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Original Research

Nutritional Assesment of Nigerian Ethnic Vegetable Soups (Marugbo, Tete and Ila)

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Abstract

The inclusion of leafy vegetables' in human diets has been shown to be protective against incidence of chronic, degenerative and age-related diseases, due to the presence of antioxidants. In Nigeria, green leafy vegetables are traditionally cooked and eaten as a relish with starchy staple. This study investigated the functional, antioxidant and antimicrobial activities of three indigenous Nigerian soups made from leafy vegetables of 'Marugbo' (*Clerodendrum volubile*), 'Tete' (*Amaranthus hybridus*) and Ila (*Abelmoschus esculentus L.*). Results obtained suggested that these soups could be utilized as good dietary sources of minerals, protein and antioxidants. Protein content of the soups ranged from 34.35% to 46.41%, crude fibre from 12.78% to 14.5%. The soups showed good radical scavenging ability with 2, 2-diphenyl-1-picrylhydrazyl (DPPH %) ranging from 8.57 - 31.00. Total flavonoid and total phenolic contents were also high ranging from 2.41 - 5.25 mg/g and 12.27 - 16.54 mg/g respectively.

Keywords

Ila; Marugbo; Tete

Introduction

Nigeria is a multi-cultural society endowed with diverse traditional vegetable soups which are indigenous to different ethnic groups and consumed along with traditional dietary staples, obtained from cassava, yam, cocoyam, sweet potatoes, plantain, millet, rice and maize [1]. The soups are cooked utilizing varieties of indigenous vegetables which are not only known for their rich food nutrient content but are also health promoting [2]. Consumption of dietary antioxidants from these vegetables is beneficial in preventing diseases [3,4]. Apart from promoting good health, increased consumption of these indigenous vegetables will help to enhance crop diversity, alleviate poverty and promote food security [5]. Immense attention has thus been directed to these vegetables due to the increased awareness of their health protecting properties and bioactive phytochemicals that have been linked to protection against cardiovascular and other degenerative diseases [6].

African Indigenous Green Leafy Vegetables (AIGLV) are inexpensive sources of proteins, carbohydrate, minerals, vitamins and dietary fibres [7]. Some of the AIGLV indigenous to the Yoruba ethnic group of South West

Nigeria include: Amunututu {(*Basella alba* (green) and *rubra* (red))}, Odu (*Solanum nigrum*), African Glossy Night Shade (*Solanum scabrum*), Ewuro or Bitter leaf (*Vernonia amygdalina*), Ebolo (*Crassocephalum rubens*), Isapa or Roselle (*Hibiscus sabdariffa*), Wild leafy Marugbo (*Clerodendrum volubile*), Eggplant leaf (*Solanum macrocarpon*), Efinrin or African Basil (*Ocimum Gratissimum L.*), Igbo (*Detarium microcarpum*), Gbure or Water leaf (*Talinum triangulare*), Snake tomato (*Trichosanthes cucumerina*), Sokoyokoto or Spinach (*Celosia argentea L.*), Tete or Amaranth (*Amaranthus hybridus*), Fluted pumpkin (*Telfaria occidentalis*) and Ila or Okra (*Abelmoschus esculentus L.*).

Marugbo (*Clerodendrum volubile*), belongs to the family *Lamiaceae* (*Verbenaceae*) and is one of the widely distributed vegetables in the warm temperate and tropical regions of the world. The plant, otherwise called "Eweta" is commonly consumed mostly blended with other vegetables and spices with sweet aroma and taste. Locally, the leaves can be blended either fresh or dried and applied as spices in cooking [8]. The leaves of *Clerodendrum volubile* have great nutritional value as well as herbal and medicinal value and a potential source of amino acid in the human diet [9]. The leaves were reported to contain huge quantity of iron and zinc and presence of phenolic compounds and phytochemicals [8].

Amaranth is the collective name for the genus Amaranthus (family Amaranthaceae). Amaranth, known as 'Tete' in South West Nigeria, is highly nutritious, cheap to produce and easily adapts to the environment in which it grows [10]. Tete leaves have been reported to contain 17.5 - 38.3% protein (dry weight basis), (Table 1), 5% of which is lysine, an essential amino acid lacking in most cereal and tuber-based diets. The leaves are also an important source of micronutrients and high level of beta-carotene [11].

Okra (*Abelmoschus esculentus L*), commonly known as 'Ila', in South West Nigeria, is an important vegetable crop in tropical and warm temperate regions of the world with total trade estimated to over $5 billion [19-21]. The immature fresh and green seed pods are consumed as vegetable, salads, soups and stews; offering mucilaginous consistency after cooking. Mature Ila pods contain vitamins A, B6 and C, folic acid, riboflavin, calcium, zinc and dietary fibre. Ila seed oil is also a rich source of linoleic acid, a polyunsaturated fatty acid [12].

Little research has been done on the nutritional potentials of these Nigerian indigenous soups despite the high level of literature on the leaves (Table 1), hence, this study evaluated the chemical composition, nutritional and antioxidant properties of the indigenous soups produced from three selected AILV in South West Nigeria which are Marugbo, Tete and Ila. This is to increase the knowledge base as well as promote consumption of these soups which are rich naturally in micronutrient and can help reduce occurrences of some micronutrient deficiencies.

Materials and Methods

Source of materials

Marugbo and Tete leaves as well as fresh Ila pods with other ingredients such as onions, beef, palm oil, fresh pepper, pepper soup spices, cat fish and salt (dangote iodized table brand) were purchased from the local Oja Oba market in Akure South West Nigeria.

	Ila	Marugbo	Tete
Moisture (dry weight)	9.69-13.33 g/100 g [12]	8.87 g/100 g [7]	9.6 g/100 g [13]
Crude Protein	10.25-26.16 g/100 g [12]	13.88 g/100 g [7]	12.6 g/100 g [13]
Ash	5.37-11.30 g/100 g	11.67 g/100 g [7]	1.8-2.94 g/100 g [1,13]
Crude Fibre	10.26-26 g/100 g [12]	11.26 g/100 g [7]	3.3 g/100 g [13]
Fat	0.56-2.49 g/100 g [12]	6.12 g/100 g [7]	10.4 g/100 g [13]
Carbohydrate	7.45 g/100 g [14]	44.69 g/100 g [7]	62.2 g/100 g [13]
Potassium	299 mg/100 g [14]	27.69 mg/100 g [7]	208 mg/100 g, 128 mg/100 g [1,15]
Sodium	3.33-8.31 mg/100 g [12]	22.86 mg/100 g [7]	92 mg/100 g, 420 mg/100 g [1,15]
Phosphorous	25.62-59.72 mg/100 g [12]	27.61 mg/100 g [7]	26mg/100g, 480 mg/100 g [1,15]
Magnesium	57 mg/100 g [14]	27.11 mg/100 g [7]	249.92 mg/100 g [4]
Calcium	82 mg/100 g [14]	30.91 mg/100 g [7]	136-160 mg/100 g [1,15]
Zinc	80 mg/100 g [16]	24.27 mg/100 g [7]	0.6-1.67 mg/100 g [17]
Iron	0.62 mg/100 g [14]	6.22 g/100 g [7]	3.2-6.4 mg/100 g [1,15]
Tannin	4.93 mg/100 g [12]	2.19 mg/100 g [7]	105 mg/100 g [18]
Phytate	0.87 mg/100 g [12]	16.30 mg/100 g [7]	119-194.7 mg/100 g [18]
Oxalate	0.04 mg/100 g [12]	3.67 mg/100 g [7]	250 mg/100 g [18]

Table 1: Chemical composition of Ila, Marugbo and Tete fresh leaves.

Preparation of soups

Selected Nigerian soups mentioned above were prepared using facilities of the department of Food Science and Technology, Federal University of Technology, Akure. The preparation methods used for the selected soups were those earlier established by recipe book of the Federal Institute of Industrial Research, Oshodi (FIIRO) [22]. Each soup was cooled to room temperature and equal portions of the dishes were homogenized with a Kenwood blender. The soups were prepared in triplicates and analyses were carried out on dry weight basis.

Preparation of Marugbo soup

Marugbo leaves were plucked from the stalk, washed, shredded and blended together with bitter leaf, onions, pepper soup spices and fresh pepper. To this vegetable mixture, onion, garlic and ginger powder were added and boiled for 2 minutes on slow heat with 200 ml water. Then salt, sugar, cloves and pepper were added. A pot of the boiled ingredients (meat & fish) was put on a hot plate heater and allowed to boil, then 100 ml of water was added and allowed to boil for 5 minutes, after which 5 g of seasoning salt was added and allowed to boil for another 5 minutes at 100°C.

Preparation of Tete soup

Tete leaves were washed, sliced and blanched to deactivate enzymes and reduce microbial load. The vegetable soups were prepared using standard ingredients as described in FIIRO recipe book. Fresh meat cuts were washed and steamed with 5 g of salt, onions and seasoning for 30 min, deboned dried fish was added and cooked in the meat broth for 5 min, then water was added and cooking sustained for 15 min before ground crayfish was added. The soup was stirred about 2-3 times then cut vegetables were added and cooked for further 5 min before oil was added and cooking sustained for further 5 min at 100°C.

Preparation of Ila soup

Fresh Ila fruits were washed and sliced into pieces. Locust beans, pepper, deboned dried fish, oil, salt (5 g), stock cube were added in a pot and cooked for 5 min. The sliced Ila was added to the mixture and cooked for further 5 min at 100°C.

Proximate composition analysis

Dried samples of the soups were obtained by drying using hot air flow at 65°C in the first four hours and then reduced to 50°C till completely dried. Each sample was analyzed for moisture, ash, crude fat, and crude fiber using the methods of the Association of Official Analytical Chemists [23]. Nitrogen was determined by Kjeldahl method and percentage nitrogen was converted to crude protein by multiplying the value with 6.25. Carbohydrate was determined by the difference. Results were reported on the wet weight basis.

Mineral analysis

Sodium (Na), Potassium (K), Magnesium (Mg) and Zinc (Zn) contents were determined using flame photometer (Sherwood Flame Photometer 410, Sherwood Scientific Ltd. Cambridge, UK). The concentration of Iron was determined after wet digestion with a mixture of perchloric and nitric acid using Atomic Absorption Spectrophotometry (AAS, Model SP9, pye Unicam, UK).

Functional Properties

The bulk density was determined using the method described by Monteiro and Prakash [24] while the water and oil absorption capacities were determined using the method of Sathe and Salunkhe [25]. The swelling capacity was also determined using the method of Ukpabi and Ndimele [26].

Antioxidant properties

The total phenolic content was determined by the method of Singleton et.al [27], total flavonoid by method of Bao [28]. The DPPH radical scavenging activity of the samples was determined according to the method of Ansari et al. [29].

Antimicrobial activities

The antimicrobial activity of the soup extracts were determined by dilution to various concentrations according to the macroboth dilution technique [30]. Test organisms used were *Escherichia coli* and *Staphylococcus aureus* which were pure strains obtained from the Food Microbiology laboratory of the Federal University of Technology, Akure. These two organisms were used because they are commonly implicated in cases of diarrhea in Nigeria [31]. Standardized innoculum was added to series of sterile nutrient broth containing two fold dilutions of the soup extracts followed by incubation at 37°C for 24 hours. Minimum inhibitory concentration was measured as the least concentration that inhibits the growth of organisms.

Statistical analysis

All determinations were performed in triplicate and the results are expressed as means values ± Standard Deviations (SD). The data were subjected to statistical analysis using statistical program package STATISTICA. The one-way Analysis of Variance (ANOVA) followed by Duncan multiple range test and the differences between individual means were deemed to be significant at $P < 0.05$.

Plate 1: Fresh Marugbo leaves.

Plate 2: Tete leaves.

Plate 3: Fresh Ila pods.

Results and Discussion

Proximate chemical composition of Ila, Marugbo and Tete leaves were shown on table 2. Protein, ash and fibre values were significantly higher in Marugbo leaves than the Ila pods and Tete leaves. This result is consistent with the findings of Ogunwa et al., [7] and Sanusi et al., [32], in the Nigerian Food Composition table 1. Protein values in soups however ranged from (34.35% - 46.41%) with Tete soup (Amaranth) exhibiting significantly higher moisture and protein contents than the other samples (Table 3). The moisture, crude fibre and fat contents of Tete soup were also highest among the samples while crude ash and crude fibre contents of Marugbo soup were equally appreciable. The high protein content of Tete soup is consistent with findings of Mnkeni et al., [11] and Shukla et al., [33] which reported high protein level of Tete leaves, 5% being lysine, an essential amino acid lacking in most cereal and tuber-based diets. The higher crude protein content of these soups (Marugbo, Tete and Ila) can also be attributed to inclusion of animal protein (beef or fish). They are thus good sources of protein, which is needed in the body for growth and tissues replacement. Tete and Marugbo soups

also exhibited higher water and oil absorption capacities as well as swelling capacities while bulk density of Ila soup was highest at 98.23%. The higher bulk density of Ila soup confers packaging advantages as more quantity can be packaged within a constant volume.

Minerals are vital in human nutrition for overall physical and mental health as well as maintenance of acid-base balance, response of nerves to physiological stimulation and blood clotting. Significant differences were observed in the mineral contents of the soup extracts. Marugbo soup extracts exhibited highest Na, K, Fe, Zn and Mg levels compared to the others as shown in table 4 and figure 1. This is higher than the findings of Ogunwa et al., [7] which reported lower Na and K contents

Parameters (%)	Ila pods	Marugbo leaves	Tete leaves
Energy (Kcal)	59.66	78.95	88.59
Moisture	84.67 ± 0.04	64.49 ± 0.03	72.96 ± 0.03
Crude Protein	2.71 ± 0.05	8.57 ± 0.05	6.34 ± 0.05
Crude Ash	1.18 ± 0.03	4.07 ± 0.08	3.25 ± 0.08
Crude Fibre	1.95 ± 0.00	8.97 ± 0.05	6.34 ± 0.01
Crude Fat	1.48 ± 0.02	3.04 ± 0.00	1.22 ± 0.06
Carbohydrate	7.91 ± 0.01	10.69 ± 1.42	9.89 ± 0.02

Table 2: Proximate chemical composition of Ila pods, Marugbo and Tete leaves.

Parameters (%)	Ila soup	Marugbo soup	Tete Soup
Moisture content	3.64 ± 0.20^{c}	3.42 ± 0.361^{b}	4.00 ± 0.19^{a}
Crude Protein	34.35 ± 1.71^{c}	41.45 ± 1.53^{b}	46.41 ± 0.55^{a}
Crude Ash	8.67 ± 0.58^{c}	11.00 ± 0.86^{a}	10.04 ± 1.28^{b}
Crude Fibre	14.53 ± 0.75^{a}	13.91 ± 4.89^{a}	12.78 ± 0.13^{c}
Crude Fat	10.87 ± 0.47^{b}	12.04 ± 0.00^{b}	14.02 ± 0.87^{a}
Carbohydrate	27.83 ± 2.79^{a}	20.69 ±1.42^{b}	12.73 ± 1.68^{c}
Water Absorption Capacity	186.67 ± 11.54^{c}	210.00 ± 10.00^{b}	248.33 ± 10.41^{a}
Oil Absorption Capacity	78.33 ± 10.41^{b}	136.55 ± 10.75^{a}	138.17 ± 9.65^{a}
Swelling Capacity	3.64 ± 0.20^{c}	156.67 ± 15.27^{a}	145.00 ± 5.00^{a}
Bulk Density	98.23 ± 1.91^{a}	88.13 ± 0.93^{b}	95.25 ± 1.34^{a}

Table 3: Proximate composition and Functional properties of Ila, Marugbo and Tete soups.

Values are means SEM (Standard Error of the Mean). Means having different superscripts within the same row are significantly different at $P < 0.05$.

	Sodium	Potassium	Iron	Zinc	Magnesium
Dried Ila soup	17.57 ± 0.05	8.01 ± 0.04	0.38 ± 0.05	0.14 ± 0.01	0.43 ± 0.01
Dried Marugbo soup	19.99 ± 0.01	14.2 ± 0.03	1.29 ± 0.01	0.29 ± 0.05	0.52 ± 0.02
Dried Tete Soup	18.4 ± 0.01	9.26 ± 0.02	0.41 ± 0.05	0.16 ± 0.03	0.51 ± 0.01

Table 4: Mineral Composition of Ila, Marugbo and Tete soups.

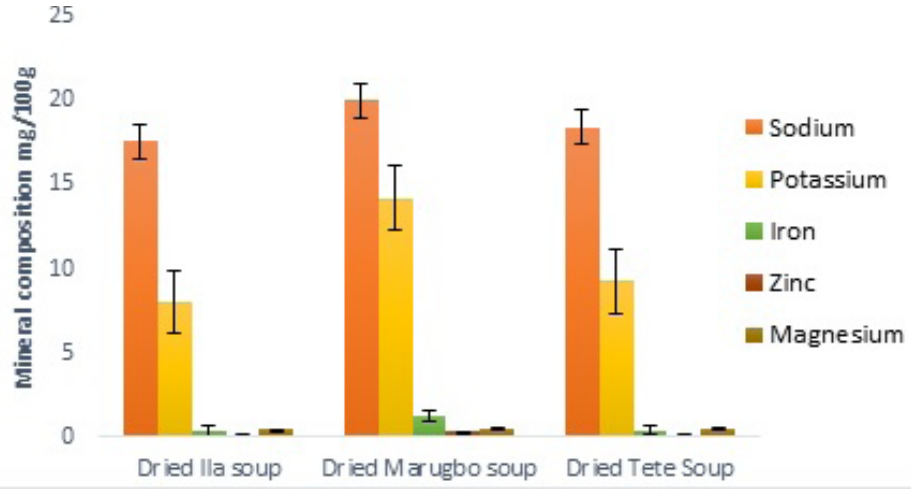

Figure 1: Mineral composition of Ila, Marugbo and Tete soups. Values are means SEM.

for Marugbo leaves. This could be due to addition of salt to the soup. The zinc content was however appreciably higher compared to that of cabbage, 0.18 mg [34]. The RDA for zinc is 11 mg, which indicates the soups as good sources. Zinc functions as an antioxidant and can stabilize membranes [35]. The iron contents of the soups are also comparable to other studied vegetables like lettuce, 1.2 mg [34]. Iron has been shown to be a cofactor for the antioxidant, catalase.

Antinutrients are generally toxic and may negatively alter the nutrient value of foods via impairment of mineral availability and starch digestibility [7]. Phytate is however a beneficial phytochemical and has some antioxidant activity in the body. From figure 2, the Tete soup sample had the highest concentration of phytate at 20.84 mg/g while the saponin content of Ila soup was highest at 61.15 mg/g. Saponins have a wide range of biological activities relevant to human health, including anti-fungal, anti-viral, anti-cancer, hypoglycemic diuretic and anti-inflammatory activities [28]. The nutritional value of Ila is thus enhanced due to the presence of saponin.

Antioxidant activities are usually determined by the presence of phenols and flavonoids as well as the DPPH radical scavenging activities [36]. From table 5 below, the three soups under study exhibited appreciable DPPH radical scavenging activity, total phenol content and flavonoids. Among all these vegetable soups, Tete showed highest scavenging activity with an inhibition of 31%, phenolic content of 16.54 mg/g and flavonoid content of 5.25 mg/g whereas Marugbo had the lowest activity at 8.57%, 12.27 mg/g and 2.41 mg/g respectively.

From table 6 below, the result of the antimicrobial activities of the three soups showed that Marugbo and Tete soups had appreciable anti-microbial activities at 15.5 mm and 14.00 mm respectively. These results are consistent with the findings of Dubey et al., [37] in his study of some selected vegetables.

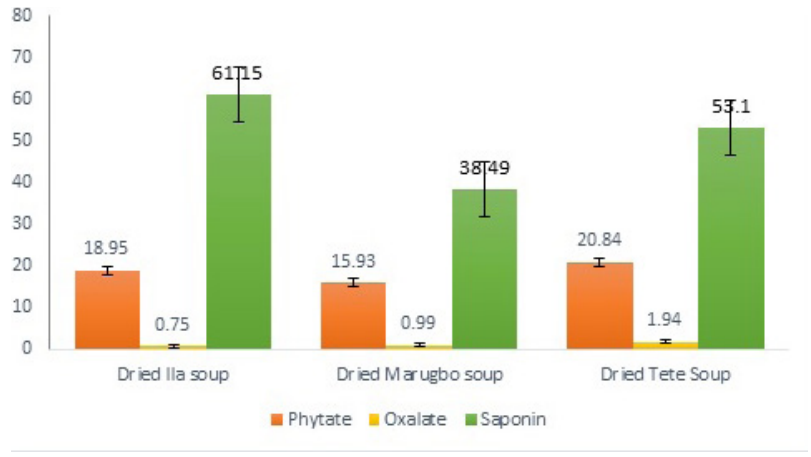

Figure 2: Antinutrient properties of Ila, Marugbo and Tete soups. Values are means SEM.

Samples	DPPH (%)	Phenols (mg/g)	Flavonoids (mg/g)
Dried Ila soup	20.57 ± 0.63^{b}	13.82 ± 1.83^{b}	3.96 ± 0.14^{b}
Dried Marugbo soup	8.57 ± 1.84^{c}	12.27 ± 0.42^{b}	2.41 ± 0.05^{c}
Dried Tete Soup	31.00 ± 2.65^{a}	16.54 ± 0.62^{a}	5.25 ± 0.06^{a}

Table 5: Antioxidant properties of Ila, Marugbo and Tete soups.

Values are means SEM (Standard Error of the Mean). Means having different superscripts within the same column are significantly different at $P < 0.05$.

Samples	Zone of inhibition (mm)	
	Escherichia coli	*Staphylococcus aureus*
Control (Ciprofloxacin)	21.60 ± 1.53^{a}	20.50 ± 1.00^{a}
Dried Ila soup	11.87 ± 0.55^{c}	11.00 ± 0.50^{a}
Dried Marugbo soup	15.50 ± 1.00^{b}	7.67 ± 0.70^{d}
Dried Tete Soup	13.00 ± 0.50^{c}	14.00 ± 0.71^{b}

Table 6: Antimicrobial activity of Ila, Marugbo and Tete soups.

Values are means SEM (Standard Error of the Mean). Means having different superscripts within the same column are significantly different at $P < 0.05$.

Values interpretation: Below 8 = resistance, between 12-18 = intermediate, above 20 = susceptible,

Conclusion

This study indicated that these soups, Marugbo, Tete and Ila are of high nutritional value. They are good sources of proteins, minerals and very low antinutritional oxalate composition. Tete soup serves as a great antioxidant composition and the good value of these soups is an indicator that the cultivation and utilization should be promoted. It is recommended that cultivation of the should be encouraged and further work should be done on the bioavailability of these nutrients in the human body.

Conflicts of Interest

All authors have no conflicts of interest to declare.

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