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NUTRACEUTICAL POTENTIALS OF WILD AND NEGLECTED EDIBLE LEAFY VEGETABLES (*STERCULIA TRAGACANTHA* AND *SESAMUM INDICUM*) IN AKWA IBOM STATE-NIGERIA

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ABSTRACT
The study encompasses nutraceutical compositions of two wild and neglected edible leafy vegetables (*Sterculia tragacantha* and *Sesamum indicum*) collected from Uyo in Akwa Ibom State, Nigeria. Standard analytical methods were used to determine secondary metabolites, nutrient potentials, minerals and vitamins. The results of phytochemical screening confirmed that *S. tragacantha* contained: alkaloids (6.53±0.55), saponins (1.06±0.26), flavonoids (6.26±0.25), cardiac glycosides (7.36±0.88) and terpenes (5.72±0.28) while *S. indicum* revealed the presence of tannins (1.87±0.25), saponins (1.03±0.17), flavonoids (6.84±0.14), cardiac glycosides (7.80±0.05) and terpenes (5.91±0.47) in mg/100g samples. The tested vegetables showed the presence of very good amount of nutrients such as crude protein, fibre, CHO and caloric value whereas crude lipid, ash and moisture contents were relatively low. Mineral profile (Ca, Mg, K, Fe, P and Zn) were moderate and fell within the permissible limit. Vitamins A, B_1, B_2 and C concentrations were significant (p=0.05). The anti-nutrient (oxalate, phytate, tannins, cyanide and saponins) were detected in trace amounts ranging from 0.01-1.92 mg/100g. *S. tragacantha* and *S. indicum* possess high contents of useful metabolites and therefore could be excellent sources of antioxidant which have good medicinal potentials that meet the standard requirement for drug formation. Based on these, their consumption at any stage in life should be encouraged in our society to increase the nutritional needs in human diet.

KEYWORDS: *Sterculia tragacantha*, *Sesamum indicum*, edible, wild, leaves, phytochemical screening, nutraceutical status, diets, metabolites, phytotherapy.

INTRODUCTION
Nutraceuticals or functional foods are natural bioactive ingredients that have health promoting, disease preventing and medicinal properties. The secondary metabolites present in them give specific medical benefit other than purely nutritional. Nutraceuticals have thus played dual roles as food and therapeutic agent i.e. aids in prevention and/or treatment of disease/disorder. The other benefit is, being natural: they have no side effects as other therapeutic agents. Nutraceuticals may range from single isolated nutrients, dietary supplements or secondary metabolites to genetically engineered designer foods.[1]

Nutraceutical is the opposite of "junk food" and according to the World Health Organization, over 80% of the world's population amounted to about 4.3 billion people rely upon such traditional plant-based systems of medicine as phytochemicals, nutritional constituents or as functional food. Functional foods are ordinary foods that have components and ingredients incorporated in them to give a specific medicinal and physiological benefit other than a purely nutritional effect.[2,3]

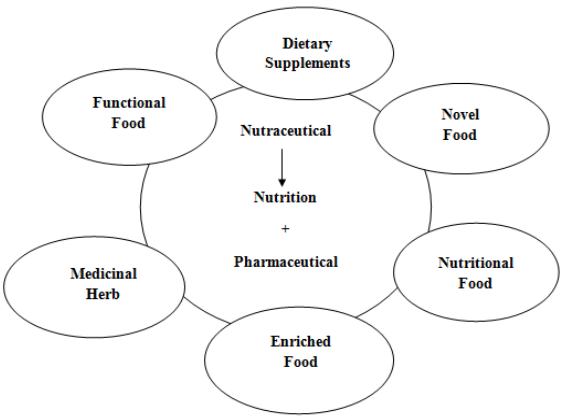

Figure 1: Inter-relationship of various foods as nutraceuticals.[4]

Leafy vegetables are good choice for a healthy diet because they do not contain cholesterol and are naturally low in calories and sodium. Many of the health benefits that leafy greens provide come from phytonutrients, unique compounds that provide protection for plants. These compounds are becoming recognized as part of a nutritious diet that promotes long-term health.[5] Obtaining adequate nutrients from various foods plays a vital role in maintaining normal function of the human body. With recent advances in medical and nutrition sciences, natural products and health-promoting foods have received extensive attention from both health professionals and the common population. New concepts have appeared with this trend, such as nutraceuticals, nutritional therapy, phytonutrients and phytotherapy.[6] These functional or medicinal foods and phytonutrients or phytomedicines play positive roles in maintaining well-being, enhancing health, and modulating immune function to prevent specific diseases. This is the more reason why our food should be our medicine and our medicine our food.

Sterculia tragacantha commonly known as African tragacanth is a medium sized tree belonging to the genus *Sterculia*, family Sterculiaceae. *Tragacantha* is sometimes a deciduous shrub growing 5 - 12 metres tall, but more often it becomes a tree growing up to 25 metres tall with exceptional specimens growing to 40 metres. The crown tends to be fairly small and sparsely branched. The bole which sometimes has winged buttresses can be 75cm in diameter and unbranched for up to 18 metres. The tree is valued especially for the gum obtained from its trunk which has a range of applications. The young leaves are sometimes an important local food. *S. tragacantha* ranges from Tropical Africa - Sierra Leone to DR Congo, South to Angola, Zambia and Tanzania. It has habitat of mangrove: open and drier parts of rain and swampy forests; secondary and transition forests; gallery forest; wooded savannah; at elevations from near sea level to about 1,500 metres. It is often found in groups at forest edges.[7] Young shoots and leaves can be cooked as a vegetable. The leaves are used for wrapping 'dokon', an acidic, fermented corn dumpling. Seeds can be roasted and eaten whole like peanuts or roasted, pounded and then cooked with vegetables such as peas or pumpkins.[8]

Sesame is an annual plant that belongs to the Pedaliaceae family. Sesame is considered to be the oldest of the oilseed plants and has been under cultivation in Asia for over 5000 years.[9] *S. indicum* is known as king of oilseeds in Vietnam. It grows to 50-70 cm in height with opposite decussate leaves; 4–14 cm long. The leaf margin is entire in leaves in the upper part of the shoot but deeply lobed in basal leaves. The apex is acute with an ovate shape with pubescent texture and nerves pinnately arranged with up to 3 lobes. The leaf base is obtuse. The flowers are white to purple and tubular; 3–5 cm long. Sesame seeds are flattened and obovoid; 2-3 mm long, up to 1.5 mm thick, narrowly ridged all round, rather smooth, with multiple colours ranging from white, ivory, grey, beige, brown, red to black enclosed in a capsule sheet.[10] Sesame leaves and young shoots are used as vegetables. They impart a mucilaginous, slippery or sticky consistency to soup. Sesame seeds are eaten, but not popular in Nigeria. The high quality oil is used for cooking and also added to salads and other dishes. Sesame oil cake or expressed cake is rich in protein and therefore used as poultry and livestock feed.[8] Medicinally, the seeds are eaten to stimulate and increase lactation and menstrual flow in women. The whole plant is believed to be aphrodisiac. Sesame leaves can remedy bronchial problems, are used to treat kidney and bladder infections and to promote hair growth.[8,11] The nutraceutical potentials of these leafy edible wild vegetables worth validated and documented to be cherished by the consumers as a delicacy in dishes. This study evaluates the nutritional and medicinal values of *Sterculia tragacantha* and *Sesamum indicum.*

MATERIALS AND METHODS

Collection of Plant Materials and Authentication

The edible leaves of *Sterculia tragacantha* and *Sesamum indicum* were collected from Ikot Inyang Idung Uyo Local Government Area in Akwa Ibom State, Nigeria on October, 2nd, 2015 by the corresponding author, Department of Biological Science, Akwa Ibom State University, Nigeria. The plants were identified and authenticated by a Plant Taxonomists based on morphological characteristics. Voucher specimens were deposited at the herbarium of the Botany and Ecological Studies Department, University of Uyo, Uyo, Nigeria.

Plate 1: Plant showing leaves of *Sterculia tragacantha.*

Plate 2: Plant showing leaves of *Sesamum indicum*

Preparation of Plant Extract

The collected leaves were washed, shade–dried, pounded to powdered form of uniform sizes and macerated with 70% ethanol (v/v) for 72 hours. The solutions were filtered using funnel packed with cotton wool. The filtrate were evaporated to dryness by heating in a water bath at 40^0C to yield semi-dry extract. This was re-suspended in 250 ml distilled water and stored in 100 ml beaker in a refrigerator until ready for use in phytochemical screening.[12]

Qualitative and Quantitative Phytochemical Screening

The analysis was carried-out in the Postgraduate Laboratory, Department of Pharmacognosy and Natural Medicine, University of Uyo, Akwa lbom State. Chemical tests were carried-out on the ethanol leaf extract using standard procedures to identify various bioactive components as described by Sofowora.[12,13]

Determination of Nutrients, Anti-nutrients, Minerals and Vitamins Compositions

The samples were analyzed chemically for moisture content, crude protein, fat (lipids), crude fibre, carbohydrate and ash content according to AOAC.[14] Tannin, oxalate, phytate and cyanide, vitamins A, B_1, B_2 and C were determined using the methods of AOAC[14] and Onwuka.[15] Minerals such as potassium (K), Magnesium (Mg), calcium (Ca), phosphorus (P), Zinc (Zn) and Iron (Fe) were determined by the atomic absorption spectrophotometric (UNICAM 939 AAS) method.[16] The analyses were carried-out in triplicates.

Statistical Analysis

Data obtained were processed, summarized and expressed as mean ± standard error of the mean of replicates and was subjected to statistical analysis by two-way analysis of variance (ANOVA) and student' t-test using SPSS version 17.0. Probability limit was set at 95% level of significance (p=0.05) as described by Ubom.[17]

RESULTS

Phytochemical screening of *Sterculia tragacantha* leaves extract showed the presence of alkaloids (6.53±0.55), saponins (1.06±0.26), flavonoids (6.26±0.25), cardiac glycosides (7.36±0.88) and terpenes (5.72±0.28 mg/100g) while *Sesamum indicum* revealed the presence of tannins (1.87±0.25), saponins (1.03±0.17), flavonoids (6.84±0.14), cardiac glycosides (7.80±0.05) and terpenes (5.91±0.47 mg/100g) tannins and alkaloids were detected in the vegetables (Table 1 and 2) respectively. The highest concentration of quantitative phytochemical was recorded in cardiac glycosides while the lowest was saponins in both vegetables. Table 3 shows the mineral contents of *Sterculia tragacantha* were recorded as: Ca (7.68±0.10), Mg (6.90±0.77), K (7.97±0.00), Fe (11.82±0.29), P (4.78±0.01) and Zn (0.20±0.00 mg/kg) while *Sesamum indicum* recorded thus: Ca (5.82±0.00), Mg (5.11±2.01), K (8.04±0.05), Fe (11.91±0.77), P (6.47±0.05) and Zn (0.13±0.06 mg/kg). The concentrations of Zn were very low in both vegetables (Table 3). Nutrients profile in the vegetables ranged between 7.80+0.00 – 45.20+0.48%, recorded in crude lipid and carbohydrate being the lowest and highest respectively (Table 4). Figure 2 summarised anti-nutrients concentrations which were very low and recorded as follows *Sterculia tragacantha*: Oxalate (<0.001), phytate (0.79), tannic acid (<0.001), cyanide (<0.001) and saponins (1.06 mg/100g) while *Sesamum indicum* showed: oxalate (<0.001), phytate (0.38), tannic acid (1.87), cyanide (<0.001) and saponins (1.97 mg/100g). The vitamin constituents of the vegetables are summarised in Figure 2. The results showed that the vegetables were relatively rich in vitamin A (Axerphthol) and vitamin C (Ascorbic acid). Vitamin B_1 (thiamin) and vitamin B_2 (Riboflavin) concentrations were moderate. The vitamin A content in *Sesamum indicum* had the highest concentration (12.56 mg/100ml) while *Sterculia tragacantha* had 10.45 mg/100ml. Vitamin B_1 concentrations were 6.72 mg/100ml and 8.55 mg/100ml in *Sterculia tragacantha* and *Sesamum indicum* respectively. Vitamin B_2 concentration was recorded in *Sterculia tragacantha* (5.83 mg/100ml) and *Sesamum indicum* (6.00 mg/100ml). The amount of Vitamin C was higher in *Sesamum indicum* than in *Sterculia tragacantha* in the samples (Figure 3).

Table 1: Qualitative Phytochemical screening of *Sterculia tragacantha* and *Sesamum indicum* ethanol leaves extract.

TEST	*Sterculia tragacantha*	*Sesamum indicum*
ALKALOIDS		
Dragendoff's test	+++	ND
Mayer's test	++	ND
Wagner's test	++	ND
SAPONNINS		
Frothing test	+	+
Fehling test	+	+
Sodium bicarbonate test	+	+
TANNINS		
Ferric chloride test	ND	+
Bromine water test	ND	+
FLAVONOIDS		
Shinoda's test	+++	+++
Ammonia test	+++	++
CARDIAC GLYCOSIDES		
Lieberman's test	+	++
Keller Kiliani's test	++	+++
Salkowski's test	++	+++
TERPENES		
Lieberman's Burchards test	++	+++

Legend: + = Trace, ++ = Moderate, +++ = Abundance, ND = Not Detected

Table 2: Quantitative Phytochemical Screening of wild Edible Leafy Vegetables (mg/100g).

Names of Compound	*Sterculia tragacantha*	*Sesamum indicum*
Alkaloids	6.53 ± 0.55^{b}	ND
Tannins	ND	1.87 ± 0.25^{a}
Saponins	1.06 ± 0.26^{c}	1.03 ± 0.17^{a}
Flavonoids	6.26 ± 0.25^{d}	6.84 ± 0.14^{b}
Cardiac glycosides	7.36 ± 0.88^{c}	7.80 ± 0.05^{c}
Terpenes	5.72 ± 0.28^{e}	5.91 ± 0.47^{d}

Results are means of three determinations of dry weight basis ± Standard Error, ND = Not Detected

Table 3: Mineral Contents of the Wild Edible Leafy Vegetables (mg/kg).

Elements	*Sterculia tragacantha*	*Sesamum indicum*
Ca	7.68 ± 0.10^{a}	5.82 ± 0.00^{a}
Mg	6.90 ± 0.77^{b}	5.11 ± 2.01^{b}
K	7.97 ± 0.00^{b}	8.04 ± 0.05^{c}
Fe	11.82 ± 0.29^{c}	11.91 ± 0.77^{d}
P	4.78 ± 0.01^{d}	6.47 ± 0.05^{a}
Zn	0.20 ± 0.00^{e}	0.13 ± 0.06^{e}

Results are means of three determinations of dry weight basis ± Standard Error,
[a-e] Means in the same row with different superscripts are significantly different (p=0.05).

Table 4: Nutrients Composition of the Wild Edible Leafy Vegetables.

Nutrients (%)	*Sterculia tragacantha*	*Sesamum indicum*
Crude Protein	11.10 ± 0.41^{a}	13.80 ± 0.00^{a}
Crude Lipid	7.80 ± 0.00^{a}	6.20 ± 0.92^{b}
Ash	6.60 ± 0.86^{b}	5.10 ± 0.44^{b}
Crude Fibre	20.20 ± 0.05^{c}	26.90 ± 0.04^{c}
CHO	45.20 ± 0.48^{d}	39.40 ± 2.00^{d}
Moisture Content	9.10 ± 0.0^{a}	8.60 ± 0.05^{b}
Caloric Value (Kcal)	383.00 ± 0.05^{e}	282.03 ± 0.11^{e}

Results are means of five determinations of dry weight basis ± Standard Error,
[a-e] Means in the same row with different superscripts are significantly different (p=0.05)

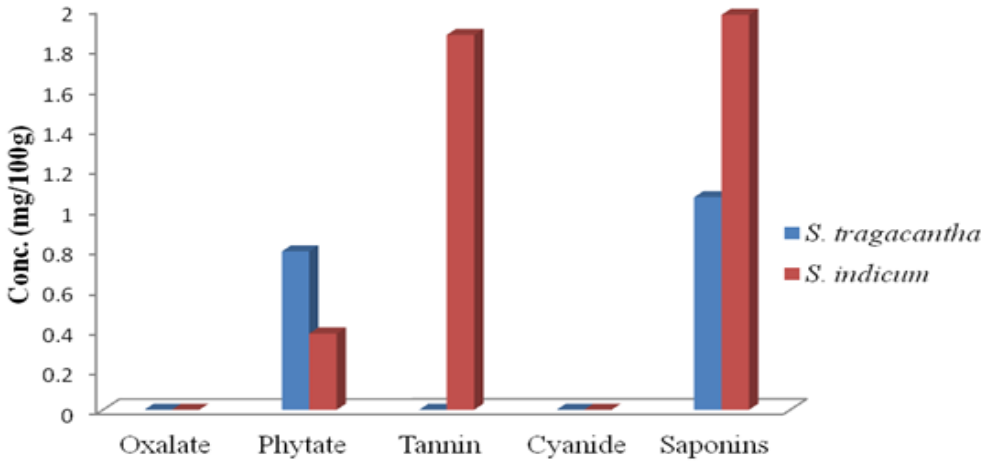

Figure 2: Quantitative anti-nutrients composition of wild edible leafy vegetables.

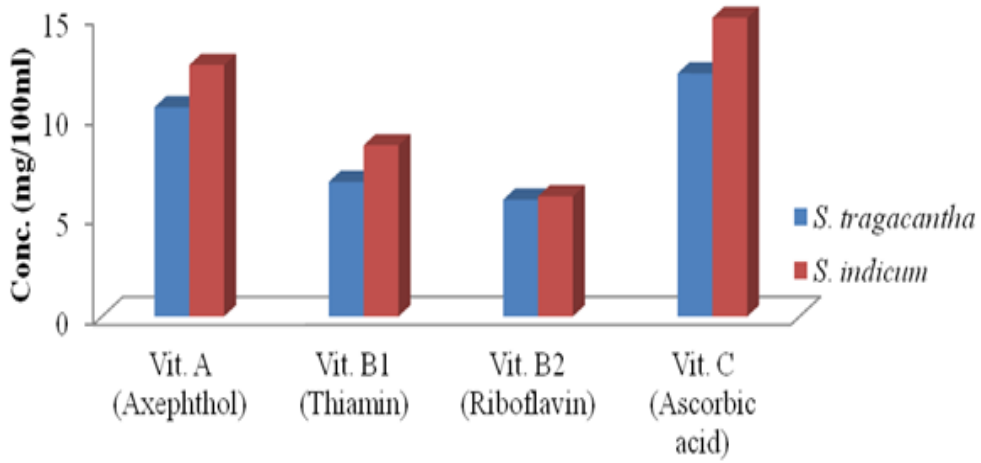

Figure 3: Quantitative vitamin composition of wild edible leafy vegetables.

DISCUSSION

The concentrations of secondary metabolites analysed in the two edible leafy vegetables were significantly (p=0.05) higher compared to the standard. These secondary metabolites have been known to possess properties that make them vital to animals and plants. The bioactive compounds detected include alkaloids, tannins, saponins, flavonoids, cardiac glycosides and terpenes. The importance of alkaloids, tannins and saponins in various antibiotics used in the treatment of some pathogenic ailments has been reported by Kubmarawa *et al*.[18] Alkaloids which occurs naturally in leaves, bark, roots and seeds of plants have been found to stimulate the nervous system, elevate or lower blood pressure as well as act as pain relievers.[19] Flavonoids are known to exercise anti-oxidative activities, protection against allergies, inflammation, platelet aggregation, microbes, ulcer, hepatic toxicity, viruses and tumour.[20, 21,22] Tannins, flavonoids and cardiac glycosides detected in *Peristrophe bicalculata* shows the potency to promote haemopoietic indices and restore the lost blood during excessive bleeding.[23] Similar results were obtained in *Uvaria chamae* root extract by Okon *et al*.[24] Terpenes in modern clinical studies have supported the role of vegetables as anti-inflammatory and analgesic agent.[25] Nassiri and Hoaaein[26] reported that terpenes produced an antiseptic effect against bacteria. The presence of these phytochemicals in *S. tragacantha* and *S. indicum* may be partly responsible for their medicinal properties.

Mineral content in this study were in abundance in both vegetables. Iron (Fe) is important in immune functions, cognitive development, temperature regulation and energy metabolism.[27] Fe is required for the synthesis of haemoglobin and myoglobin and it is an important mineral in pregnant and nursing women, infants and elderly people to prevent anaemia and other related diseases.[28] Regular consumption of iron rich vegetables can prevent iron deficiency anaemia. Calcium and phosphorus are required for bone teeth formation as well as maintenance and can also help in blood clothing, muscle contraction and regulation of cell permeability.[27] Magnesium plays a crucial role in DNA and RNA synthesis during cell proliferation. Mg is important for

nerves and heart function, increase insulin and decreases blood pressure by dilating arteries and preventing abnormal hearts rhythm, Mg also control blood-glucose levels and support healthy immune.[27] Therefore, regular consumption of this magnesium rich vegetables may control blood glucose level. Potassium has (K) been noted for the prevention and treatment of high blood pressure due to its diuretic nature.[27] Zinc is very useful in protein synthesis, cellular differentiation and replication, immunity and sexual functions in fertility.[29] It's deficiency may lead to growth failure and poor development of gonadal function.[30]

Nutrients like protein, CHO and fibre were significantly (p=0.05) high. The crude protein content in both vegetables were very high (11.10±0.41 - 13.80±0.00%) close to some wild leafy vegetables such as *C. hardwicki* (11.9±1.36%) and *Eurya acuminata* (14.72±0.04%). It is generally recommended that plant food providing more than 12% of its energy content. Protein has been reported for the building and repairing of body tissues, regulation of body processes and formation of enzymes and hormones. Proteins aid in the formation of antibodies that enable the body to fight infections and also a major energy supplier.[31] The results obtained in this research showed the vegetables to be rich sources of protein. Ramula and Rao[32] stated that intake of fibre can lower serum cholesterol and prevent the risk of coronary heart disease, hypertension, diabetes, colon and breast cancer. World Health Organisation (WHO) recommends fibre intake of 22-23kg for every 1000 Kcal of diet which is necessary for digestion and effective elimination of waste.[33] These wild edible vegetables contained a good amount of crude fibre similar to commercial vegetables. The prime role of CHO is to produce energy required for smooth functioning of the body especially for the vegetarians.[34] The high CHO content makes these vegetables good sources of CHO for human consumption. Antinutrient in *S. tragacantha* and *S. indicum* were found in trace quantity. Consumption of high concentration of oxalate may result in kidney disease.[35] Phytate is an anti-nutritional factor which prevent various fruits and vegetables, it high concentration is known to reduce mineral content in vegetables/fruits.[36] Excessive ingestion of hydrogen cyanide can be very poisonous as it interferes with electron flow in the mitochondria thereby inhibiting energy generation in the body.[37]

Vitamins A and C contents were high and significant at p=0.05 while vitamins B_1 (thiamin) and vitamin B_2 (Riboflavin) were moderate. Vitamin A is important for normal vision, gene expression, growth and immune function by its maintenance of epithelial cell function.[38] Vitamin B_1 maintains good appetite and aid in digestion and also for essential co-enzyme in Kerbs' cycle. Vitamin B_2 function as a co-enzyme in tissue oxidation. It serves as a co-enzyme in respiration and involved in metabolism of protein, fat and CHO.[39] Vitamin C is well known for antioxidant and its properties. Its physiological and biochemical actions is due to electron donor by donating electrons. It prevent other compound from being oxidized.[40] It is required for the prevention of scurving and maintenance of healthy skin, gums and blood vessels. deficiency of vitamin C causes bruising, bleeding, dry skin and depression.[33] It could be used in human diet to fulfil WHO recommendation.

CONCLUSION/RECOMMENDATION

This study showed that *S. tragacantha* and *S. indicum* leaves contained nutraceutical substances. The consumption of these vegetables could make a significant contribution to the recommended dietary allowances for nutrients. Therefore, this provides a fundamental information to the selection and promotion of wild edible leafy vegetables for increased utilization and better nutrition. Based on the findings from this research work, further investigations are needed to explore (isolate and characterize) its relevant therapeutic effects and substantiate its ethnomedicinal usage.

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