Comparative Evaluation of the Proximate, Phytochemical and Antioxidant Properties of Selected Leafy Vegetables (Bitter, Pumpkin and Spinach Leaves)

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Abstract

The study was aimed at comparative evaluation of the proximate, phytochemicals and antioxidant properties of three leafy vegetables (V. amygdalina, Spinaciaoleracea and Telfairiaoccidentalis). The study was carried out using standard analytical procedures. The proximate analysis revealed highest percent moisture (5.08±0.13%), crude protein (19.69±0.87%), carbohydrate (38.31±1.42%) and metabolizable energy (244.24±3.82 KJ/100g) in pumpkin, highest percent ash (15.20 ± 0.86 %) and crude fat contents (8.30±0.18%) in spinach, while bitter leaf recorded the highest percent crude fibre (20.01 ± 1.20%). The phytochemical analysis revealed the presence of flavonoid, saponin, alkaloid, tannin and phenol which ranged from 8.67±0.11 mg/100 g to 18.98± 0.15 mg/100g. 0.9±0.00 mg/100g to 1.21± 0.10 mg/100g, 8.87±0.21 mg/100 g to 11.65±0.68 mg/100g, 0.81 ± 0.01 to 10.32± 1.2 mg/100g and 1.36 ±0.01 mg to 4.24±0.01 mg/100g, respectively. The antioxidant activities revealed highest percent inhibition (71.20%) in bitter leaf. However, based on the analysis of variance on the results obtained, the study revealed that there were significant differences in most of the analyzed parameters at 95% confidence level. Therefore, this study inferred that the nutritional and phytochemical contents of the leafy vegetables samples varied significantly and their consumption in a diet will be responsible for maintaining good health and proper functioning of the body system.

Keywords: Proximate, phytochemicals, antioxidant, leafy vegetables

Introduction

The nutritional and health benefits of eating green leafy vegetables have been demonstrated by several studies [1–3]. Thus, the nutrients (protein, minerals, fibers, etc) included in leafy vegetables can be absorbed by the body and employed as protective and regulating substances [2]. Additionally, they hold a significant position among other food crops since they give the body plenty of several different vitamins and minerals [3]. However, for the underprivileged portion of the population, green leafy vegetables are an affordable yet high-quality source of nourishment, particularly in areas where malnutrition is common [1, 4]. According to literature, leafy vegetables are great for calorie-conscious individuals who can satiate their hunger without consuming a lot of carbohydrates because they are low in calories and provide very little utility energy [5–6]. Furthermore, according to Udochukwu et al., they contain phytochemicals which several of these phytochemicals are anti-nutrients that lower the bioavailability of vitamins and minerals. While certain types of these phytochemicals have been utilized in traditional medicine to treat a variety of ailments in people [7].

Moreover, in Nigeria, starchy foods like rice, yam, and cassava flour are often consumed with cooked green vegetables as a soup or seasoning [2]. Additionally, in order to add flavor, taste, color, and aesthetic appeal to diet, these dishes can be made with a combination of several vegetables [8]. However, information on the statistical comparative evaluation of the nutritive, phytochemical and antioxidant properties of these leafy vegetables (bitter leaf, pumpkin and spinach) is still scanty. Therefore, this study is aimed at statistical evaluation of the proximate, phytochemical and antioxidant properties of selected leafy vegetables (Bitter Leaf, Spinach and fluted pumpkin) commonly consumed in Nigeria.

Materials and Methods

Sample collection and preparation

Fresh samples of three different vegetable leaves namely; spinach (Spinaciaoleracea), and pumpkin (Telfairiaoccidentalis) and bitter (V. amygdalina) leaves were collected directly from different farms in Keffi LGA of Nasarawa State. They were thoroughly washed to remove soil particles and other impurities. After washing, the samples were air dried by spreading them on polythene bags for two weeks. Finally, the dried samples were ground into smaller sizes or powder using a mortar and pestle and stored in polythene bags for further analyses.

Determination of proximate compositions

Moisture, ash, crude fiber, crude protein (% N x 6.25), and ether extract (EE) were determined for proximate compositions using the standard procedures outlined by the Association of Official Analytical Chemists [9].

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By using the difference, the total carbohydrate content was calculated. The calorific values (KJ/100g) were calculated by summing up (% proteins x 2.44) + (% carbohydrates x 3.57) + (% lipids x 8.37) for each sample. Each parameter in the samples was calculated in triplicate, reported as in percentage, and its standard deviation was computed and displayed as indicated in the Tables. All the reagents used were of analytical grade.

Phytochemical screening
The phytochemical compositions of the leafy vegetable extracts were screened to identify and quantify for the presence of tannins, saponins, alkaloids, flavonoids and phenol, using standard analytical procedures reported by Chukwuma and Ejikeme [10] with slight modifications.

Antioxidant activity
The free-radical antioxidant activities of the samples were investigated using 2,2-diphenyl-1-picrylhydrozyl radical (DPPH) in methanol as adopted by Jibrin et al. [11] with slight modifications. Thus, 1 mL of 1 mM of DPPH in methanol was prepared under darkness condition and 2 mL of this solution was added to 1 mL of various concentrations (0.2 - 1.0 mg/ml) of the extracts. Vitamin C was used as a standard. The absorbance was taken after 30 minutes at 517 nm and Percentage DPPH radical scavenging activity was calculated by the following equation,

\[
\% \text{ inhibition} = \frac{[A_{\text{control}} - A_{\text{extract}}]}{(A_{\text{control}})} \times 100
\]

Statistical analysis
Data were presented in mean and standard deviation and were also subjected to analysis of variance (ANOVA) for comparative analysis using R-statistical software (R-4.2.3).

Results and Discussion
The result of the proximate compositions of the selected vegetables (bitter leaf, pumpkin and spinach) is presented in Table 1.

From the Table (1), the moisture contents of the samples fell within the range of 3.38 to 5.08%. Statistically, the values indicated that there was no significant difference between bitter leaf and spinach samples but there was with the pumpkin sample at 95% confidence level. However, the values obtained for the studied samples are better sources of protein than those reported in the literature. This study also revealed that the values were also found to be slightly lower than 12.11 - 33.00% for the leafy vegetables (Amaranthushybridus, Andasoniadigitata, Ceibapatendra, Hibiscus sabdariffa and Vignaunguiculata) except for Ceibapatendra which is the least value (12.11%) reported by Asaolu et al. [14]. Investigations revealed that fiber cleanses the digestive tract by removing potential carcinogens from the body and prevents the absorption of excess cholesterol. Another finding also revealed that a high dietary fiber consumption is linked to improved insulin sensitivity, which suggests it may help prevent and manage Type 2 diabetes [3, 8]. This suggests that the substantial amount of fiber obtained from the leafy vegetable samples could help in keeping the digestive system healthy and functioning properly when consumed in a diet. The crude fat values were found to be 5.70% in bitter leaf, 8.30% in spinach and 7.10 in pumpkin respectively. The result showed a significant different among the samples at 95% confidence level. The values were also found to be in agreement with the crude fat values obtained from Talinumtriangulare (5.90%), Basella alba (8.71%), Amaranthushybridus (4.80%), Callchorus africanum (4.20%) [17]. Jibrin et al. [18] reported that a diet that provides 1–2% of a person’s energy as fat is adequate for them because consuming too much fat has been linked to various cardiovascular disorders.
This suggests that the vegetables samples are good for consumption since they had low fat contents. The result showed that the carbohydrate values ranged from 29.16 to 37.80% which showed no significant difference between spinach and pumpkin leaves but showed a statistical difference with bitter leaf at 95% confidence level. These values were found to be very low when compared with 82.8% reported by Okon et al. [19] for sweet potatoes leaves but higher than 20% reported for *Senna obtusifolia* [20]. Thus, high carbohydrate content contributes to the energy value of any given food substance. This suggests that the studied samples will contribute higher energy values than *Senna obtusifolia* but lower than sweet potatoes leaves. The calorific values obtained from this study fell within the range of 196.05± 1.61 to 244.24±3.82 which showed no significant difference between spinach and pumpkin but showed a statistical difference within the bitter leaf sample. However, the calorific values were found to be very low when compared with 1337.7-1536.43 KJ/100g for sweet tamarind (*Dialium guineense*) (seed, pulp and shell) reported by Jibrin et al. [18], 1352.70 ± 2.10 to 1594.80 ± 3.50 KJ/100 g for Baobab (pulp and seeds) reported by Hashim et al. [21] and 1801.05 ± 2.15 to 2139.58 ± 4.55 KJ/100 g for blood plum (pulp and seeds) reported by Aremu et al. [22]. This confirms the reported literature which describes leafy vegetables as low calorific values containing foods [5, 23]. This also suggests that comparatively, the studied samples cannot be considered as good sources of energy.

The result of the phytochemical analysis revealed the presence of flavonoids, tannins, phenols, saponins and alkaloids at different concentrations as shown in Table 2. However, this study agrees with most literatures on the presence of these phytochemicals at different concentrations in the studied samples [24-26]. The result also revealed that there was a significant difference in most of the phytochemicals presence among the samples. Thus, the concentrations of flavonoids ranged from 18.98 ± 0.15 to 8.67 ± 0.11 mg/100g which shows a significant difference among the samples at 95% confidence level with bitter leaf having the highest concentration. Research has demonstrated that flavonoids may enhance the body’s production of detoxifying enzymes, decrease inflammation, and inhibit the growth of malignancies [26-27]. This suggests that consumption of bitter leaf among the samples will more advantageous due its high flavonoids content and its roles in the body. According to research, tannins have been linked to a variety of physiological and anti-microbial activities, including the stimulation of phagocytic cells, host-mediated tumor activity, and a broad spectrum of anti-infective effects [27-28]. However, this research revealed that the concentrations of tannin fell within the range of 0.71 ± 0.01 to 10.32± 1.2 mg/100g which showed high significant difference between bitter leaf and the other samples. The high concentration of tannin found in bitter leaf sample is in consistent with the value (9.62 mg/100g) obtained by Udochukwu et al. [24] in his study on the phytochemical analysis of *Vernonia amygdalina* and *Ocimum gratissimum* extracts and their antibacterial activity on some drug resistant bacteria. This suggests that the bitter leaf sample is a better source of tannin compare to the other samples. As a result, consumption of bitter leaf may be a source of bioactive compounds useful in the treatment and prevention of cancer in the body [29]. According to Abdullahi and Santhose [30], the antioxidant properties of phenols are far stronger than those of vitamins C and E. This study revealed that the concentrations of phenols fell within the range of 4.24 ± 0.01 to 1.36 ± 0.01 mg/100g. However, the result showed that there was a significant difference among the samples at 95% confidence level. Highest concentration of phenol was observed in bitter leaf which also suggests that it’s a good source of phenols. The result also revealed a significant difference in the values of alkaloids among the samples at 95% confidence level. According to Olasupo et al. [26], alkaloids constitute a significant class of naturally occurring medications that are used to treat congestive heart failure. Because of their extreme toxicity and pronounced bitter taste, alkaloids are employed by plants as a defense mechanism against invertebrate pests, microbial diseases, and herbivores [24, 27]. Furthermore, according to Adetunji et al. [31], alkaloids possess antispasmodic, antibacterial, therapeutic, and antimalarial characteristics, making them the most effective phytochemical. Highest concentration of alkaloid was found in bitter leaf.

### Table 1: Proximate compositions of bitter, pumpkin and spinach leaves samples

<table>
<thead>
<tr>
<th>Parameters (%)</th>
<th>Bitter leaf</th>
<th>Spinach</th>
<th>Pumpkin</th>
</tr>
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<tbody>
<tr>
<td>Moisture content</td>
<td>3.78± 0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.38 ± 0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.08± 0.13&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Ash content</td>
<td>15.10± 1.30&lt;sup&gt;a&lt;/sup&gt;</td>
<td>15.20± 0.86&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11.65± 1.41&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>28.13± 1.67&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20.01± 1.20&lt;sup&gt;a&lt;/sup&gt;</td>
<td>18.17± 1.10&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Crude fat</td>
<td>5.70± 1.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.30± 0.19&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.10± 1.13&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Crude protein</td>
<td>18.13± 1.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>15.31± 1.27&lt;sup&gt;a&lt;/sup&gt;</td>
<td>19.69± 0.87&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>29.16± 0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>37.80± 0.56&lt;sup&gt;a&lt;/sup&gt;</td>
<td>38.31± 1.42&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Energy</td>
<td>196.05± 1.61&lt;sup&gt;a&lt;/sup&gt;</td>
<td>241.80± 0.86&lt;sup&gt;a&lt;/sup&gt;</td>
<td>244.24±3.82&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Each value represents the mean ± standard deviation of triplicate determinations values within the same row with different superscripts are significantly different at 95% confidence level.

### Table 2: Phytochemical analysis of bitter leaf, pumpkin and spinach

<table>
<thead>
<tr>
<th>Phytochemicals (mg/100g)</th>
<th>Bitter leaf</th>
<th>Spinach</th>
<th>Pumpkin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flavonoids</td>
<td>18.98 ± 0.11&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.67 ± 0.11&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11.84 ± 0.23&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Phenols</td>
<td>4.24 ± 0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.16 ± 0.02&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.36± 0.01&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Alkaloids</td>
<td>11.32± 0.16&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.65± 0.68&lt;sup&gt;b&lt;/sup&gt;</td>
<td>9.87 ± 0.21&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Saponins</td>
<td>1.03± 0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.97 ± 0.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.21± 0.10&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Tannins</td>
<td>10.32± 1.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.02 ± 0.12&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.81 ± 0.01&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Each value represents the mean ± standard deviation of triplicate determinations; value within a row with different superscripts are significantly different at 95% confidence level.

### Phytochemical screening

The phytochemical compositions of the selected leafy vegetables (bitter leaf, spinach and pumpkin) are shown in Table 2.
This implies that bitter leaf is good source of alkaloids and its consumption will help in the treatment of some ailments as mentioned above. According to literature, bioactive chemicals known as saponins have the ability to reduce the stomach’s absorption of glucose and cholesterol [24, 26, 29]. In addition, a family of naturally occurring substances called saponins complexes with cholesterol to create holes in bilayers of cell membranes. Consequently, these substances may be employed as agents that lower or inhibit cholesterol absorption [25]. Consequently, these substances may be employed as agents that lower or inhibit cholesterol absorption and function as anti-inflammatory and cholesterol-lowering agents. The presence of saponins in bitter leaf could be attributed to the high percentage compositions of phytochemicals present in the bitter leaf compared to the other vegetable samples and the ability of the body to maintain good health and proper functioning of the body system.

Conflict of interest: The authors hereby declared no conflict of interest in this research work.

References


