Assessment of Proximate Compositions of Twelve Edible Vegetables in Nigeria

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Abstract: Local vegetables in Akwa Ibom State, Nigeria have been consumed by the people for the desired flavor and taste without much attention to nutritional value. Research, however, has established that vegetables supply significant quantities of essential nutrients to the body and, assist in the maintenance of health and prevention of diseases. Twelve different vegetables commonly used as food in Nigeria were therefore subjected to analysis to determine their proximate nutrients content. Proximate nutrients values in the vegetables range from 5.50%-16.1% (ash), 10.9%-32.8% (crude protein), 1.85%-11.4% (crude fat), 0.85%-4.40% (crude fibre), 46.7%-79.5% (carbohydrate) and 67.1%-98.8% (moisture content). The highest proximate parameters were recorded as follows: ash (A. hybridus, 16.10%±0.10), crude protein (T. occidentalis, 32.82%±1.32), crude fat (L. sativa, 11.35%±0.05), crude fibre (A. hybridus, 4.40%±0.01), carbohydrate contents (B. olerecea, 98.85%±0.05), moisture content (B. olerecea, 79.46%±1.41) and caloric value (O. grattissimum, 408.7Kcal±0.65). All the vegetables are low fat source and nutritious, but the nutrient levels vary widely. Vegetables when combined would complement each other and make for more nutrient-rich local soups and diets.

Keywords: Edible vegetables; Nutrient composition; Akwa Ibom State; Nigeria.

1. Introduction

Akwa Ibom State is located in the Niger Delta region of Nigeria between Latitudes 4° 33’ and 5° 33’ North and Longitude 7° 35’ and 8° 25’ East. The State falls within the tropical zone with a
dominant vegetation of green foliage of trees, shrubs and oil palm tree belt, and is rich in varieties of leafy vegetables. Vegetables invariably contribute significant component of the diet of the people. The vegetables are consumed singly or combined in soups, as in the local delicacies—‘edikang ikong’ soup ($Talinum$ $triangulare$ plus $Telfaria$ $occidentalis$) and ‘ukwoho’ soup ($Talinum$ $triangulare$ plus $Gnetum$ $africanum$). Asaolu et al. reported that vegetables are widely consumed in the processed, semi-processed or raw form as part of a main dish or salad because of the taste and flavor added to the food [1]. Vegetables play an important role in the maintenance of good health as source of nutrients, which are usually in short supply in daily diets [2]. The nutrients in vegetables can be absorbed and used as regulatory and protective materials, as well as for body building [3, 4]. Vegetables have become significant part of human diets supplying the body with low calories and substantial amounts of necessary minerals and vitamins [5]. The low caloric content of vegetables is of importance; plants produce food in the leaves but do not store food in the leaves [6]. Consequently, vegetables do not supply excess energy to the body. The fibres in vegetables are known to promote digestion and prevent constipation [7]. Fats and oils in vegetables have been reported to lower blood lipids, leading to a reduction in the occurrence of diseases associated with coronary artery failure [8]. Plant materials that possess nutritional and medicinal functional values are referred to as nutraceutical plants [9].

$Talinum$ $triangulare$ (Waterleaf) belongs to the family of Portulacaceae. The leaves are small, soft and green in colour, and used medically in the treatment of cardiovascular diseases such as stroke and obesity [10]. The leaves are also used in treating diarrhea and gastro-intestinal disorders [11]. $Telfaria$ $occidentalis$ (Fluted pumpkin) belongs to the family Cucurbitaceae. The leaves are petiolate and green in colour. Both the leaves and seeds are very nutritive [12] and have been reported to serve as blood purifiers [13]. The leaves also are rich in iron and can be used to treat anemia [14], hence its usefulness in maintenance of good health in developing countries. $Brassica$ $oleracea$ (Cabbage or Kale) belongs to the Brassica family. The local name in some places is “hospital-too-far”; this is as a result of its numerous health benefits. The leaves are light green in colour, curly and overlap each other giving a circular shape; and are used in treating ulcers, eczema, acne and in cleansing of the colon [15]. $Murraya$ $koenigii$ (Curry leaf) is a member of the Rutaceae family. The leaves are characterized by a strong fragrant aroma, and are used as anti-diarrheal and dysentery, and blood purifier [16]. $Vernonia$ $amygdalina$ (Bitter leaf), a member of the Asteraceae family has leaves that are green, petiolate and elliptic in shape. The leaves have characteristically bitter taste, and the extract is used medicinally in treatment of skin infections, fever and diabetes [14]; and pile, stomach ache and hypertension [11].

$Heinsia$ $crinita$ (Bush apple) belongs to the family known as Rubiaceae. The local name is Atama. According to Etukudo, the leaf extract is used in treatment of skin rashes, and the leaves for the treatment of umbilical hernia [14]. $Piper$ $guineensis$ (West African Black Pepper) belongs to the
Piperaceae family. The leaves are broad and characterized by a pungent odour, and are used in the regulation of menstrual cycle [17]. Mensah et al. also reported use of the leaves in enhancing fertility in women [11]. *Amaranthus hybridus* (Bush Green, Amaranth, or Pigweed) belongs to the family of plants called Amaranthaceae. The leaves are green, petiolate and elliptic in shape. Mensah et al. reported use of similar species in same family, *Amaranthus cruentus*, in treating tapeworm and as a relief for respiratory diseases [11].

*Ocimum gratissimum* (Scent leaf or Tea bush) belongs to the family Lamiaceae whose leaves are green in colour, possess a strong fragrant aroma, and used as spice in preparation of meals. The leaves have been used in the treatment of conjunctivitis [1] and high fever, convulsions, diarrhea, eczema and piles [18]. *Lasianthera africana*, locally known as Editan, belongs to the family of Icacinaceae. The leaves are used as an antacid, analgesic, antiulcerogenic, antidiabetic and antimalarial [19]. *Lactuca sativa* (Lettuce) belongs to the family Asteraceae. The leaves are spirally aligned to form a dense rosette [20] and, are used mainly in salads. Traditionally, the leaves are used in treating a wide range of medical conditions including insomnia, anxiety, neurosis, dry coughs, and rheumatic pains [21]. *Gnetum africanum*, locally known as Afang in Akwa Ibom State, belongs to the family Gnetacea. The seeds are oval and small, and have been used in the treatment of pile, hypertension, enlarged spleen and sore throats [11, 12].

The study aims at assessing and comparing the proximate nutrient compositions of twelve commonly consumed leafy vegetables bought in Uyo, Akwa Ibom State in Nigeria.

2. Materials and Methods

2.1. Sampling and Sample Treatment

Twelve different leafy vegetables were purchased from different market sellers at Uyo main market, Uyo, Akwa Ibom State, Nigeria. The leafy vegetables were handpicked, rinsed with tap water, then with distilled water and oven-dried at 40 °C. The dried samples were ground into powder with mortar and pestle, and then passed through a 0.5 mm mesh size sieve. Each of the samples was stored in plastic containers until analysis.

2.2. Proximate Analysis

Moisture, ash, crude fat, crude protein, and crude fibre were determined in accordance with the official methods of the Association of Official Analytical Chemists [22]. Nitrogen was determined by the micro-kjeldahl method [23] and the nitrogen value was converted to percentage crude protein by multiplying by a factor of 6.25. Carbohydrate content was determined by estimation using the arithmetical difference method. The caloric values of the vegetable samples were estimated by...
summing the multiplied values for crude protein, crude fat and carbohydrate by 4 kcal, 9 kcal and 4 kcal respectively.

3. Results and Discussion

The results for proximate analysis are summarized in Tables 1 and 2.

**Table 1. Results of Proximate Composition Analysis (Moisture, Ash, Crude Protein, Crude Fat)**

<table>
<thead>
<tr>
<th>S/N</th>
<th>Vegetable Type</th>
<th>Moisture (%)</th>
<th>Ash (%)</th>
<th>Crude Protein (%)</th>
<th>Crude Fat (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Talinum triangulare</em></td>
<td>98.50±0.10</td>
<td>15.10±0.00</td>
<td>25.38±0.88</td>
<td>8.60±0.05</td>
</tr>
<tr>
<td>2</td>
<td><em>Telfaria occidentalis</em></td>
<td>86.15±0.15</td>
<td>7.65±0.27</td>
<td>32.82±1.32</td>
<td>6.85±0.00</td>
</tr>
<tr>
<td>3</td>
<td><em>Brassica oleracea</em></td>
<td>98.85±0.05</td>
<td>6.15±0.46</td>
<td>10.94±1.31</td>
<td>2.42±0.03</td>
</tr>
<tr>
<td>4</td>
<td><em>Murraya koenigii</em></td>
<td>80.75±0.05</td>
<td>11.10±0.10</td>
<td>25.38±0.88</td>
<td>1.85±0.05</td>
</tr>
<tr>
<td>5</td>
<td><em>Vernonia amygdalina</em></td>
<td>84.10±0.10</td>
<td>9.10±0.00</td>
<td>29.32±0.44</td>
<td>10.13±0.03</td>
</tr>
<tr>
<td>6</td>
<td><em>Heinsia crinita</em></td>
<td>67.80±0.00</td>
<td>7.35±0.46</td>
<td>11.38±0.00</td>
<td>6.15±0.05</td>
</tr>
<tr>
<td>7</td>
<td><em>Piper guineensis</em></td>
<td>85.10±0.10</td>
<td>10.60±0.10</td>
<td>11.82±0.44</td>
<td>6.08±0.08</td>
</tr>
<tr>
<td>8</td>
<td><em>Amaranthus hybridus</em></td>
<td>76.15±0.15</td>
<td>16.10±0.10</td>
<td>23.64±0.00</td>
<td>6.03±0.03</td>
</tr>
<tr>
<td>9</td>
<td><em>Ocimum gratissimum</em></td>
<td>78.60±0.10</td>
<td>9.75±0.27</td>
<td>21.88±0.00</td>
<td>11.30±0.05</td>
</tr>
<tr>
<td>10</td>
<td><em>Lasianthera africanum</em></td>
<td>73.70±0.20</td>
<td>8.85±0.27</td>
<td>17.51±0.88</td>
<td>5.25±0.00</td>
</tr>
<tr>
<td>11</td>
<td><em>Lactuca sativa</em></td>
<td>74.45±0.05</td>
<td>12.50±1.19</td>
<td>17.07±0.44</td>
<td>11.35±0.05</td>
</tr>
<tr>
<td>12</td>
<td><em>Gnetum africanum</em></td>
<td>67.10±0.10</td>
<td>5.50±0.10</td>
<td>17.94±0.44</td>
<td>5.60±0.05</td>
</tr>
</tbody>
</table>

Values are mean ± Standard Deviation of four replicate determinations

3.1. Moisture

High moisture content helps in maintaining the protoplasmic contents of the cells [17]. It also supports a greater activity of water-soluble enzymes and co-enzymes needed for metabolic activities of these leafy vegetables [24]. However, high moisture content makes vegetables susceptible to spoilage [17]; microorganisms that cause spoilage are known to thrive in foods containing high moisture content [25].

It was observed that *Brassica oleracea* and *Talinum triangulare* had the highest moisture content of 98.50% and 98.85% respectively (Table 1). Sheela *et al.* (2004) reported 85% moisture content in *Brassica oleracea* [26], which is lower than the value obtained in the present study. However, Caunii *et al.*, reported similar moisture content of 92.52% for *Brassica oleracea* [27]. Kwenin *et al.* also reported high moisture content of *Talinum triangulare* (91.83%) [28]. *Brassica oleracea* and *Talinum triangulare* therefore would have short shelf life and cannot be stored for as
long as the other vegetables. For *Amaranthus hybridus*, Akubugwo et al. reported a higher value of moisture content (83.48%) [29] than that obtained in present study (76.15%).

*Gnetum africanum* (67.10%) and *Heinsia crinita* (67.80%) had the lowest moisture content among the vegetables. Stored *Gnetum africanum* and *Heinsia crinita* leaves therefore are expected to have the longest shelf life, as the relatively low moisture content would inhibit growth of microorganisms. The moisture content of *Gnetum africanum*, although the lowest among the vegetables, was higher than results obtained in 1996, 37.39% [30] and in 2007, 31.6% [12].

**Table 2.** Results of Proximate Composition Analysis (Crude Fibre, Carbohydrate, Caloric value)

<table>
<thead>
<tr>
<th>S/N</th>
<th>Vegetable Type</th>
<th>Crude Fibre (%)</th>
<th>Carbohydrate (%)</th>
<th>Caloric Value (K cal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Talinum triangulare</em></td>
<td>4.23±0.08</td>
<td>46.70±0.90</td>
<td>365.70±0.55</td>
</tr>
<tr>
<td>2</td>
<td><em>Telfaria occidentalis</em></td>
<td>1.50±0.05</td>
<td>51.19±1.22</td>
<td>397.65±0.40</td>
</tr>
<tr>
<td>3</td>
<td><em>Brassica oleracea</em></td>
<td>1.08±0.03</td>
<td>79.46±1.41</td>
<td>383.43±0.63</td>
</tr>
<tr>
<td>4</td>
<td><em>Murraya koenigii</em></td>
<td>2.70±0.05</td>
<td>58.98±1.08</td>
<td>354.05±0.35</td>
</tr>
<tr>
<td>5</td>
<td><em>Vernonia amygdalina</em></td>
<td>2.03±0.03</td>
<td>49.44±0.77</td>
<td>406.13±0.03</td>
</tr>
<tr>
<td>6</td>
<td><em>Heinsia crinita</em></td>
<td>1.95±0.05</td>
<td>73.17±0.25</td>
<td>393.55±0.55</td>
</tr>
<tr>
<td>7</td>
<td><em>Piper guineensis</em></td>
<td>2.50±0.03</td>
<td>69.21±0.86</td>
<td>378.78±1.03</td>
</tr>
<tr>
<td>8</td>
<td><em>Amaranthus hybridus</em></td>
<td>4.40±0.00</td>
<td>49.84±0.13</td>
<td>348.13±0.28</td>
</tr>
<tr>
<td>9</td>
<td><em>Ocimum gratissimum</em></td>
<td>2.20±0.05</td>
<td>54.87±0.05</td>
<td>408.70±0.65</td>
</tr>
<tr>
<td>10</td>
<td><em>Lasianthera africanum</em></td>
<td>1.95±0.00</td>
<td>66.45±0.82</td>
<td>383.05±0.20</td>
</tr>
<tr>
<td>11</td>
<td><em>Lactuca sativa</em></td>
<td>3.13±0.08</td>
<td>55.96±0.21</td>
<td>393.90±0.10</td>
</tr>
<tr>
<td>12</td>
<td><em>Gnetum africanum</em></td>
<td>0.85±0.00</td>
<td>70.11±0.39</td>
<td>402.60±0.65</td>
</tr>
</tbody>
</table>

Values are mean ± Standard Deviation of four replicate determinations

### 3.2. Ash Content

Ash content in leafy vegetables is a reflection of the amount of mineral elements present in the vegetables [18]. High ash content in a leafy vegetable would imply high mineral content, hence very nutritious. But Ukam reported that it could be the reverse if it contained toxic metals which also contribute to the ash percentage in leafy vegetables [31]. Therefore, high ash content is not necessarily a conclusive factor regarding the health benefits of vegetables. However, Ifon and Bassir, reported that leafy vegetables with ash content greater than 8.8% are healthful [32]. Only *Telfaria occidentalis* (7.65%), *Heinsia crinita* (7.35%), *Brassica oleracea* (6.15%) and *Gnetum africanum* (5.50%) have ash content values below 8.8% (Table 1).
Amaranthus hybridus was observed to have the highest ash content among the vegetables. The high ash content of Amaranthus hybridus is consistent with the report of Asaolu et al. (15.55%) [1], and Akubugwo et al. (13.8%) [29]. The lowest ash content was observed in Gnetum africanum, 5.50%, which was still higher than 1.2% reported by Ekop [12]. Values of 9.56% and 13.01% ash content in Vernonia amygdalina and Ocimum gratissimum respectively have been reported [1]; these values compare favorably with values obtained in the present study. Percent ash content obtained for Telfaria occidentalis was higher than the value reported by Ekop, 6.9% [12] and Asaolu et al. 8.54% [1].

3.3. Crude Protein

Protein content in the fresh vegetables range from 32.82% in Telfaria occidentalis to 10.94% in Brassica oleracea as presented in Table 1. Protein is an important part of diets that is used in body building and repair of tissues. Onwordi et al. considers plant food providing more than 12% of its calorific value from protein as a good source of protein [33]. As a result, all investigated vegetables excluding Piper guineensis (11.82%), Heinsia crinita (11.38%) and Brassica oleracea (10.94%), could be recommended as source of protein.

The crude protein content of Gnetum africanum in the study is similar to that reported in 2007 (17.5%) [12]. Fagbohun et al. reported the crude protein content of Talinum triangulare as 31.0% [18] and is similar to the result obtained in this study. Several results reported by different authors however, were either higher or lower than values obtained in this study – Taiga et al. reported a value of 13.33% [34] and Asaolu et al. a higher value of 61.7% [1] in Telfaria occidentalis. For Amaranthus hybridus, Akubugwo et al. reported a lower value of 17.9% [29], while Asaolu et al. reported higher value (49.0%) [1]. Crude protein content of Ocimum gratissimum in this study was slightly higher than the result obtained by Fagbohun et al. (14.6%) [18], but considerably lower than values obtained by Asaolu et al. (62.7%) [1]. These vast disparities may be attributed to differences in application of manure to enrich the nitrogen content of the soils where the different vegetable samples were obtained [3].

3.4. Crude Fat

Dietary fat is a major determinant of palatability of food [35]. It has also been reported that vegetable fats and oil lower blood lipids, hence contribute to reduction in the occurrence of diseases associated with damage of coronary artery [8].

Lactuca sativa (11.35%), Ocimum gratissimum (11.3%), Vernonia amygdalina (10.13%) had the highest fat content among the vegetable samples (Table 1). Crude fat content of Ocimum gratissimum was higher than values reported by others 7.57% [18] and 4.02% [1], while crude fat
content of *Vernonia amygdalina* was similar to that reported (9.05%) by Asaolu *et al.* [1]. Lower values of crude fat were obtained in *Gnetum africanum* [12, 18], than that reported in this study. Furthermore, in *Amaranthus hybridus* values reported [18, 29] were slightly higher than our result. *Brassica oleracea* and *Murraya koenigii* were observed to have extremely low fat content of 2.42% and 1.85% respectively compared to the other vegetables, which range from 5.25%-11.35%. As a result, these two vegetables could be more suitable for consumption by people with obesity.

### 3.5. Crude Fibre

Fibre in leafy vegetables plays a number of roles in the body. Fibre is known to cleanse the digestive tract, remove potential carcinogens from the body, as well as keep blood sugar levels under control [25].

*Amaranthus hybridus* contains significantly high quantity (4.40%) of crude fibre compared to other vegetable samples (Table 2). Higher values of crude fibre have been reported in *Amaranthus hybridus* [1, 29]. *Amaranthus hybridus* is a good source of fibre, which makes it suitable for people with high blood cholesterol levels. Similarly, *Talinum triangulare* was observed to have a high percentage of crude fibre (4.23%), though lower than value obtained by Kwenin *et al.* [28]. Crude fibre content of *Ocimum gratissimum* was similar to that obtained by Agbaire and Emoyan (2.4%) [36], and that of *Piper guineensis* was comparable to 2.9% reported by Emebu and Anyika (2011) [25]. The least value of crude fibre (0.85%) was recorded in *Gnetum africanum* and is consistent with that reported in 2007 (0.8%) [12].

### 3.6. Carbohydrate

The main function of carbohydrate is to provide the body with fuel and energy that is required for daily activities and exercise. The human body needs constant supply of energy to function properly, and lack of carbohydrate in the diet may result in tiredness or fatigue, poor mental function, and lack of endurance and stamina.

Of the macronutrients (carbohydrate, fat and protein), carbohydrate content was the highest with values in the range of 46.7%-79.46% (Table 2). Highest values were recorded in *Brassica oleracea* (79.46%), *Heinsia crinita* (73.17%) and *Gnetum africanum* (70.11%). When compared with other studies, carbohydrate content in *Gnetum africanum* was lower than the 87.62% reported [12]. The value obtained for *Amaranthus hybridus* was in line with the result reported by Akubugwo *et al.* (52.18%) [29]. Similarly, Fagbohun *et al.* reported 56.16% carbohydrate value for *Ocimum gratissimum* [18], which was similar to the result obtained in the present study (54.87%).
Carbohydrate content in *Telfaria occidentalis* was higher than 31.25% reported in 2007 [12] but lower than 63.64% reported in 2008 [34].

3.7. *Caloric Value*

The caloric value of the vegetable samples offers a direct and easy comparison of the energy supplied by consumption of the leafy vegetables. It has been reported that in healthy humans, the rate of gastric emptying is a function of caloric value [37].

From the results obtained, *Ocimum gratissimum* and *Vernonia amygdalina* have the highest caloric values of 408.70 Kcal and 406.13 Kcal respectively (Table 2). The high caloric value of *Vernonia amygdalina* was also observed by Saidu and Jideobi (2009) [3]. Amongst the popularly consumed vegetables in Uyo, Nigeria, *Murraya koenigii* (354.05 Kcal) and *Amaranthus hybridus* (348.13 Kcal) have the lowest caloric value, therefore may supply the lowest energy compared to other vegetables.

4. *Conclusions*

All the vegetables have nutritional value but the levels vary widely. *Talinum triangulare* apart from the low carbohydrate content has very rich food value. Vegetables when combined, especially *Talinum triangulare* with other vegetable would complement each other and make for more nutritious local soups and diets.

Further analysis of the mineral composition as well as the levels of toxicants and anti-nutrients present in these vegetables is necessary to determine accurately the nutritional importance. It is also necessary to consider other aspects, such as the effect of processing methods on the nutrient availability and anti-nutrient levels in order to determine the bioavailability of the nutrients. These investigations would provide an accurate description of the nutritive value of the vegetables.

**References**


