Comparative studies of chemical compositions of two species of Basella

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Abstract
Comparative chemical compositions of Basella

Antioxidants, proximate and mineral elements analyses were conducted on two species of Basella (B.alba and B. rubra), an under-cultivated and underutilized leafy vegetable in Nigeria. The protein, fibre, fat, ash (in g/100g edible portion) contents for B. alba and B. rubra were (7.0, 4.1), (0.9, 2.0), (0.02, 0.79) and (1.9, 0.9) respectively. Potassium was the most abundant mineral in both species at (435 and 538 mg/100g) followed by Iron (177.5 and 75mg/100g), Magnesium (63.3 and 77.8mg/100g), and Calcium (14.3 and 38.5 mg/100g) respectively. The antioxidant activities in both species are very high (89% and 91%) for B. alba and B. rubra respectively. The antioxidant phenolic compounds are very high. Total phenol concentration in B. rubra was higher than in B. alba, while the concentration of flavonoid was higher in B. alba. Though the consumption of B. alba is more common in Nigeria, both species are high in essential minerals, protein and antioxidants.

Introduction
Basella (alba L. and rubra L.) commonly known as Ceylon spinach and locally called “Amunu-tutu” in southwestern Nigeria is a leafy vegetable that belongs to the family Basellaceae. Ceylon spinach is commonly grown for its young shoots, which make a succulent, slightly mucilaginous vegetable. It is boiled, used as a potherb in stews or soups, fried in oil, or sometimes used as a green salad. It is a short lived perennial herb up to 4-8mm long, succulent, stem twining, slender, smooth, green (B. alba L.) or purplish (B. rubra L.). The harvest of crop begins 3 to 6 weeks after sowing. The crop yields up to 40 – 80 tons/ha (Abukutsa-Onyango, 2003).

There is strong evidence that a diet rich in fruits and vegetables has a positive effect on human health, offering protection against degenerative disease of aging, such as heart disease, cardiovascular disease, Alzheimer’s disease, cataracts and several forms of cancer (Williamson, 1996; Liu et. al, 2001; Joshipura et. al, 2001). This protective action is attributed to the presence of antioxidants, especially antioxidant vitamins including ascorbic acid, X-tocopherol and B-carotene (Cao et al., 1996). In addition, poly-phenolic components of higher plants can have antioxidant properties (Jacob, 1995).

Fruits and vegetables possess major food constituents such as protein, fat and carbohydrate, micro nutrients such as vitamins, minerals and trace elements in addition to other compounds such as ascorbic acid, carotenoids and flavonoids that may have a positive effect on human health. (Bergquist, 2006).

In Nigeria, few rural and urban women cultivate few stands of Basella at their backyard for consumption and can be available throughout the year if well maintained. The leaves and shoots of Basella are useful as vegetable which can be eaten cooked as green or added to soups or with melon. Though leafy vegetables are generally known to add taste, flavour and substantial amounts of nutrients to the diet, there is scanty published information on the chemical composition of Basella especially the antioxidant and mineral elements of the two available species of Basella in the southwestern Nigeria, where it is semi domesticated and underutilized. Hence, this study was designed to determine and compare the antioxidant properties and nutrient compositions of the B. alba and B. rubra available in the South West Nigeria.
Material And Methods

The fresh samples of B. alba and B. rubra were collected at Ile-Ife, Nigeria, during the rainy season of 2010. The fresh leaves of the vegetables were dried at 40°C in an oven for about 48hrs. The dried samples were then ground into fine powder using a kitchen hand mill. 20g each of the powder was then extracted by soxhlet for 24hrs using 80% methanol. The crude extract was obtained by evaporation of the methanol soluble extract to dryness. The samples were analyzed for antioxidant properties and mineral elements. The proximate contents (Protein, fat, ash, fibre and carbohydrate) were analyzed on wet weight basis.

The antioxidant activities or 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 (1995). DPPH reacts with an antioxidant compound which can donate hydrogen, it is reduced. The change in colour from deep violet to light yellow was measured spectrophotometrically at 517 nm. Total phenol content was determined by the method of Singleton and Rossi (1965) using the Folin – Ciocelateau reagent in alkaline medium. Total flavonoid content was determined using AlCl₃ method as described by Lamaison and Carnet, (1990). The proanthocyanidin content was determined using a modified method of Porter, et al, (1986) using the AlCl₃ / Butan – 1-01 assay method. The total anthocyanin content of the test samples was determined using the pH differential method of Fuleki and Francis (1968) as described by Guisti and Wrolstad (2001).

About 0.2g of the digested sample was used each to carry out the elemental analysis of Mg, As, Ni, Se, Cd, Mn, Cr, Cu, As, Co, Ca and Fe, using Atomic Absorption Spectrophotometer (AAS). Crude protein, carbohydrate, ash, crude fibre, ether extract (fat) and moisture contents were determined using the routine chemical analytical methods of Association of Official Analytical Chemists (AOAC, 1995).

Statistical Analysis

All data were subjected to combined analysis of variance SAS (2003). Means squares, where significantly different for the analyzed parameters were separated using Duncan Multiple Range Test (DMRT) at and Least Significant Difference (LSD) 5% level of probability.

Result

The antioxidant properties of B. alba and B. rubra were presented on Table 1. The antioxidant activities and total phenol concentration in the B. rubra (91.3% and 3044mg/100g) were significantly (P=0.05) higher compared to those of B. alba (89.3% and 2817mg/100g) respectively, though they were both very high. However, the flavonoid, anthocyanin and proanthocyanidin concentrations in B. alba were significantly (P=0.05) higher than those of B. rubra.

The results of proximate contents of B. alba and B. rubra were shown on Table 2. The protein content of B. alba (7.0g/100g) was significantly (P=0.05) higher compared to that of B. rubra (4.05g/100g). The same trend was observed in ash and vitamin C contents of B. alba, they were significantly (P=0.05) higher compared to those present in B. rubra. Vitamin C content of B. alba was 75.7% higher than that of B. rubra. However, the contents of fibre, fat, moisture and carbohydrate were significantly (P=0.05) higher in B. rubra.

Table 3 showed the results of mineral elements in B. alba and B. rubra. Iron (Fe) was 58% higher in B. alba than in B. rubra. Cobalt, Copper, Manganese, Nickel and Arsenate were also significantly (P=0.05) higher in B. alba than in B. rubra. However, Calcium (Ca) was about 65% higher in B. rubra than in B. alba. Lead (Pb), Zinc (Zn), Cadmium (Cd) and Magnesium (Mg) were significantly (P=0.05) higher in B. rubra than in B. alba. Selenium (Se) was not detected in both species, while Co and Cr, Ni and As were absent in B. rubra.

Discussion

Comparing the results of the antioxidant properties of B.alba and B.rubra in this study, the radical scavenging activity was higher in B.alba, though both species have very high antioxidant activities compared to more available & more consumed leafy vegetables in Nigeria. For instance, radical scavenging activity in pepper ranged from 33-52% while it was 74% in Amaranth (Donglin and Yasunori, 2003; Oloyede et al, 2013). Free radical scavenging is one of the known mechanisms by which antioxidants inhibit lipid oxidation caused by free radicals. (Donglin and Yasunori, 2003). In this study, radical scavenging activities in Basella species were related to the concentrations of phenolic antioxidant compounds. Total phenol was higher in B.rubra, however flavonoid, anthocyanin and proanthocyanin were found to be higher in B.alba. High levels of variability have been found also in nutrient composition within varieties and species (Gina and Barbara, 2000).

The protein in B. alba (7g/100) is comparable to the composition in other dark green leafy vegetables with high moisture content. Protein content (5.9 g/100 g), Celosia argentea (5.8 g/100 g), cabbage (1.6g/100g), carrot (1.0 g/100 g), fluted pumpkin leaves (4.3 g/100 g), and Celosia trygina (5.1 g /100 g) on dry weight basis (Osagie and Offiong, 1997; FAO, 2010; Oloyede et al., 2011). According to USDA, 2002, fresh Ceylon spinach shoots per 100g edible portion is water 93g, E= 79KJ
(19kcal), Protein - 1.8g, fat 0.3g, Carbohydrate 3.4g. The Composition is comparable to other dark green leafy vegetables with high moisture content.

A low-potassium, high-sodium diet plays a major role in the development of hypertension and other cardiovascular diseases, but a diet high in potassium and low in sodium is protective against these diseases (Arbeit, et al., 1992). A dietary potassium-to-sodium ratio of greater than 5:1 is recommended to maintain optimum health. In this study, the ratio was 50:1 and 38:1 for B. alba and B. rubra respectively. The Ca content (109mg) and Ascorbic Acid (102mg) as recorded for this crop by USDA, 2002 were much higher compared to what were obtained in this study while the Fe (1.2mg) content was much lower compared to what was obtained from both species of Basella, in this study. Different factors such as environment, agronomy and post harvest handling could be responsible. According to Food and Agriculture Organization (2004), deficiencies in Iron and Zinc accounted for a high proportion of micronutrient deficiencies related problems. Consumption of both species of Basella could provide solution to these problems.

In conclusion, both species of Basella are high in antioxidants, essential mineral elements and protein, though in different concentrations. They could contribute towards combating problems of micronutrient deficiencies and free radicals in man.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Antioxidant activities (%)</th>
<th>Phenol (mg/100g)</th>
<th>Flavonoid (mg/100g)</th>
<th>Anthocyanin (mg/100g)</th>
<th>Proanthocyanidin (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. alba</td>
<td>89.3± 0.10%</td>
<td>2817b</td>
<td>3044a</td>
<td>1.96a</td>
<td>0.28a</td>
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<tr>
<td>B. rubra</td>
<td>91.3%</td>
<td>3044a</td>
<td>760b</td>
<td>0.01b</td>
<td>0.03b</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>0.23</td>
<td>2.27</td>
<td>2.27</td>
<td>0.02</td>
<td>0.02</td>
</tr>
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</table>

Values are means of triplicate analyses expressed on dry matter basis.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Protein (g/100g)</th>
<th>Moisture (g/100g)</th>
<th>Fat (g/100g)</th>
<th>Ash (g/100g)</th>
<th>Crude fiber (g/100g)</th>
<th>Carbohydrate (g/100g)</th>
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<tbody>
<tr>
<td>B. alba</td>
<td>7.00</td>
<td>90.00</td>
<td>0.02</td>
<td>0.91</td>
<td>0.90</td>
<td>0.18</td>
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<tr>
<td>B. rubra</td>
<td>4.05</td>
<td>90.20</td>
<td>0.79</td>
<td>0.88</td>
<td>1.96</td>
<td>2.18</td>
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<tr>
<td>LSD (0.05)</td>
<td>1.40</td>
<td>0.02</td>
<td>0.06</td>
<td>0.13</td>
<td>0.25</td>
<td>0.70</td>
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Values are means of triplicate analyses expressed on dry matter basis.

<table>
<thead>
<tr>
<th>Minerals</th>
<th>Fe</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Co</th>
<th>Pb</th>
<th>Zn</th>
<th>Cr</th>
<th>Cd</th>
<th>Ni</th>
<th>Na</th>
<th>K</th>
<th>As</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. alba</td>
<td>177.5a</td>
<td>14.3b</td>
<td>63.3b</td>
<td>13.0a</td>
<td>0.75a</td>
<td>3.1b</td>
<td>1.3b</td>
<td>2.0a</td>
<td>19.3b</td>
<td>12.5a</td>
<td>8.7b</td>
<td>435.2b</td>
<td>50.0</td>
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<tr>
<td>B. rubra</td>
<td>75.0b</td>
<td>38.5a</td>
<td>77.8a</td>
<td>11.5b</td>
<td>0.0b</td>
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<td>4.8a</td>
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<td>39.9a</td>
<td>0.0b</td>
<td>14.1a</td>
<td>537.6</td>
<td>0.0b</td>
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