Antioxidant Activities and Food Value of Five Underutilized Green Leafy Vegetables in South Western Nigeria

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ABSTRACT

Objectives: To determine the food value and antioxidant activities of five underutilized leafy vegetables namely: *Bidens pilosa* L.-Beggar's ticks/ Cobbler's pegs; *Celosia trigyna* L.- Woolflower; *Crassocephalum crepidioides* (Benth) S. Moore - Fireweed/Redflower ragleaf; *Launaea taracifolia* (L.) Cars- Wild lettuce and *Solanum nigrum* L. - Black Nightshade/Sun berry.
Materials and methods: Fresh shoots of the five vegetables were collected from the wild, cleaned and milled. Food values which include proximate, minerals, and vitamin C contents were analyzed following the routine chemical analytical methods of Association of Official Analytical Chemists. 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging effect and phenolic compounds concentrations of the plants extracts were determined spectrophotometrically.
Results: The antioxidant activities and nutrient contents of the five vegetables showed variable trends and considerable high values. Across the vegetables, antioxidant activities ranged from 67.2% (*L. taracifolia*) to 91.8% (*B. pilosa*) at a concentration of 1mg/ml of the extracted material. The total phenol contents were between 5953.5±1.5 and 10193.5±0.5 mg/100g. The flavonoid contents varied from 3438±1.00 to 4974±1.00 mg/100g. Anthocyanin content in mg/100g ranged from 0.385±0.005 to 5.065±0.015 while Proanthocyanidin content varied from 0.125±0.05 to 2.050±0.15 in the extract powder. Crude protein values ranged from 3.5 to 9.16 g/100g, Carbohydrate contents varied from 1.09 to 9.43 g/100g while ascorbic acid (Vitamin C) compositions ranged from 27.2 to 87.3 mg/100g. Ca content ranged from 31.23 to 54.90 mg/100g, while Fe content varied from 21.25 to 139.75 mg/100g.
Conclusion: The vegetables contained appreciable quantities of protein, iron, calcium and vitamin C. The antioxidant activities and phenolic antioxidant contents of the vegetables were also high. The health claims associated with some of these food values and bioactive compounds are noteworthy, thereby underlining the potential role of these underutilized vegetables as functional foods.

Keywords: Food value, underutilized, leafy vegetables, antioxidant activity, Western Nigeria

INTRODUCTION

Traditional or indigenous leafy vegetables are those plants whose leaves or aerial parts have been integrated in a community's culture for use as food over a large span of time. They are highly recommended because they have a relatively high nutritional value compared to the introduced varieties. Their consumptions give diversity to daily food intake, adding flavour and zest to diet. They are rich in vitamins, minerals, trace elements, dietary fibre and proteins. The vegetables are important in food security, during times of drought or poor harvest and are also vital for income generation. Apart from their food value, the vegetables also serve as a source of medicines, hence important in their ecological, agronomic and cultural values (1-9). The antioxidants are radical scavengers which protect the human body against free radicals that may cause pathological conditions such as ischemia, anaemia, asthma, arthritis, inflammation, neurodegeneration, Parkinson's disease, mongolism, ageing process and perhaps dementia. They also have the ability to cure most diseases of man particularly the Central Nervous System ailments. Flavonoids and flavones are widely distributed secondary metabolites with antioxidant and antiradical properties (10-12)

Green leafy vegetables occupy an important place among the food crops because they provide adequate amounts of many vitamins and minerals for humans. In addition, they are rich sources of carotene, ascorbic acid, riboflavin, folic acid and minerals (13). There are many underutilized greens of promising nutritive values, which can nourish the ever increasing human population. Many of

these can thrive in adverse climatic and edaphic conditions.

It has been documented that indigenous leafy vegetables compare favourably with the routinely cultivated leafy vegetables both in terms of leaf yield and nutrient composition. Vegetables have also been reported among the most threatened plants diversity. Over the years, the indigenous leafy vegetables have been neglected by researchers and development process. In all discussions of the status of food in Nigeria, indigenous leafy vegetables often disappear from mention (14). Some of these vegetables remain underutilized as a result of lack of awareness of their nutritive values, in addition to the economic advantage they can bring.

The five underutilized leafy vegetable studied namely: *Bidens pilosa* L. - Beggar's ticks/ Cobbler's pegs, *Celosia trigyna* L. - Woolflower, *Crassocephalum crepidioides* (Benth) S. Moore - Fireweed/Redflower ragleaf, *Launaea taracifolia* (L.) Cars- Wild lettuce and *Solanum nigrum* L. - Black Nightshade/Sunberry are gathered from the wild when needed. Like many commonly consumed leafy vegetables in the Southwestern Nigeria, the vegetables evaluated are usually blanched before consumption. Despite the use of these plants as food especially by the inhabitants of the area where these plants grow, no report is available on their nutritional content and antioxidant activities. Hence, the lack of basis to give them any serious cultivation attention. Some are even being threatened with extinction, since they are treated as weeds. Application of herbicides on some, alongside with other weeds have prevented their emergence in those areas. If this continues in every area where they are found, extinction is inevitable. Some of the people in the South-Western Nigeria consume low and limited leafy vegetables which have resulted to deficiency in the basic vitamins and minerals needed in human diet. This study was thus designed to analyze the antioxidant activities, proximate and minerals compositions of these underutilized leafy vegetables of South-Western Nigeria for the purpose of popularizing their consumption and encouraging their cultivation.

MATERIALS AND METHODS

Study location

The five leafy vegetables studied were collected from the wild from Ile-Ife, in July, 2008. Ile-Ife lies in the rainforest vegetation characterized by bimodal rainfall pattern with peaks in June and September. Their scientific identities were confirmed at the Herbarium of the Department of Botany, Obafemi Awolowo University Ile-Ife, Osun State, Nigeria. About 1kg fresh leaves of the vegetables collected were dried at 40°C in an oven for about 48hrs. The dried samples were then milled and kept in a refrigerator before the analysis was carried out.

Proximate analysis

Crude protein, carbohydrate, ash, crude fibre, ether extract, moisture and ascorbic acid contents were determined using the routine chemical analytical methods of Association of Official Analytical Chemists (15).

Mineral contents evaluation

About 0.2g of the digested sample was used each to carry out the elemental analysis of Magnesium (Mg), Arsenium (As), Nickel (Ni), Selenium (Se), Cadmium (Cd), Manganese (Mn), Cromium (Cr), Copper (Cu), Cobalt (Co), Calcium (Ca) and Iron (Fe), using Atomic Absorption Spectrophotometer (AAS).

Antioxidant assay

About 10g each of the powder was extracted by cold extraction for 24hrs using 80% methanol. The crude extract was obtained by evaporation of the methanol soluble extract to dryness in a rotary evaporator at 45°C. The hydrogen donating or radical scavenging of the extract was determined using the stable radical DPPH (2, 2-diphenyl-2-picrylhydrazyl hydrate) according to the method described by Brand-Williams (16). Total phenol content was determined by the method of Singleton and Rossi (17) using the Folin – Ciocalteau reagent in alkaline medium. Total phenol value was expressed in terms of gallic acid equivalent (mg/g of sample), which is a common reference compound.Total flavonoid content was determined using $AlCl_3$ method as described by Lamaison and Carnet, (18). Total flavonoid values were expressed in terms of quercetin equivalent (mg/g of sample), which is a common reference compound.The proanthocyanidin content was

determined using a modified method of Porter *et al.* (19) using the AlCl / Butan – 1-0l assay method. The proanthocyanidin content was expressed as mg cyanidin g/kg of sample. The total anthocyanin content of the test samples was determined using the pH differential method of Fuleki and Francis (20). The anthocyanin content was expressed as mg cynanidin 3 – glucoside/100g sample. The analyses were carried out in triplicates.

Analysis of data

Mean values of each of the analysed nutrients of each of the species were generated from the three replicates and standard errors were calculated to reveal the degree of spread of the data.

RESULTS

Names and growth habit of the five underutilized leafy vegetables studied are presented on Table 1.

Table 1: Names and Growth habit of the five underutilized leafy vegetables

S/N	Family	Botanical name	Common name	Local name (Yoruba)	Growth habit
1	Asteraceae	*Bidens pilosa* L.	Beggar's ticks/ Cobbler's pegs	Omolanganran	Erect herb
2	Amaranthaceae	*Celosia trigyna* L.	Woolflower	Ajefowo	Erect herb
3	Asteraceae	*Crassocephalum crepidioides* (Benth) S. Moore	Fireweed/Redfl ower ragleaf	Ebolo	Erect herb
4	Asteraceae	*Launaea taraxifolia* (L.) Cars	Wild lettuce	Yanrin	Erect herb
5	Solanaceae	*Solanum nigrum* L.	Black Nightshade/Su nberry	Odu	Erect herb

Antioxidant activities and components of the vegetable species are shown in Table 2.

The amount of antioxidant activity varied in different species of the vegetable studied and ranged from 67.2% for *L. taraxacifolia* to 91.8% for *B. pilosa* at a concentration of 5mg/ml of the extracted material. The highest antioxidant activity was detected in *Bidens pilosa* L., *Crassocephalum crepidioides* (Benth) S. Moore, and *Solanum nigrum* L. and the lowest in *Celosia trigyna* L. and *Launaea taraxacifolia* (L.) Cars. Their IC_{50} ranged from 0.343 to 2.121(mg/ml). The total phenol contents of the extracts in terms of gallic acid equivalent (the standard curve equation: $y=0.029234x + 0.0000000$, $r^2= 0.999$) were between 5953.5±1.5 and 10193.5±0.5 mg/100g. The flavonoid contents in terms of quercetin equivalent varied from 3438±1.00 to 4974±1.00 mg/100g i.e. highest in *B. pilosa* and lowest in *L. taracifolia*. Anthocyanin content in mg/100g ranged from 0.385±0.005 to 5.065±0.015 while Proanthocyanidin content varied from 0.125±0.05 to 2.050±0.15 in the extract powder. Se ranged from 23.95 to 40.93mg/100g. *C. crepidioides* had highest ascorbic acid (Vitamin C) content (87.3mg/100g) followed by *C. trigyna* (54.7mg/100g) and lowest in *B. pilosa* (27.2mg/100g).

Total phenol and flavonoid contents of *B. pilosa* with 10193.5±0.5 and 4974±1.00mg/100g respectively had the highest amounts among the plants in this study.

Table 2: Antioxidant activities and properties of the five underutilized leafy vegetables on dry weight basis

Vegetable species	% Inhibition	IC_{50} (mg/ml)	Phenol	Flavonoid	Anthocyanin	Proantocyanin	Vitamin C	Solenium
			mg/100g					
B. pilosa L.	91.8±0.05	0.154±0.04	10193.5±0.50	4974±1.00	0.385±0.005	0.415±0.11	27.2±0.05	23.95±0.36
C. trigyna L.	81.7±0.15	0.375±0.02	8153.0±1.00	4528±0.08	5.065±0.015	2.050±0.15	54.70±0.01	40.93±0.14
C. crepidioides (Benth) S. Moore	91.7±0.05	0.343±0.12	9224.0±1.00	4189±0.09	2.215±0.005	0.745±0.06	87.3±0.03	29.49±0.38
L. taraxacifolia (L.) cars	67.2±0.12	1.306±0.10	5953.5±1.50	3439±1.00	2.345±0.05	0.250±0.07	44.8±0.06	39.90±0.12
S. nigrum L.	91.4±0.06	2.121±0.09	7578.0±0.08	4357±1.00	2.550±0.05	0.125±0.05	30.30±0.02	37.89±0.12

The data are mean value ± standard error (SE) of three determinations: IC_{50} = Inhibitive concentration at 50%
% inhibition = antioxidant activity

Table 3 shows the result of the proximate composition of the leafy vegetables studied.

TABLE 3: Proximate Composition of the five underutilized leafy vegetables on wet weight basis

Names of Vegetables	Crude protein	Crude fibre	Ether extract	Ash	Moisture	Carbohydrate
	g/100g					
Bidens pilosa	4.46± 0.02	3.21 ± 0.01	0.80± 0.01	1.82± 0.02	86.50±0.24	3.22±0.17
Celosia trygina	5.06 ± 0.13	2.02 ±0.05	0.81± 0.01	0.87± 0.03	90.17±0.09	1.09±0.01
C. crepidioides	3.5 ± 0.01	0.12 ± 0.02	0.02± 0.01	1.96± 0.01	85.00±0.01	9.43±0.03
Launaea taraxacifolia	4.30± 0.06	1.28 ± 0.01	0.31± 0.01	1.33± 0.02	90.57±0.23	2.81±0.13
Solanum nigrum	9.16 ± 0.02	0.02± 0.01	0.01± 0.01	1.00± 0.01	85.00±0.04	4.80±0.03

The data are mean value ± standard error (SE) of three determinations

Crude protein content of the samples ranged between 3.50 to 9.16g/100g. it was highest in *Solanum nigrum* (9.16g/100g) and lowest in *Crassocephalum crepidioides* (3.50g/100g). Ash content (minerals) was highest in *Crassocephalum crepidioides* (1.96g/100g) and lowest in *Celosia trigyna* (0.87g/100g).

protection from long term degenerative diseases (21, 22). The macronutrients such as Ca and Mg and micronutrients such as Fe, Mn and Zn compositions of the five vegetables analyzed are high enough and compare favourably with the composition of other known and well-utilized edible leafy vegetables and higher in some instances as reported by Raghuvanshi *et al.* (23) and Sheela *et al.* (13). The relatively high concentrations of Fe, Zn and Mn could contribute towards combating the problem of micronutrient deficiencies in poor rural communities. The protein contents are high especially that of *S. nigrum* compared with the average for other vegetables consumed in Nigeria (24). Hence, this wild vegetable could be promoted as a good protein supplement to cereal grains or as meat substitute for poor rural communities.

Phenols have antioxidant capacities that are much stronger than those of Vitamins C and E. Some evidence has shown that flavonoids could protect membrane lipids from oxidation and a major source of flavonoids is vegetables and fruits (25).

Table 4: Mineral composition of the five underutilized leafy vegetables (mg/100g) on dry weight basis

Minerals	Fe	Ca	Mg	Mn	Co	Pb	Zn	Cr	Cd	Ni	As
Biden pilosa	125.50±1.95	41.73±0.14	206.45±0.07	6.45±0.02	N.D	N.D	1.03±0.01	0.08±0.01	N.D	N.D	2.50±0.03
Celosia trygina	139.75±0.74	54.90±0.06	522.20±0.52	4.78±0.05	0.13±0.01	0.25±0.08	0.40±0.01	0.25±0.01	0.01±0.03	2.25±0.03	3.75±0.03
C. crepidioides	79.75±0.86	31.23±0.34	253.20±0.01	4.35±0.02	0.15±0.04	N.D	N.D	0.05±0.01	0.01±0.05	N.D	1.00±0.06
Launaea taraxacifolia	21.25±0.21	37.43±0.04	104.53±0.06	1.70±0.01	N.D	0.10±0.01	0.28±0.02	0.10±0.01	0.01±0.02	N.D	N.D
Solanum nigrum	76.50±0.86	54.00±0.08	578.98±0.82	2.43±0.03	0.10±0.04	N.D	0.35±0.05	N.D	N.D	N.D	5.50±0.06

The data are mean value ± standard error (SE) of three determinations

As presented in Table 4, the Ca content is highest in *C. trigyna* (54.90 mg/100g) and lowest in *C. crepidioides* (31.23mg/100g), Fe content ranges from 21.25 to 139.75 mg/100g, being highest in *C. trigyna* and lowest in *L. taraxacifolia.* Mg content ranged from 104.53 to 578.98 mg/100g, Mn varied from 1.70 to 6.45 mg/100g.

DISCUSSION

Vegetables play an important role in human diet; they are important source of both digestible and indigestible carbohydrates. They are also important sources of minerals and certain vitamins especially vitamins A and C. They are responsible for more subtle feelings of daily well-being and for

The compounds such as flavonoids, which contain hydroxyls, are responsible for the radical scavenging effect in the plants (26, 27). The most practical way to combat degenerative diseases is to improve body antioxidant status, which could be achieved by higher consumption of vegetables and fruits. Incidentally, the 5 vegetables evaluated were all high in antioxidant activities/radical scavenging activity. The total phenol content of the vegetables analyzed in this study ranged from 6.0% to 10.2%. These values are above what Oboh (22) reported for some commonly consumed green leafy vegetables in Nigeria such as *Amaranthus cruentus* and *Corchorus olitorus* which is 0.3% each.

Findings from this study have supported the claim that indigenous vegetables can contribute to nutritionally balanced diets, especially for poor rural communities in developing countries like Nigeria. The good food values and high antioxidant activities of these plants are indicators that their cultivation and utilization should be promoted.

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