COMPARATIVE EVALUATION OF PROXIMATE COMPOSITION OF SELECTED WILD-EDIBLE PLANTS IN CENTRAL CROSS RIVER STATE

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ABSTRACT
The need to document the nutritional profiles of different wild-edible plants and put them to use for the larger population is important. In this research, four wild edible plants namely - *Adenia cissampeloides*, *Arthropteris palisoti*, *Ficus glumosa*, and *Ceiba pentandra*, were harvested from the forage of central Cross River State to quantify and compare their nutritional components. The determination of the proximate composition was carried out using the standard method. No significant differences were observed in the moisture content (%) between *Adenia cissampeloides* (ACD), *Ceiba pentandra* (CPD) and *Ficus glumosa* (FGD) (*P* < 0.05). The same trend was observed in the moisture content of APD (*Arthropteris palisoti*), CPD and FGD. Samples FGD and APD had significantly (*P* < 0.05) higher fat content matched to ACD and CPD. The crude fibre content of *Ceiba pentandra* (CPD) and *Adenia cissampeloides* (ACD) was higher than *Arthropteris palisoti* (APD) and (FGD). Considering the sample, therefore, one can conclude that the wild *Adenia cissampeloides*, *Arthropteris palisoti*, *Ceiba pentandra*, and *Ficus glumosa* had high energy value, fat, ash content and the lowest content of protein and carbohydrate.

Keywords: nutrition, wild-edible plants, proximate, food, and public health

INTRODUCTION
Wild edible plants are species that are either domesticated or cultivated but exists in their natural habitats (Magdalene et al., 2019). Distribution of Plants species is influenced by drought-resistant ability, reproduction, and regeneration. Wild plants are endowed with bioactive components that are beneficial to humans and animal health. Despite their spectrum of activities, wild edible plants are low-cost for propagation/management and maintenance of good health; these wild edible plants are underutilized due to lack of awareness about their nutritional profile. Indeed, huge amounts of edible plants may be wasting away in the wild due to unawareness. Their potential as alternate dietary sources of calories, minerals, vitamins, and therapeutic properties are unknown to many people.

Incidences of foods shortages usually arose when the anticipated harvests of cultivated plants are not achieved or when there is a drastic reduction of stored dietary resources. Seasonal scarcity of edible plants may limit the availability of popular foodstuffs. Some plants diets can provide excellent and balanced supply of vital proteins (amino acids) especially in combination with vegetable proteins in the diet. Living organisms, directly or indirectly depend on vegetable resources to meet their daily vitamins and minerals (Cochart, 2011). Biodiversity is significant in meeting the basic needs of humans (Uprety et al., 2012). Some plants served as sources of herbal therapy and food to man and animals (Adou et al., 2016).

Before the evolution of agriculture, all plants foods materials existed in the wild. These plants were grown within the human settlements to make them accessible to people (Freedman, 2015). Historically, before the advent of animals and plants domestication, humans lived as nomadic hunter-gatherers owing to their reliance on animals and plants as a source of livelihood (Scarre, 2005). As people gained knowledge about plants’ growth/development, the practice of domesticating plants commenced (Baker, 2009). Moreover, edible plants from wild habitat offer potential for crop
improvement and development of new crops via domestication. (Shrestha and Shrestha, 2004; Hajjar and Hodgkin, 2007; Termote et al., 2011).

Given the rapid decline of ecological knowledge about wild food plants, the evaluation and documentation of the traditional information related to the usage, status, and diversity of wild plant species are crucial (Bhattarai et al., 2009; N’danikou et al., 2011). At the local levels, consumers are poorly informed about the nutritional benefits of some foods they consume concerning the nutrients and anti-nutrients (Bhattarai et al., 2009).

*Adenia cissampeloides* is called snake climber, monkey rope, wild granadilla (Grace and Fowler, 2007). It is locally called "Igwu" in Yala, Nigeria. *A. cissampeloides* is a climbing, robust tree that uses tendrils to attach itself to the surrounding plants. It is bluish-green and dioecious. Its stem grows to about 30 m tall with a diameter of 10 cm. *Adenia cissampeloides* contain several minerals and bioactive components in its leaves, bark, roots, stems, and fruits, (Grace and Fowler, 2007; Fern, 2014), figure 1a.

*Ficus glumosa* is known as mountain fig or African rock fig, while its local names in Nigeria are "Kudung" (Obudu) and "Baure" (Hausa). *F. glumosa* is a tree of small to medium size, which grows to 5.0 – 10 m height and 50 cm in diameter. The plant is supported by stilt roots and wide-spreading branches (Ntchapda et al., 2015). This tree possesses three types of flowers: short-styled female, a long-styled female and male flowers (Cochart,
Arthropteris palisoti is a tropical creeping, epiphytic fern, belonging to the family of pteridophytes (vascular cryptogams).

Pteridophytes are flowerless constituting the second largest group of vascular plants. They significantly enrich plant biodiversity (Adou et al., 2016). Figure 1c. Ceiba pentandra otherwise known as “kapok tree”, “Fromager” (in French), “Otorokpa” (in Yala), is a massive tree with about 200 feet height, which makes it tower over the surrounding vegetation. Its trunk (with a diameter of 9.0 – 10 feet) and large branches are dotted with unique conical prickles (or spines) (Jukofsky, 2002). The leaves are palmate composing of 5.0 – 9.0 leaflets and can produce an enormous 500 – 4,000 fruits at a time with 200 seeds enclosed in a single fruit. The seeds are edible while its young leaves are used to prepare soup in some localities (Jukofsky, 2002; Hellmuth, 2011; Friday et al., 2011). Seeds are the primary stage in a plant life cycle and they have a potent defense mechanism which may be due to the activities of Phyto-constituents (Kiran et al., 2012). Furthermore, the oil from the kapok tree is yellowish with a mild pleasant odor and taste similar to cottonseed oil. On exposure to air, its oil quickly turns rancid but does not dry out due to its high iodine value (85 - 100) (Hori et al., 2000; Hellmuth, 2011), figure 1d.

Wild plants are endowed with bioactive compounds that are beneficial to humans. Despite the spectrum of wild edible plants, their low cost of management and beneficial roles are grossly underutilized. This is due to lack of awareness on the nutritional profile. This study evaluated the nutritional profile and protein bioavailability of selected lesser-known wild leafy vegetables (Adenia cissampeloides, Arthropteris palisoti, Ceiba pentandra, and Ficus glumosa) consumed in Nigeria.

MATERIALS AND METHODS
Collection and identification of vegetables
The vegetables such as Adenia cissampeloides “Igwu” collected from Yala-Nkum in Ikom LGA, Arthropteris palisoti “Ikpaladi” was collected from Ekor, in Yakurr LGA, Ceiba pentandra “Otorokpa” was obtained from Okpoma in Yala LGA and Ficus glumosa “Kudung” gotten from Abochiche in Bekwarra LGA. They were identified and authenticated by Dr. S. Udo from the Department of Biological Science, Cross River University of Technology (CRUTECH), Calabar.

Proximate analyses
Moisture content estimation, total protein, fats estimation, determination of fibre level, ash content estimation and total carbohydrate, were carried out using the method of (A.OA.C, 1995). Energy values were determined by the method of Onyeike et al., (2000) and estimation of some anti-nutritional elements was analyzed by the method of Munro and Bassir (1969).

RESULTS
Proximate composition
Significant differences were not observed in the moisture content (%) between Adenia cissampeloides (ACD), Ceiba pentandra (CPD) and Ficus glumosa (FGD) (P < 0.05). The same trend was observed in the moisture content of APD (Arthropteris palisoti delicacy), CPD and FGD. Samples FGD and APD had significantly (P < 0.05) higher fat content compared to ACD and CPD (Table 1). The crude fibre content of Ceiba pentandra (CPD) and Adenia cissampeloides (ACD) was significantly (P < 0.05) higher than compared Arthropteris palisoti delicacy (APD) and (FGD).
Table 1 Proximate composition of four plants

<table>
<thead>
<tr>
<th>Delicacy type</th>
<th>Moisture (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Fibre (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACD</td>
<td>14.77 ± 3.18	extsuperscript{a}</td>
<td>24.73 ± 2.39	extsuperscript{a}</td>
<td>24.64 ± 0.58	extsuperscript{a}</td>
<td>13.39 ± 0.37</td>
</tr>
<tr>
<td>APD</td>
<td>11.07 ± 0.75	extsuperscript{b}</td>
<td>17.18 ± 2.22</td>
<td>46.71 ± 0.87</td>
<td>8.63 ± 1.11	extsuperscript{a}</td>
</tr>
<tr>
<td>CPD</td>
<td>12.93 ± 1.96	extsuperscript{a,b}</td>
<td>28.47 ± 3.17	extsuperscript{a}</td>
<td>22.07 ± 1.82	extsuperscript{a}</td>
<td>15.85 ± 1.43</td>
</tr>
<tr>
<td>FGD</td>
<td>11.9 ± 0.2	extsuperscript{a,b}</td>
<td>10.33 ± 0.66</td>
<td>54.40 ± 3.94</td>
<td>9.73 ± 0.65	extsuperscript{a}</td>
</tr>
</tbody>
</table>

Test groups with identical superscripts are not significantly different at $P < 0.05$, while test groups with non-identical superscripts are significantly different at $P < 0.05$, for the proximate composition of Adenia cissampeloides (ACD), Arthropteris palisoti (APD), Ceiba pentandra (CPD) and Ficus glumosa (FGD), respectively. $n = 3$.

Table 2 Proximate compositions

<table>
<thead>
<tr>
<th>Delicacy type</th>
<th>Ash (%)</th>
<th>Carbohydrate (%)</th>
<th>Energy(kcal/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACD</td>
<td>14.47 ± 1.31</td>
<td>21.77 ± 4.18	extsuperscript{a}</td>
<td>407.76 ± 3.67	extsuperscript{a}</td>
</tr>
<tr>
<td>APD</td>
<td>14.87 ± 2.58</td>
<td>10.62 ± 4.35	extsuperscript{b,c}</td>
<td>526.91 ± 6.11</td>
</tr>
<tr>
<td>CPD</td>
<td>15.03 ± 1.50</td>
<td>17.18 ± 1.64	extsuperscript{a,b}</td>
<td>381.20 ± 19.20	extsuperscript{a}</td>
</tr>
<tr>
<td>FGD</td>
<td>17.33 ± 0.43</td>
<td>7.35 ± 3.88	extsuperscript{c}</td>
<td>560.35 ± 22.52</td>
</tr>
</tbody>
</table>

Test groups with identical superscripts are not significantly different at $P <0.05$ whereas test groups with non-identical superscripts are significantly different at $P < 0.05$. $n = 3$, for proximate composition (%) of Adenia cissampeloides (ACD), Arthropteris palisoti (APD), Ceiba pentandra (CPD) and Ficus glumosa (FGD).

Results of the proximate analysis showed that Adenia cissampeloides (ACD) and Ceiba pentandra delicacy (CPD) had significantly higher ($P < 0.05$) carbohydrate content compared to the other as shown in Table 2. Results of the energy (caloric) value determination showed that samples APD and FGD had significantly ($P < 0.05$) higher energy value (ACD and CPD).

Anti-nutritional elements

Table 3 showed the content (mg/100 g) oxalate in Ceiba pentandra (CPD) and Ficus glumosa (FGD). They were not significantly different from one another. The overall results revealed that APD contained the highest amount of oxalate while ACD had the least content. The content (mg/100 g) of phytate in Ceiba pentandra (CPD) delicacy was the lowest among the samples at $P < 0.05$. The following comparisons showed non-significant difference viz. Adenia cissampeloides (ACD) versus Ficus glumosa (FGD) and Arthropteris palisoti (APD) versus Ficus glumosa (FGD) at $P < 0.05$ as regards the phytate content. The level of phytate in APD was significantly increased relative to ACD ($P < 0.05$). Hydrogen cyanide (HCN) was not detected in Adenia cissampeloides (ACD) as shown in Table 3. However, quantitative analysis of antinutrient revealed that its content (mg/100 g) did not vary.
significantly compared to the following: *Arthropteris palisoti* (APD) versus *Ficus glumosa* (FGD) and *Ficus glumosa* (FGD) versus *Ceiba pentandra* (CPD) at $P < 0.05$. 

### Table 3 Antinutrient profile

<table>
<thead>
<tr>
<th>Delicacy type</th>
<th>Oxalate (mg/100 g)</th>
<th>Phytate (mg/100 g)</th>
<th>Hydrogen cyanide (mg/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACD</td>
<td>± 0.02</td>
<td>8.27 ± 0.15</td>
<td>0.00 ± 0.00</td>
</tr>
<tr>
<td>APD</td>
<td>0.41 ± 0.02</td>
<td>8.90 ± 0.44</td>
<td>0.04 ± 0.01</td>
</tr>
<tr>
<td>CPD</td>
<td>0.33 ± 0.02</td>
<td>7.63 ± 0.25</td>
<td>0.02 ± 0.01</td>
</tr>
<tr>
<td>FGD</td>
<td>0.36 ± 0.02</td>
<td>8.70 ± 0.10</td>
<td>0.03 ± 0.01</td>
</tr>
</tbody>
</table>

Test groups with identical superscripts are not significantly different at $P < 0.05$ whereas test groups with non-identical superscripts are significantly different at $P < 0.05$. $n = 3$, for anti-nutrients analysis (mg/100 g) of *Adenia cissampeloides* (ACD), *Arthropteris palisoti* (APD), *Ceiba pentandra* (CPD) and *Ficus glumosa* (FGD).

### DISCUSSION

Quantitative analyses of wild *Adenia cissampeloides*, *Arthropteris palisoti*, *Ceiba pentandra*, and *Ficus glumosa* showed that FGD had the highest energy value, fat, ash content and the lowest content of protein and carbohydrate. The protein quality of the experimental diets was largely within the same range but was comparatively lower than the reference (casein) diet administered.

The present study showed that the moisture content was significantly higher in *Adenia cissampeloides* delicacy (ACD) than in *Arthropteris palisoti* delicacy (APD). This difference may be due to the variations in the soil structure/texture where the plants grew as well as meteorological factors such as evaporation (Araya and Garcia-Baquero, 2014). Plants are sensitive to the availability of water (Seneviratne et al., 2010, Piedallu et al., 2013). They have adaptive and sensing mechanisms that ensure their survival and competitive success. Water influences the functionality and growth of plants.

According to Khan *et al.* (2016), plant food is a good source of protein where 12 percent or more of its caloric value are provided by protein. The principal functions of proteins are growth and development (Mutiaura *et al*., 2013). Besides, protein, carbohydrate, fat, and water are the main determining factors of body weight in an individual (Nelson and Cox, 2013).

The proximate analyses of the nutrient contents of *Adenia cissampeloides* (ACD), *Arthropteris palisoti* (APD), *Ceiba pentandra* (CPD) and *Ficus glumosa* (FGD) showed that carbohydrate content in ACD was the highest. This was consistent with Udo *et al.* (2013) report of insignificant high levels of carbohydrates in *Adenia cissampeloides* vegetable compared to *Ceiba pentandra* vegetable and this outcome was replicated in their energy values where there was also a non-significant difference between ACD and CPD Table 1 and 2. However, FGD had the highest significant energy value and fat content. Carbohydrate, fat, and protein serve as energy substrates for biochemical processes. On the other hand, the provision of energy is not the primary function of proteins (Nagendra *et al*., 2011). The high fibre content in CPD was because *Ceiba pentandra* is a perennial tree (Jukofsky, 2002) which may accumulate fibre in its cells. Dietary fibers (cellulose and hemicellulose) are polysaccharides embedded in the cell walls of plants and they are integral constituents of sclerenchyma tissues hence contribute to the support, tensile strength and density of plants (Armstrong, 2010).

Besides, the hygroscopic nature of fibers enables them to absorb and retain water (Celino *et al*., 2013) which may also account for the high moisture content in ACD than in APD.
(their fiber content indicated a similar trend). This implies that the higher the amount of fiber in a vegetable, the more volume of moisture it will retain. Likewise, the differential extent of complexes that dietary fibers form with the anti-nutrients (hydrogen cyanide, phytate, and oxalate) may partially be responsible for the observed variations among the selected anti-nutrient contents, since they occur in molecular complexes with fibers (Omoruyi et al., 2007; Dlamini et al., 2009; Siddiqui and Prakash, 2014). Additionally, the degree of chelation by these anti-nutrients to minerals (Sikora et al., 2008; Adeniyi et al., 2009) such as calcium, magnesium, sodium, and phosphorus may partly explain the differences noticed in the mineral levels.

It is also plausible that some of the minerals may have leached into the cooking medium which is in line with Bernhardt and Schlich (2006) assertion that during cooking, minerals are not destroyed by heat but leached into the surrounding liquid medium. This is buttressed by the differences in ash contents. Ash content is an established index of mineral content (Hussain & Khan, 2010). Minerals (otherwise called micronutrients) though constituted only 4.0 – 6.0 percent of the human body is of critical importance in foods. The optimal functioning of the body requires the participatory roles of calcium in many of its biochemical processes (Shad et al., 2013; Khan et al., 2016). One mechanism by which proteins influence energy balance in the body is via the regulation of appetite. In order to enhance the diets of vulnerable populations, it is necessary to factor the proximate aspect of wild edible plants (Obi-Abang et al., 2018).

Considering the rapid decline in knowledge about the diversity of wild plants, their choices as foods are difficult to establish due to toxicity and intoxication. In the local communities, consumers are poorly informed on the nutritional benefits of some wild plant with respect to the basic nutrients and anti-nutrients or general food quality (Obi-Abang et al., 2018). Therefore, the quantity and quality of food is an important feature in the modulation and regulation of appetite/satiety.

CONCLUSION
The data obtained indicated that wild Adenia cissampeloides, Arthropteris palisoti, Ceiba pentandra and Ficus glumosa vegetable contain valuable nutrients at varying concentrations. The plants could contribute reasonably to the protein, carbohydrate and fat needs of the consumers. Therefore, if delicacies are made from these known edible vegetables they can supplement the nutritional needs of the individual.

REFERENCES


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