Nutritional Assessment of Selected Leafy Vegetables

Muinat N. Lewu, and Learnmore Kambizi

Abstract— *Brassica oleracea* L. var acephala (leaf cabbage) commonly known as ‘Chomoullier’ and *Brassica napus* L. (leaf ‘rape’) are traditional leafy vegetables widely grown in Kenya (East Africa) and Zimbabwe (southern Africa). *Urtica urens* on the other hand, is a wild leafy vegetable consumed in rural communities of South Africa. A comparative study of the nutritional compositions of the leaves of these vegetable species was carried out. The results showed that the three species were high in moisture, carbohydrate and energy contents. The levels of ash, crude protein and crude fibre in *U. urens* were consistently higher than those of the two *Brassica* species. Moreover the crude lipid contents of the *Brassica* species (6.32% for *B. napus* and 7.94 for *B. oleracea* L. var acephala respectively) were significantly higher (*P < 0.05*) than that of *U. urens* (1.10%). *U. urens* was superior in all the micronutrients. Consumption of foods like *U. urens* that is rich in micronutrients could help in building a strong immune system, thereby helping the body to absorb, utilize and digest nutrients. The significantly higher level of iron in *U. urens* implies that consumption of this wild vegetable may increase the blood level and may therefore be recommended for anemic patients. In addition, because the cultivation of both *Brassica* species investigated in this study is not affected by season; hence, large scale production of these vegetables should be encouraged in order to make it available to all. *U. urens* on the other hand; being a wild vegetable can close the nutritional gap for those that are economically challenged. However, *U. urens* should be steamed or cooked before ingestion to destroy the stinging hairs.

Keywords— *Brassica napus* L, *Brassica oleracea* L. var acephala, mineral composition, proximate composition, *Urtica urens*

I. INTRODUCTION

In developing countries, the fight against poverty, hunger, malnutrition and undernourishment continues to be a basic goal of development and a variety of strategies are being applied. Strategies based on micronutrient rich food like vegetables are considered essential [1]. The inclusion of vegetables in human diets has been identified as a major means of promoting balanced diets across populations of various income brackets. This is because green vegetables have been recognized as one of the richest natural sources of essential minerals, protein and vitamins [2]-[5]. In addition to being cheap sources of macro and micronutrients, vegetables could also be efficiently produced with limited resources. The regular consumption of vegetables, specifically the dark green leafy vegetables is highly recommended because of their potential in reducing the risks of chronic diseases [6]-[8].

Among plant foods with health benefits are crops from the family *Brassicaceae* (also known as *Cruciferae*). In many parts of the world, many species of the cruciferous family (especially *Brassica*) are highly consumed as vegetables [9]. *Brassica oleracea* L. var acephala (leaf cabbage) commonly known as ‘Chomoullier’ and *Brassica napus* L. (leaf ‘rape’) are species of vegetable widely grown in Kenya (east Africa) and Zimbabwe (southern Africa). Both *Brassica* species are able to flourish well throughout the year, provided their water requirements are adequately met. There are numerous cultivars and clones of leaf cabbage. Some grow tall for repeated leaf pickings; these are popular everywhere in East and southern Africa while others are short. In Zimbabwe, the giant species are locally known as “Rugare” or “Covo”, “Sukuma wiki” in eastern Africa and ‘muRhodesia’ in northern part of South Africa.

Furthermore, because cultivated plants such as green vegetables are now becoming too costly for low income groups, wild and semi-wild food resources are frequently consumed as the dominant source of leafy vegetables especially in rural communities [10]. One of these wild green leafy vegetables is *U. urens* (family *Urticaceae*) commonly called annual nettle, dwarf nettle, small nettle, and lesser nettle which was evaluated in this study. *U. urens* is a wild leafy vegetable which is widely known for its medicinal uses. Like all green vegetables, nettle leaf is a micronutrient dense, nutritious food; however, it should be steamed or cooked before ingestion to destroy the stinging hairs, which contain histamine, formic acid, acetylcholine, acetic acid, butyric acid, leukotrienes, 5-hydroxytryptamine, and other irritants. Contact with the hairs leads to a mildly painful sting, development of an erythematous macule, and itching or numbness for a period lasting from minutes to days [11]-[14].

These vegetables are being referred to as “Morogo” or “Imifino” by the African population in South Africa. They are consumed as vegetable dish or prepared into sauces accompanying the starchy staple food like pap/stiff porridge made from maize (*Zea mays*) flour.

Despite the fact that “Rape” and “Choumollier” are widely cultivated in southern Africa and annual nettle also consumed as wild vegetable in South Africa, very little research has been conducted on their nutritional value. Although it is generally accepted that these leafy vegetables are delicious and nutritious, information on the nutritional profiles of the species growing in southern Africa is scanty. Compared with other edible *Brassica* species in this region, there is a dearth of information on scientific research carried out on the nutritional composition of *B. oleracea* L. var acephala “Choumollier” and *B. napus* L. “Rape” cultivated in this region of Africa.

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Likewise, having identified *U. urens* as a wild vegetable consumed in South Africa, there is a need for a systematic study and documentation of research findings on the nutritional quality of these three leafy vegetables as well as elucidates the nutritional benefit that may be derived from the consumption of both the cultivated and wild species investigated in this study.

II. MATERIALS AND METHODS

The leaves of *Brassica napus* “Rape” and *B. oleracea* var acephala “Chomoullier” were obtained from the experimental plot located at Cape Peninsula University of Technology, South Africa. The plants were grown in the glasshouse and later transplanted unto the field prior to this investigation. Materials for the analysis were collected three months after planting from the experimental field. Fresh leaves of *U. urens* were also collected from the wild around O.R. Tambo District municipality, Eastern Cape, South Africa. Fully grown fresh leaves of each vegetable were plucked with the stalk and labeled for identification. Leaf samples were weighed, washed in distilled water, air dried and chopped into thin pieces. Each sample was further oven-dried at 60°C to constant weight. The dried leaf samples were separately milled and stored in well labeled air-tight containers and refrigerated for the determination of proximate and mineral composition. All reagents used afterwards for the chemical analysis were of analytical grade.

A. Chemical analyses:

The moisture, dry matter, ash, crude lipid, and crude fibre contents of *B. napus* L. “*B. oleracea* L. var acephala and *U. urens*” were determined using the method described by the Association of Official Analytical Chemists [15]. Crude protein (N x 6.25) was determined by the micro-Kjeldahl method [16]. Carbohydrate content was also obtained using estimation by difference [by subtracting the total ash content, crude lipid, crude protein, and crude fibre from 100] [17]. The caloric value of each sample was calculated using Atwater factor method [(4 x crude protein) + (9 x crude lipid) + (4 x crude carbohydrate)] as described by [18].

For the elemental composition, a mixture of concentrated sulphuric acid (H₂SO₄), a catalyst (selenium), salicylic acid and hydrogen peroxide was used for sample digestion, and subsequently, total nitrogen, phosphorus, calcium, magnesium, sodium, potassium, zinc, copper, iron and manganese in the digests were determined. The mineral element composition of the samples was determined using the Atomic Absorption Spectrophotometer (AAS). Mineral K, S, Mg and C contents were determined by reading their absorbance at 766.5, 589.0, 285.2, and 422.7 nm wavelengths, respectively, while the Cu, Mg, Zn and Fe contents were measured at 324.8, 279.5, 213.9 and 248.3 nm wavelengths. Reference [16] reported that total P was obtained using the ascorbic acid blue colour procedure by reading the absorbance at a wavelength of 880 nm on a spectrophotometer.

B. Statistical analysis:

All determinations were replicated three times. The data obtained were subjected to analysis of variance (ANOVA) [19] using package and differences between means were tested with Duncan Multiple Range Test.

III. RESULTS AND DISCUSSION

A. Proximate composition:

Table I shows the result of the proximate analysis expressed in percentages. The three species investigated were high in moisture. The *Brassica* species had significantly higher moisture content (85.19% and 84.72% for “Chomoullier” and “Rape” respectively) compared with *U. urens* (83.70%). This agrees with the reported range (81.4-90.3%) in some Nigerian green leafy vegetables [7]. High moisture content in leafy vegetables is indicative of freshness as well as easy perishability [20]. High amount of moisture in leafy vegetables makes them vulnerable to microbial attack, hence, spoilage [21].

The levels of ash, crude protein and crude fibre in *U. urens* were consistently higher than those of the two *Brassica* species. The ash content is an index of the nutritionally important mineral contents present in the food material. In this case, the ash content of *B. napus* and *B. oleracea var acephala* is in accordance with the observation of [22] on three lines of leaf cabbage. The ash value (19.08%) for *U. urens* in this study was slightly lower than 27.75% reported for *U. urens* by [23]. However, the ash contents in the investigated vegetables are still considered high enough when compared with commonly consumed leafy vegetables like lettuce (0.4% DM), spinach (0.7% DM) and chomte (1.7% DM) [24]. These results compare favourably with the values reported for *Ipomea batatas* (11.10%), *Vernonia colorata* (15.86%) and *Moringa oleifera* (15.09% DW) [25]-[26].

Higher crude protein contents in *U. urens* (14.54%) further indicates that the leaves of this plant may be another cheap source of plant protein for marginal resource communities of South Africa. The crude protein contents of the examined vegetables, which ranged from 13.33% to 14.54% are greater than protein content of *Momordica foecid* (6.32% leaves) and *Ipomea batatas* (11.10%), *Vernonia colorata* (15.86%) and *Moringa oleifera* (15.09% DW) [25]-[26].

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There is high percentage of crude fibre in *U. urens* (4.6%) leaves and *Momordica foecid* (4.6%) leaves consumed in Nigeria and Swaziland [27]-[29]. Plant foods that provide more than 12% of their calorific value from protein have been shown to be good source of protein [30]. This shows that all the leafy vegetables investigated are good sources of protein.

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<table>
<thead>
<tr>
<th>Material</th>
<th>Moisture (%)</th>
<th>Dry Matter (%)</th>
<th>Ash (%)</th>
<th>Crude Lipid (%)</th>
<th>Crude Protein (%)</th>
<th>Crude Fibre (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>B. napus</em></td>
<td>83.70</td>
<td>16.30</td>
<td>19.08</td>
<td>4.68</td>
<td>8.50</td>
<td>20.90</td>
</tr>
<tr>
<td><em>B. oleracea</em></td>
<td>85.19</td>
<td>14.81</td>
<td>21.72</td>
<td>5.23</td>
<td>9.90</td>
<td>19.20</td>
</tr>
<tr>
<td><em>U. urens</em></td>
<td>85.72</td>
<td>14.28</td>
<td>23.54</td>
<td>4.98</td>
<td>10.50</td>
<td>23.50</td>
</tr>
</tbody>
</table>

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vegetables are low lipid containing food, and this may be an advantage for people suffering from obesity [33]. However, the result obtained for *U. urens* is lower than 7.3% reported for *U. urens* by [34] while the values observed in the two *Brassica* species were higher than 3.71 to 4.29% reported for *B. oleracea* var acephala by [22].

*Brassica napus* had the highest carbohydrate and energy contents. Generally, all the vegetables investigated were moderately high in carbohydrate (43.27% to 50.46%). This is close to 39.05% reported values for *Momordica balsamina* leaves [29], but lower than reported values for *Corchorus tridens* (75.0% DW) and sweet potato leaves (82.8%) [35].

The caloric values recorded in this study ranged between 246.39 kcal to 313.94 kcal with *U. urens* having the lowest. Nonetheless, these three vegetable species can be considered a good source of energy for both human and livestock that may eat them. These values compare favourably with 285.02 kcal and 260.93 kcal reported for *Argemone subfusiformis* and *U. urens* respectively [34]. One reference [35] also reported comparable energy content in some green leafy vegetables grown in Ghana.

**B. Mineral composition:**

The results of the analyses of the mineral compositions of the leafy vegetables are presented in Table II. *U. urens* was more superior in all the micronutrients. The significantly higher level of iron in the *U. urens* implies that consumption of this wild vegetable may increase the blood level and may therefore be recommended for anemic patients [36]. Consumption of foods like *U. urens* that is rich in micronutrients helps in building a strong immune system, thereby helping the body to absorb, utilize and digest nutrients. High concentrations of iron and zinc in *U. urens* as well as their moderate levels in the *Brassica* species is a good indication since the deficiencies of these two elements are the most prevalent micronutrient malnutrition in the world [37].

Although *U. urens* was significantly higher than the *Brassica* species in magnesium, both *U. urens* and *B. oleracea* L. acephala had higher levels of calcium compared to *B. napus*. M is an important mineral element in connection with circulatory diseases such as ischemic heart disease and calcium metabolism in bone [38]. Mineral C is required for strong bones, teeth, hair, nails and plays an important role in muscle contractions and relaxation, blood clotting, synoptic transmission and many cellular functions, such as production of energy and the maintenance of the immune function [39].

Furthermore, *B. napus* was significantly low in S compared to *B. oleracea* L. var acephala and *U. urens*. The results further indicate that potassium is one of the most abundant mineral elements in this study. This report agrees with early findings on the leaves of *C. esculenta* [40, 41]. Based on an earlier study, high dietary P in humans plays a protective role against hypertension, stroke, cardiac dysfunctions, renal damage, hypercalciumia, kidney stones and osteoporosis [42].

P, Mg, C and zinc levels of *B. oleracea* in this study were closely related to the results obtained for the same elements by [43] when six genotypes of *B. oleracea* L. var acephala were assessed for their nutrient contents. However, while K, Mn and Fe levels were lower in this investigation, C and S contents were more when compared to the results obtained for the six genotypes of *B. oleracea* L. var acephala cultivated in northern KwaZulu-Natal, South Africa [43]. The observed variations may be due to the differences in the genetic background, climate, season and the agronomic factors during cultivation [44].

**IV. Conclusion**

The present investigation has shown that *B. napus*, *B. oleracea* L. var acephala and *U. urens* are good sources of many nutrients like protein, crude fibre, C, P, Fe, Mn, Zn and Cu. Considering the substantial amount of minerals in these vegetables, and most especially high level of micronutrients in *U. urens*, these plants may be considered valuable and important contributors to the diets of the people in South Africa especially among the marginal income populations. In addition, because the cultivation of both *Brassica* species investigated in this study is not affected by season; hence, large scale production of these vegetables should be encouraged in order to make it available to all. *U. urens* on the other hand can close the nutritional gap for those that are economically challenged.

**V. Appendix**

**TABLE I**

**PROXIMATE COMPOSITION OF THE LEAVES OF RAPE (**BRASSICA NAPUS** L.), CHOUMOLLIER (**B. OLERACEA** I VAR ACEPHALA) AND **URTICA URENS**.

<table>
<thead>
<tr>
<th>Plant species</th>
<th>Moisture</th>
<th>Ash</th>
<th>Crude Protein</th>
<th>Crude Fibre</th>
<th>Crude Lipid</th>
<th>Carbohydrate</th>
<th>Kaloric value (Kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Brassica napus</em></td>
<td>84.72&lt;sup&gt;b&lt;/sup&gt;</td>
<td>14.76&lt;sup&gt;c&lt;/sup&gt;</td>
<td>13.79&lt;sup&gt;b&lt;/sup&gt;</td>
<td>14.66&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.32&lt;sup&gt;b&lt;/sup&gt;</td>
<td>50.46&lt;sup&gt;a&lt;/sup&gt;</td>
<td>313.94&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td><em>Brassica oleracea</em></td>
<td>85.19&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16.30&lt;sup&gt;b&lt;/sup&gt;</td>
<td>13.33&lt;sup&gt;b&lt;/sup&gt;</td>
<td>19.16&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.94&lt;sup&gt;a&lt;/sup&gt;</td>
<td>43.27&lt;sup&gt;b&lt;/sup&gt;</td>
<td>297.87&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><em>Urtica urens</em></td>
<td>83.70&lt;sup&gt;a&lt;/sup&gt;</td>
<td>19.08&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14.54&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20.69&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.10&lt;sup&gt;c&lt;/sup&gt;</td>
<td>44.59&lt;sup&gt;b&lt;/sup&gt;</td>
<td>246.39&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

LSD: 0.35 0.66 0.69 1.08 0.51 1.82 5.25

Data presented as the mean, n=3. LSD = Least Significant Difference. Means with different letters within the same column shows significant difference (*P* < 0.05).

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TABLE II
ELEMENTAL COMPOSITION OF THE LEAVES OF RAPE (BRASSICA NAPUS L.), CHOUMLIOLIER (B. OLERACEA L. VAR ACEPHALA) AND URTICA URENS.

<table>
<thead>
<tr>
<th>Plant species</th>
<th>Macro elements</th>
<th>Micro elements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P (%)</td>
<td>K (%)</td>
</tr>
<tr>
<td>Brassica napus</td>
<td>0.56&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.20&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Brassica oleracea</td>
<td>0.56&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.81&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Urtica urens</td>
<td>0.46&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.91&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

LSD: 0.03 0.16 0.08 0.03 76.18 7.61 62.54 0.76 6.52

Data presented as the mean, n=3. LSD = Least Significant Difference. Means with different letters within the same column shows significant difference (P < 0.05).

ACKNOWLEDGMENT

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REFERENCES


