrayan *et al*., 2005; Chinnasammi *et al*., 2011).

Mineral elements determination

The elemental macro and micro nutrients were quantified using X-Ray Fluorescence (XRF) transmission emission technique at the Centre for Energy Research and Development (CERD), Obafemi Awolowo University, Ile-Ife, Nigeria, with model: PX2CR Power Supply and Amplifier for the XR-100CR Si Detector. The ground samples were pelletized and then irradiated with X-Ray for 1000s, to obtain the characteristics spectral, each spectral was made up of peaks which was characteristics of certain elements contained in the sample. The spectrum was checked on the computer system and then interpreted for quantitative determination of elements by direct comparison of count rates.

Quantification of ascorbic acid (vitamin C)

Ascorbic acid (Vitamin C) was quantified by the method described by Adebooye (2008). Ascorbic acid was measured by titration with phenol indo-2, 6-dichlorophenol (DPIP). The leaves samples (0.2 g) were separately homogenized with 40 ml of a buffer solution made up of 1 g/L oxalic acid and 4 g/L sodium acetate anhydrous. This was titrated against a solution containing 295 mg/L DPIP and 100 mg/L sodium bicarbonate. The results were expressed as mg/100 g dry weight.

Determinations of anti-nutrients phytochemicals

Tannin was determined using the method described by Boham and Kocipai (1994), using tannin acid as standard, the colored product developed was measured at 120 nm within 10 min. Saponin was determined gravimetrically by the method of Obadoni and Ochuko (2001). Alkaloid was determined by the method of Harbone (1993) by being precipitated using concentrated ammonium hydroxide. Phytate was determined by titration method as described by Wheeler and Ferrei (1971), using $FeCl_3$ as standard. Oxalate was determined titrimetrically and calculated by taking 1ml of 0.05 M $KMnO_4$ as equivalent to 2.2 mg oxalate (Chinma and Igyor, 2007).

Statistical analyses

Statistical analyses of all data were performed by means of MS Excel version 7 software. Results were expressed as mean value ± standard deviation of three separate determinations.

Results and Discussion

Proximate constituents

The proximate compositions were presented in Figure. 1. The moisture contents of the leaves were found to be 8.04 ± 0.02 g/100 g in V. doniana, 10.26 ± 0.01 g/100 g in S. indicum. The current findings are lower compared to a range of 55.76 ± 0.05 to 91.83 ± 0.04 g/100 g moisture reported for some conventional leafy vegetables (Kwenin *et al*., 2011). Although moisture content makes an important contribution to the texture of the leaves and help in maintaining

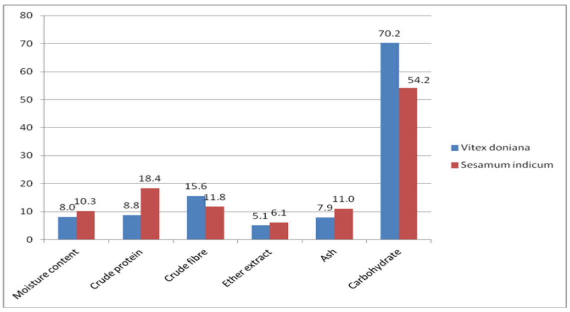

Figure 1. Proximate constituents of *Vitex doniana* and *Sesamum indicum* leaves

the protoplasmic content of the plant cells, it also makes them perishable and susceptible to spoilage by micro-organism during storage. The low moisture content of the two vegetables would prolong their shelf life depending on preservation technique and if properly kept from other external conditions.

Crude protein content (8.75 g/100 g) of *V. doniana* was lower than (18.37 g/100 g) of *S. indicum*, however, both samples can complement other dietary source of protein for the alleviation of Protein Energy Malnutrition. Studies have documented the acceleration of fracture healing with a modest of 10 to 20 gram increase in protein intake among elderly hip fracture patients, poor protein status at the time of fracture predicts fracture outcome, those with low protein status take longer to heal and have more complications, including death (Koval *et al*., 1999). Consumption of these vegetables could increase dietary protein need of man.

The present crude fiber contents of the leaves were found higher when compared to a range of 1.60 ± 0.02 to 4.5 ± 0.14 g/100 g crude fiber reported for some Nigerian vegetables (Agbaire and Emoyan, 2012). Intake of fibers can lower the serum cholesterol level, prevent the risk of coronary heart disease, hypertension, constipation, diabetes, colon and breast cancer (Ishida *et al*., 2000). Thus *V. doniana* and *S. indicum* could be valuable sources of fiber in human nutrition. They could supply substantial amount out of 19-25 g/100 g, 21-38 g/100 g, 28 g/100 g and 29 g/100 g recommended daily allowance of fibers for children, adults, pregnant and lactating mothers respectively (Javid *et al*., 2010).

The ash content which is a measure of inorganic matter in samples is higher in *S. indicum* than in V. doniana, this also reflected in the level of mineral elements detected in both samples, however, both samples have higher ash content compared to 7.64 g/100 g in dry leaf of *Moringa oleifera* (Moyo *et al.*, 2011). This indicated that *V. doniana* and *S.indicum* could be good sources of mineral elements. The crude fat in *V. doniana* is lower than that of *S. indicum*, most often leafy vegetables are poor sources of fat

Table 1. Levels of some macro and micro elements in *Vitex doniana* and *Sesamum indicum*

Elements	*Vitex doniana*	*Sesamum indicum*
Ca (g/100g)	3.36 ± 0.04	2.00 ± 0.03
K (g/100g)	1.13 ± 0.03	2.04 ± 0.03
Ti (g/100g)	0.03 ± 0.00	0.08 ± 0.00
Mn (mg/kg)	50.02 ± 0.14	14.02 ± 0.27
Fe (mg/kg)	0.12 ± 0.00	0.67 ± 0.01
Cu (mg/kg)	ND	0.34 ± 0.03
Cr (μg/100g)	ND	11.92 ± 0.35
Ni (μg/100g)	ND	12.12 ± 0.69
Zn (μg/100g)	ND	0.03 ± 0.00

Mean ± SD, ND: not detected

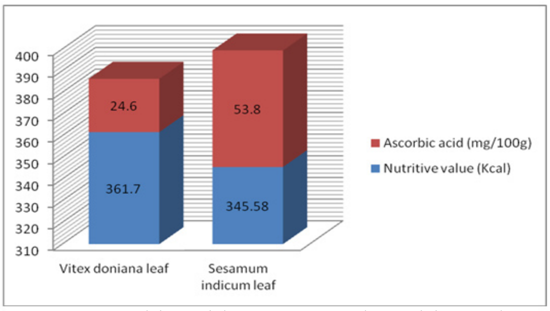

Figure 2, Ascorbic acid contents and nutritive values of *Vitex doniana* and *Sesamum indicum*

and this is beneficial for individual requiring less fat in their diet as high amount of fat has been implicated in several health related diseases like obesity and cardiovascular disorders (Antia *et al.*, 2006). The vegetables could be good substitutes for soup from groundnut which have more than 50 g/100 g oil (Asibuo *et al*., 2008). The two vegetables have higher fat content when compared to *Jatropha curcas* (4.2 g/100 g) and *Celosia argentea* (4.6 g/100 g) (Agbaire and Emoyan, 2012), they could be good sources of the fat soluble vitamins. The carbohydrate content and nutritive values of the two vegetables were found in rich amount. These values compared favourably with a range of 58.9 to 66.20 g/100 g reported for some indigenous vegetables (Nnamani *et al*., 2009). These vegetables might be a source of energy to vegetarians.

Ascorbic acid (vitamin C) is a natural antioxidant which strengthens the immune system and helps to protect the body against cancer and other degenerative diseases such as arthritis and type II diabetes mellitus (Mensah *et al*., 2008) *S. indicum* contained higher vitamin C than *V. doniana*, however, both vegetables contain higher vitamin C (fig. 2) in comparison to some leafy vegetables consumed by Edo people of Nigeria; 12.50 ± 0.82, 14.61 ± 1.30 and 21.03 ± 1.15 mg/100 g in *Pterocarpies soyauxii*, *Piper guinenses* and *Gnetum ofericanum*, respectively. Therefore the consumption of these vegetables could provide the 40 mg daily requirement of vitamin C as reported by Chinma and Igyor (2007).

The level of macro and micro elemental nutrients were presented in Table 1. Minerals are important in the diet because they serve as cofactors for many physiologic and metabolic functions; they are of

Table 2. Levels of anti - nutrient phytochemicals in *Vitex doniana* and *Sesamum indicum*

Anti-nutrients	*Vitex doniana* leaf	*Sesamum indicum* leaf
Tannin (mg/g)	2.34 ± 0.20	0.91 ± 0.10
Phytate (mg/g)	0.18 ± 0.14	0.29 ± 0.14
Saponin (g/100g)	0.37 ± 0.01	0.69 ± 0.01
Alkaloid (g/100g)	0.89 ± 0.01	0.22 ± 0.01
Oxalate (g/100g)	0.39 ± 0.14	0.95 ± 0.14

Mean ± SD

interest due to their pro-oxidant activities and health benefits (Alpha *et al*., 1996). The level of calcium is found higher in the current results than that of *Brassica oleraceae* leaf (4.05 mg/100 g Ca) consumed in Asaba, Delta state, Nigeria (Emebu and Anyika, 2011) and in fact, the level of calcium in the leaves compared favourably with the amount in *Moringa oleifera* (3.65 g/100 g) leaves (Moyo *et al*., 2011). Thus the calcium in the leaves might be beneficial in preventing calcium deficiency related diseases like osteoporosis. The level of potassium is lower in some leafy vegetables (0.08 to 6.10 mg/100 g) than our current findings. Potassium plays an important role in controlling skeletal muscle contraction and nerve impulse transmission (Mensah *et al*., 2008). The vegetables could therefore be recommended to patient with soft bone problems.

Iron was detected in both samples. It is needed in heamoglobin formation and normal functioning of the central nervous system and in the oxidation of carbohydrates, proteins and fats (Adeyeye and Otokiti, 1999). Manganese (Mn) was also detected in both samples. Mn is one of the important essential elements required in carbohydrates metabolism as well as an antioxidant in superoxide dismutase enzymes, it is required in very little quantity and its deficiency rarely occurs (Ismail *et al*., 2011). The vegetables could supply the daily intake limit of 2-5 mg of Mn which was recommended by FAO/WHO (2001). Zinc was not detected in *V. doniana* leaf but present at micro level in *S. indicum* leaf. Zinc deficiency has been reported to be associated with dermatitis, poor wound healing, retarded growth and sexual development, reduced taste acuity; apoptosis or programmed cell death is also potentiated by zinc deficiency (Erukainure *et al*., 2010). Consumption of S. indicum as a vegetable could compliment other food sources in effecting positive impact of zinc supplementation on the growth of stunted children and on the prevalence of selected childhood diseases such as diarrhea (Hussain et al., 2009).

Copper was not detected in *V. doniana* but present in *S. indicum*. This element is an essential component of many enzymes including the antioxidant enzyme; superoxide dismutase which protects the body against the harmful effects from free radicals (Agbaire and Emoyan, 2012). It would require the consumption of plenty *S. indicum* to meet the recommended daily intake of copper (2-5 mg) set by WHO (Anonymous, 1998). It has been reported that Cu consumption in excess of 3 mg/L of drinking water results in nausea and other adverse effects on the gastrointestinal tract (GIT) (Pizzaro *et al*., 1999). The level in *S. indicum* might not be of any health treat.

Trace levels of chromium and nickel were detected in *S. indicum* but were not detected in *V. doniana.* Nickel was among the suggested essential minerals with no established RDA (Eastmond *et al*., 2008). However, chromium is implicated in sugar metabolism in humans, but definitive biochemical evidence for a physiological function is lacking (Stearns, 2000). The chromium and nickel concentration of *S. indicum* were 12.12 ± 0.69 and 11.92 ± 0.35 µg/100 g, respectively. The nickel level was low when compared to the reported value of 9.21 ± 0.02 µg/g in *S. indicum* leaves from Anyigba, Kogi state, Nigeria (Omale and Ugwu, 2011). The RDA of Cr is 120 µg and it has been reported in many plant species that Cr proved to be toxic at 200 µg (FAO/WHO, 2001). The level of Cr in *S. indicum* in our current findings is lower than this, therefore the consumption of these vegetables cannot cause any risk of toxicity of chromium.

The levels of some anti-nutrient phytochemicals were reported in Table 2. Tannins are water soluble phenolic compounds with a molecular weight greater than 500 and with the ability to precipitate proteins from aqueous solution (Agbaire and Emoyan, 2012). They bind to proteins making them bio unavailable (Bello *et al*., 2008). Tannin content in *V. doniana* and *S. indicum* were 2.34 ± 0.20 and 0.91 ± 0.10 mg/g respectively, these values were found lower in the leaves than in (46.89 ± 0.02 mg/g) Melocia corchorfolia leaves (Hassan *et al*., 2011). Therefore, the levels of tannin in the vegetables will not pose any threat of toxicity especially when properly cooked as soup.

Saponins were quantified to be low in both vegetables. Saponins have been shown to possess both beneficial (cholesterol-lowering) and deleterious (cytotoxic; permeabilization of the intestine) properties (Agbaire and Emoyan, 2012). Although some saponins have been shown to be highly toxic under experimental conditions, acute poisoning is relatively rare both in animals and man (Nwinuka *et al*., 2005). The saponin content of the vegetables were found low compared to the level in *Ficus asperifolia* (2.67 ± 0.28) and *Ficus sycomorus* (1.78 ± 0.11) g/100 (Nkafamiya *et al*., 2010). Consumption of the two vegetables might not cause adverse effects due to the presence of saponins. Alkaloids are nitrogen-containing naturally occurring compound, commonly found to have antimicrobial properties due to their ability to intercalate with DNA of the microorganisms (Kasolo *et al*., 2010), they are also used in the pharmaceutical industries in the production of analgesics, owing to their analgesic properties (Erukainure *et al.*, 2011). Both *V. doniana* and *S. indicum* leaves contain alkaloids; they might also possess these health benefits.

Phytate is another phytochemical quantified in both vegetables. Phytate is known to decrease the bioavailability of minerals, especially Ca, Mg, Fe and Zn (Bello *et al*., 2008; Hassan *et al.*, 2011). Hurrel *et al.* (1992) reported that a phytic acid intake of 4-9 mg/100 g dry matter decreases iron absorption by 4 to 5 folds in human. On the other hand, phytate was an anti-carcinogen that protects against colon cancer and it is known to be a potent antioxidant that inhibits Fenton reactions leading to lipid peroxidation and inhibition of polyphenol oxidase (Hassan *et al.*, 2011). The level of phytate was higher in *S. indicum* than *V. doniana*; the levels compared favourably with 0.20 ± 0.02 mg/g in *Hibiscus cannabinus* and 0.18 ± 0.02 mg/g in *Haematostaphis barteri*; two unconventional vegetables consumed in Adamawa State of Nigeria mostly by the rural dwellers (Kubmarawa *et al.*, 2009). However, initial processing such as cooking is known to significantly reduce phytic acid content of vegetables (Bello *et al*., 2008). High level of oxalate have long been known to inhibit the absorption and utilization of minerals, it has also been implicated as a source of kidney stones (Bello *et al*., 2008). Oxalate contents of the vegetables were found lower compared to a range of 2.88 ± 0.37 g/100 g to 3.78 ± 0.28 g/100 g reported in some edible leafy vegetables (Nkafamiya *et al*., 2010). In fact, this compound is not likely to pose any danger in *V. doniana* and *S. indicum* when compared to 8.7 and 17.8 g per 100 g reported for *Amaranthus viridis* and purple variety of *Celosia argentea* two of the commonly consumed Nigerian vegetables, respectively (Falade *et al*., 2004) and 10.2 and 32.6 g per 100 g levels reported for cabbage and sweet potato, respectively (Santamaria *et al*., 1999).

Conclusion

Vitex doniana and *Sesamum indicum* leaves contained high levels of macro and micro nutrients with health benefits and very low levels of anti-nutrient phytochemicals. They have good potentials of making significant nutritional contribution to African diet when properly consumed. Both leaves should be considered as sources of edible vegetables and their cultivation should be encouraged.

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