

# Nutritional composition of Neglected Underutilized Green Leafy Vegetables and Fruits in South East Geopolitical Zone of Nigeria

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## ABSTRACT

**Background/Objective:** Vegetables and fruits play a highly significant role in food security of the underprivileged in both urban and rural settings. The study was designed to determine the nutritional implication of some neglected underutilized fruits and vegetables in Southeast geopolitical zone of Nigeria.

**Methodology:** The commonly occurring underutilized fruits and vegetables were selected for the study. The food crops were harvested and identified at the Herbarium in the Department of Plant Science and Biotechnology, University of Nigeria Nsukka. Twenty underutilized fruits and vegetables each were cleaned and analysed for nutrients composition using standard methods. Data were presented using descriptive statistics, percentage, mean, standard deviation and frequency. **Results:** The proximate composition of the fruits ranged from 54.34-80.30 % moisture, 0.27-6.21 % protein, 0-3.08 % fat, 0.28-8.58 % fibre, 0.33-11.05 % ash and 9.08-36.61 % carbohydrate. The ranges for mineral values of the fruits were iron 0.10-9.60 mg, zinc 0.02-10.30 mg, manganese 0.10-6.60 mg and calcium 5.42-46.50 mg. The vitamin contents of the fruits ranged from beta-carotene traces -5666.67 RE, ascorbic acid 0-48.82 mg and vitamin E 0 -11.99 mg. The proximate composition of the vegetables ranged from moisture 60.45-91.00%, protein 0.02-6.60%, fat 0.02-2.19 %, fibre 0.04-5.01 %, ash 0.04-4.20 % and carbohydrate 10.30-36.61 %. The ranges for mineral values of the vegetables were iron 1.40-14.80 mg, zinc trace-9.40 mg, manganese 0.07-4.80 mg and calcium 18.19-400.00 mg. The vitamin levels of the vegetables were beta-carotene 15.20-1933.33 RE, ascorbic acid 2.40-38.40 mg and vitamin E traces - 6.67 mg. **Conclusion:** The use of these fruits and vegetables should be encouraged particularly in areas where they are not produced through nutrition education in order to promote the food use of these crops.

**Keywords:** Nutritional, composition; underutilized; vegetables and fruits.

## 1.INTRODUCTION

United Nations Food and Agriculture Organization (1) has widely noted that most widespread and debilitating nutritional disorders, like birth defects, mental and physical retardation, weakened immune systems, blindness and even death has resulted from poor fruits and vegetables consumption habits (2). The ideal strategy to fighting micronutrient deficiency is to improve the diet by including a large variety of food rich in micronutrients and to increase dietary absorption of these nutrients. According to Okigbo (3) while the crisis situation caused by lack of animal foods may require broad and fundamental rethinking about policy and action, traditional foods may be the short term remedy. Micronutrients are found in vegetables and fruits but in a form less easily absorbed unless taken at the same time with enhancers or processed in a way

25 to enhance the absorption of these micronutrients (4). Quite large number of indigenous leafy  
26 vegetables and fruits have long been known and reported to have health protecting properties  
27 and uses. Vegetables and fruits are important sources of protective substances, which are  
28 highly beneficial for the maintenance of good health and prevention of diseases (5; 6). The  
29 inclusion of vegetables and fruits in the diets has provided basic nutritional requirements for  
30 man. The indigenous knowledge of the health promoting and protecting attributes of vegetables  
31 and fruits are clearly linked to their nutritional and non- nutrient bioactive properties. Indigenous  
32 fruits and vegetables have long been, and continue to be reported to significantly contribute to  
33 the dietary vitamin and mineral intakes of local populations (7). The potassium content of leafy  
34 vegetables and fruits are useful in the control of diuretic and hypertensive complications,  
35 because it lowers arterial blood pressure. The fiber content also contributes to the feeling of  
36 satisfaction and prevents constipation (8). In spite of the body of evidence confirming the  
37 nutritional contribution of indigenous vegetables and fruits to local diets, their health  
38 maintenance and protective properties, there has been very little concerted effort towards  
39 exploiting the biodiverse nutritional and health properties of fruits and vegetables to address  
40 the complex food, nutrition and health problems of the society. The ultimate goal of this  
41 research was to determine the chemical composition of these underutilized fruits and  
42 vegetables which will promote their use as food and consequently improve the nutritional status  
43 of both the rural and urban dwellers.

## 44 **2. MATERIALS AND METHODS**

### 45 46 **2.1 Study Area/ Study Design**

47  
48 The study is experimental.

49  
50 The study was carried out in South East Nigeria. South east Nigeria lies approximately between  
51  $4^{\circ} 30^1$  N and  $7^{\circ} 00^1$  N latitude and  $6^{\circ} 00^1$  E and  $9^{\circ} 00^1$  E longitude, located in the mosaic of  
52 lowland rainforest and secondary grassland vegetation zone found in some parts of Nigeria. The  
53 zone occupies about 50, 000 km<sup>2</sup> of Nigeria's total area of 923 768 km<sup>2</sup>. South East zone shares  
54 boundary with Cross River in the East, Akwa Ibom, Bayelsa and Rivers in the South, Kogi and  
55 Benue in the North and Delta in the West. In South east zone of Nigeria, due to their rich  
56 biodiversity, many underutilized indigenous leafy vegetables and fruits of promising nutritional  
57 values which can nourish the ever increasing human population exist.

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## 62 **2.2 Procurement/ Identification of Samples**

63

64 A multi stage sampling technique was used to select 20 communities for the study. The samples  
65 were harvested in 20 communities in South East Nigeria. The plants harvested were identified at the  
66 Herbarium in the Department of Botany, University of Nigeria Nsukka, Nigeria. Some samples were  
67 randomly selected and used for further study.

68

## 69 **2.3 Chemical analysis**

### 70 **Moisture determination**

71 The moisture content of the samples was determined using the air oven method of AOAC (9).

### 72 **Protein determination**

73 Crude protein content of the samples was determined using the automated micro-Kjeldahl  
74 method as described by AOAC (9).

### 75 **Fat determination**

76 The fat content was determined using the Soxhlet extraction method (9).

### 77 **Crude fibre determination**

78 The crude fibre content of the samples was determined according to the procedure of AOAC (9).

### 79 **Ash determination**

80 The ash content was determined according to the procedure of AOAC (9).

### 81 **Carbohydrate determination**

82 Carbohydrate content was calculated by difference. The estimated percentages of crude protein,  
83 ash, fat, fibre and moisture was summed up and the value subtracted from 100%.

84  $CHO = 100\% - \% (\text{protein} + \text{fat} + \text{ash} + \text{fibre} + \text{moisture})$ .

### 85 **Mineral determination**

86 The mineral contents, namely: Na, K, Ca, Mg, Cu, Mn, Hg and Pb contents were determined by  
87 the method described by Pearson (10) using a Pye Unicam SP9 Atomic Absorption

88 Spectrophotometer (AAS) connected to an SP9 computer (Pye Unicam Ltd, York Street,

89 Britain). Total phosphorus was determined by the spectrophotometric molybdovanadate (9).

### 90 **Determination of $\beta$ -carotene**

91 The extraction of carotenoids was carried out according to the method of Seo et al (11) with  
92 slight modifications.

### 93 **Determination of vitamin E profile**

94 Vitamin E content was analysed by the method described by Burri (12) using High performance  
95 liquid chromatography (HPLC).

### 96 **Vitamin C determination**

97 Vitamin C determination by iodine titration as described by Anne Helmenstine was carried out  
98 (9).

### 99 **3. RESULTS**

100 The list of underutilized vegetables selected for analysis was shown in table 1.

101 The list of underutilized fruits selected for analysis was shown in table 2.

102 The proximate composition of twenty underutilized indigenous vegetables were shown in table  
103 3a. The moisture content of these indigenous vegetables ranged from 60.45-91.00% per 100g  
104 edible portion, with *Bombaceae spp* having the highest moisture content and *Blinghia unijugata*  
105 having the least value. The protein content varied from 0.02-6.60% per 100g sample with *Ficus*  
106 *elsticoides* having the highest protein content. The fat content of the samples ranged from 0.02 in  
107 *Moraceae spp* to 2.19% in *Vaccinium parvifolium* per 100g sample. The crude fibre contents of  
108 the samples ranged from 0.04-5.01%/100g, with *Bombaceae spp* having the highest crude fibre  
109 content. The ash content of the vegetables were between 0.04 in *Euphobiaceae spp* to 4.20% in  
110 *Pterocarpus santalinoides* while the carbohydrate content of the samples were between 10.30-  
111 30.49%.

112 The proximate composition of some underutilized fruits were shown in table 3b. The moisture  
113 content of these underutilized fruits ranged from 54.34-80.30%, with *Phyllanthus debilis* having  
114 the highest moisture value and *Parkia clappatonia* having the least value. The protein content  
115 varied from 0.27-6.21% with *Irvingia gabonensis* fruits having the highest protein content. The  
116 fat content of the samples ranged from Traces-3.08%. The crude fibre contents of the samples  
117 ranged from 0.11-8.58%/100g, with *Ficus sur* having the highest crude fibre value. The ash  
118 content of the fruits were between 0.33-11.05%/100g sample while the carbohydrate contents of  
119 the samples were between 9.08-36.61%. All values are on wet weight basis.

120 The mineral composition of the twenty underutilized vegetables were shown in table 4a. The iron  
121 content of the underutilized vegetables were between 1.40-11.80mg/100g with *psychotria viridis*

122 having the highest iron content and *Bombaceae spp* and *Blinghia nitens* having the least value.  
123 The copper content was highest in *Ipomea batata* (3.14mg/100g) and lowest in *Moraceae spp*  
124 (0.02mg/100g). The levels for other minerals are zinc (0.00-9.40mg/100g), manganese (0.07-  
125 4.80mg/100g), calcium (18.19-400.00mg/100g), magnesium (4.38-47.20mg/100g), sodium  
126 (0.27-3.01mg/100g), potassium (16.20-104.23mg/100g), and phosphorus (75.40-  
127 685.60mg/100g).

128 The mineral composition of some underutilized indigenous fruits were shown in table 4b. The  
129 iron contents of these underutilized fruits were between 0.10-9.80mg/100g with *Vevet tamarind*  
130 having the highest iron content and *Gongronema spp* having the least value. The copper content  
131 was highest in *Gongronema spp* (4.06mg/100g) and lowest in *Olox viridis* (0.00mg/100g). The  
132 levels for other minerals are zinc (0.02-10.30mg/100g), manganese (0.10-6.60mg/100g), calcium  
133 (5.42-46.50mg/100g), magnesium (0.21-31.82mg/100g), sodium (Trace-6.20mg/100g),  
134 potassium (2.43-410.00mg/100g), and phosphorus (1.70-44.66mg/100g).

135 The B-carotene and vitamin composition of some underutilized vegetables were shown in table  
136 5a. The beta carotene contents of the underutilized vegetables were between 15.20-1933.33  
137 RE/100g sample with *Vitex doniana* having the highest beta carotene value. The ascorbic acid  
138 contents varied between 2.40-38.40mg /100g sample while the vitamin E contents were from  
139 Traces-6.67mg/100g sample.

140 The B-carotene and vitamin composition of some underutilized fruits were shown in table 5b.  
141 The beta-carotene content of the underutilized fruits ranges from traces of beta-carotene to  
142 5666.67RE /100g sample with *Cola parchycarpa* having the highest beta-carotene value. The  
143 ascorbic acid contents varied between 1.20 in *Cola gigantean* to 48.82mg/100g in *Artocarpus*  
144 *altilis* edible samples. The vitamin E contents ranged from traces in *Olox viridis*, *Napoleana*  
145 *imperialist* and *Icacina trichatha olive* to 11.99mg/100g in *Artocarpus altilis* samples.

## 146 **4. DISCUSSION**

### 147 **4.1 Proximate analysis**

### 148 **4.2 Moisture**

150 In the study, the moisture content of the underutilized vegetables were between 60.45-  
151 91.00%/100g sample. The result of the present study is in line with the value reported by Sheela  
152 et al. (5) who observed that the moisture content of thirty eight underutilized green leafy

153 vegetables in Southern Karnataka were between the range of 68.00-93.00%. Fasoyiro et al. (13)  
154 observed that the moisture content of fruits were from 78.24-84.81%. This falls within the range  
155 of values obtained in this study (54.34-80.30%). The high moisture content in these vegetables  
156 and fruits were not a surprise as Ene-Obong (14) noted that the most single constituent of fruits  
157 and vegetable is water, which accounts for more than 80% of the nutrients. This will result to  
158 lower contribution of other proximate components. The high moisture content of these fruits and  
159 vegetables indicates that they will not have a long keeping quality.

#### 160 **4.3 Protein**

161 The protein values (0.02-6.60%) obtained for these vegetables varied. Although vegetables are  
162 not good sources of protein, *Ficus elsticoides* had a high protein level (6.60%). Eyo et al. (15)  
163 observed that the protein levels of some vegetables are comparable to those of cereals (7.90%).  
164 The high protein content of *Ficus elsticoides* could be useful in fighting kwashiorkor in  
165 communities where protein energy malnutrition is prevalence provided it is consumed in  
166 significant quantity. The protein value obtained for the fruits were 0.27-6.21%. Inclusion of 100g  
167 portion size of *Ficus elsticoides* (6.60% protein), *Irvingia gabonensis* (6.21% protein) and  
168 *Sterculiar spp* (6.04% protein) as shown in the pictorial record to the diet may be capable of  
169 providing more than one-fifth of protein which will satisfy the RNI (27g protein) for children  
170 (16).

#### 171 **4.4 Fat**

172 Generally, vegetables and fruits are not good sources of fat. The result of the study confirms this  
173 claim (0.02-2.19% fat) for vegetables and (traces-3.08% fat) for fruits. Consumption of these  
174 vegetables and fruits may help to reduce high incidence of obesity, diabetes, cardiovascular  
175 diseases, high blood pressure, which are associated with high intake of fatty foods. The results of  
176 the vegetables were in line with the values reported by Sheela et al. (5) (0.20-2.60%).

#### 177 **4.5 Crude fibre**

178 The crude fibre levels of the underutilized vegetables (0.04-5.01%/100g) and fruits (0.11-  
179 8.58%) are of interest. The high fibre contents of *Pterocarpus santalinoides* (4.30%), *Bombaceae*  
180 spp (5.01%) and *Olox viridis* (8.58%) could provide bulk in the diet, enhance gastrointestinal  
181 function, prevent constipation and may reduce the incidence of metabolic diseases like maturity

182 onset diabetes mellitus and hypercholesterolemia (17). Portion size as shown for 100g of *Olox*  
183 *viridis* if consumed in a day may provide more than one-third of the (RNI) for fibre which is 18g  
184 (18).

#### 185 **4.6 Ash**

186 *Landolfolia dulcis* fruit (11.05%) with high ash content suggests that the mineral content of this  
187 fruit may be high. The ash levels of foods are an indication of the mineral content of the food.  
188 The values (0.60-3.40%) reported by Ajayi et al.(19) as the ash contents of some leafy vegetables  
189 studied were within the range of values observed in this study (0.04-4.20%).

#### 190 **4.7 Carbohydrate**

191 Vegetables and fruits are not major sources of carbohydrates compared to starchy foods, which  
192 form the bulk of food eaten. The very low carbohydrate contents of *Portulace oleraceae*  
193 (10.30%), *Ficus sur* vegetables (11.17%), *Phyllanthus debilis* (9.08%) and *Ficus sur* fruit  
194 (10.48%) is of interest. This is because low carbohydrate foods are good for people with obesity,  
195 high blood pressure and diabetes mellitus challenges.

#### 196 **4.8 Vitamins and Beta-carotene**

#### 197 **4.9 Ascorbate**

198 The ascorbic acid values (2.40-38.40mg) for all the vegetables studied were within the range of  
199 values (3.00-75.00mg) as observed by Sheela et al. (5) on 28 underutilized vegetables studied in  
200 Tanzania. The high ascorbate value for *Portulace oleraceae* (38.40mg), *Artocarpus altilis*  
201 (48.82mg) and *Ficus sur* fruit (40.22mg) is of interest. Consumption of adequate quantities of the  
202 fruits and vegetables with iron rich foods will enhance the absorption of iron. Ascorbic acid is  
203 important in connective tissue and for proper absorption of iron and calcium. Adequate intake of  
204 the fruits and vegetables may assist in the prevention of early death from heart diseases and  
205 cancer and may also play a primary role in collagen formation which is essential for the growth  
206 and repairs of tissue cells, gums, blood vessels, bones and teeth. Vitamin C is an important  
207 antioxidant. The high Vitamin C level in the fruits and vegetables may help to battle against  
208 cancer and many degenerative diseases (i.e. Alzheimer's, Cardiovascular Disease, Diabetes, etc).  
209 (20).

#### 210 **4.10 Vitamin E**

211 The high vitamin E content of some of the fruits and vegetables is desirable. Vitamin E is a  
212 powerful antioxidant thus neutralizing free radicals in the body that causes cellular damage. It  
213 also contributes to a healthy circulatory system and aids in proper blood clotting and improves  
214 wound healing. Some studies have shown that vitamin E decreases symptoms of premenstrual  
215 syndrome and certain types of breast disease (21). *Artocarpus altilis* fruit had 11.99mg/100g  
216 vitamin E, *Phyllanthus debilis* fruit had 8.00mg/100g, while *Blighia unijugata* vegetables had  
217 6.67mg/100g. Portion size as shown for 100g of *Artocarpus altilis* (11.99mg/100g) and  
218 *Phyllanthus debilis* fruit (8.00mg/100g), could provide half of the daily RNI need of vitamin E  
219 for breastfeeding mothers (16.80mg), adult men, women and pregnant women (13.20mg) (22).

#### 220 **4.11 Beta-carotene**

221 The high beta-carotene levels (15.20-1933.00RE) of the vegetables are not a surprise. Eyo et al.  
222 (15) observed that the yellow and green colours of vegetables indicate carotene, which is a  
223 precursor of vitamin A. Consumption of 100g of majority of the vegetables studied as shown in  
224 the pictorial record (*Vitex doniana*-1933.33RE, *Ficus vogaliana*-163333RE, *Ceiba pentandra*-  
225 1866.67RE, *Pterocarpus santalinoides*-1233.33RE, *Moraceae spp*-450.00RE, *Bombaceae spp*-  
226 616.67RE, *Blighia unijugata* -591.67RE, *Brillantaisi nitens*- 700.00RE, *Vaccinium parvifolium*-  
227 451.67RE, and *Gssampelus mucanta*- 701.67RE ) could provide the RNI (400RE) for  
228 provitamin A (23). Majority of the fruits (*Nauclea diderrichii*-1233.33 RE, *Spondian mombin*-  
229 2000.00 RE, *Vitex doniana*-1333.33 RE, *Afromomium daniella*-566.67 RE, *Myristicaceae spp*-  
230 4333.33 RE, *Irvingia gabonensis*-416.67 RE, *Cola parchycarpa*-5666.67 RE and *Parkia*  
231 *clappatonia*-970.67 RE ) have high beta carotene which are higher than the RNI (400RE) for  
232 Provitamin A. High level of beta-carotene in some of the vegetables and fruits is particularly  
233 important if they are consumed in significant quantity to reduce incidence and severity of  
234 respiratory tract infection of which pneumonia is the most serious (24). High consumption of the  
235 vegetables and fruits could help to maintain normal vision, promote healthy cell growth, improve  
236 iron utilization, gene expression, reproductive system, embryonic development, growth and  
237 immune function (25).

#### 238 **4.12 Minerals**

#### 239 **4.13 Iron (Fe)**

240 The high iron content of *Psychotria viridis* (11.80mg), *Napoleana imperialist* (9.40mg),  
241 *Hippocretae myrint* (9.60mg), *Afromomium daniella* (8.40mg), *Portulace oleraceae* (10.50mg),  
242 *Ficus fur* (10.60mg) and *Berlinia grandflora* (8.80mg) has nutritional significance. The fruits  
243 and vegetables with their high ascorbate levels could be useful in the fight against iron  
244 deficiency anemia. Vitamin C enhances the absorption of nonheme iron. The ascorbate levels  
245 for each of the fruits and vegetables were *psychotria viridis* (29.90mg), *Portulace oleraceae*  
246 (38.40mg), *Hippocretae myrint* (22.70mg), *Afromomium daniella* (14.80mg), *Ficus fur*  
247 (11.60mg) and *Berlinia grandflora* (11.40mg). Consumption of 100g portion size of *psychotria*  
248 *viridis* (11.80mg Fe), *Napoleana imperialist* (9.40mg Fe), *Hippocretae myrint* (9.60mg Fe),  
249 *Afromomium daniella* (8.40mg Fe), *Portulace oleraceae* (10.50mg Fe), *Ficus fur* (10.60mg Fe)  
250 and *Berlinia grandflora* (8.80mg Fe) may provide more than half of the RNI, for iron  
251 (12.00mg/day) (26). The result indicated that the iron content of some of the vegetables (1.40-  
252 11.80mg) were higher than those reported by Nnamani et al. (27) (3.68-7.34mg) and Maundu  
253 (28) (0.70-8.90mg) on underutilized vegetables.

#### 254 **4.14 Copper (Cu)**

255 Copper is not found in large quantity in fruits and vegetables. The values (traces-4.06mg)  
256 observed for fruits were in line with the values (0.60-3.80mg) observed by Umran and Nevo (29)  
257 on fruits. Decuypene (26) observed that the estimated safe and adequate intake of copper per  
258 day is 1.50-3.00mg. Thus including 100g portion size of *Cola parchycarpa* fruits (2.01mg) and  
259 *Blinghia unijugata* vegetables (2.28mg) in daily diet ensures up to 50% of the daily RNI for  
260 copper. Daily consumption of 100g portion size of *Gongronema spp* (4.06mg) and *Ipomea batata*  
261 (3.14mg) may provide 100% RNI for copper which is an important component of many redox  
262 enzymes, including cytochrome oxidase (30).

#### 263 **4.15 Zinc (Zn)**

264 The zinc contents of the vegetables studied were between 1.30-9.40mg/100g. The zinc levels in  
265 the fruits (0.02-10.30mg) were in line with the report of Umran et al. (31) who observed zinc  
266 levels of 1.80-9.10 mg on fruits. The zinc levels of *Vitex doniana* (9.40mg) and *Hippocretae*  
267 *myrint* (10.30mg) are of interest since plant foods are not major sources of zinc. Lippard and  
268 Berg (30) stated that zinc is a trace mineral element that plays a catalytic role in enzymes. The

269 RNI of Zn is 200mg/day. Shankar and Prasad (32) observed that zinc enrichment may be  
270 beneficial for health, but excess zinc may interact with Fe and Cu metabolism. Intake of  
271 significant quantity of the vegetables with high zinc levels (*Vitex doniana* (9.40mg) and  
272 *Hippocretae myrint* (10.30mg)) could reduce the duration and severity of diarrhea for infants and  
273 young children with acute diarrhea (33).

#### 274 **4.16 Manganese (Mn)**

275 Consumption of 100g portion size of some of the vegetables and fruits such as *Ficus vogaliana*  
276 (4.80mg), *Hippocretae myrint* (6.60mg), *Icacina trichatha olive* (5.40mg), *Bombaceae spp*  
277 (4.30mg), *Uvaria chamea* (3.60mg), and *Daniella olivera* (4.02mg) may provide the daily need  
278 of manganese in both children and adult which is 2.00-5.00mg and 2.00-3.00mg, respectively  
279 (26). The result of the fruits studied (0.10-6.60) were in line with the values reported by Umran  
280 et al. (31) on fruits (0.70-5.70mg). Manganese is essential for processing oxygen (30).

#### 281 **4.17 Calcium (Ca)**

282 Some of the vegetables studied are good sources of calcium. The values observed in this study  
283 (18.19-400.00mg) for vegetables and values (5.42-46.50mg) for fruits are of interest. Inclusion  
284 of 100g portion size of *Brillantaisi nitens* (400.00mg), *Irvingia gabonensis* (30.00mg)  
285 *Pterocarpus santalinoides* (343.40mg), *Bombaceae spp* (252.00mg), *Berlinia grandiflora*  
286 (340.00mg), *Ceiba pentandra* (261.50mg), *Daniella olivera* (281.90mg) and *Gssampelus*  
287 *mucanta* (374.00mg) in daily diet may ensure 100% RNI (250mg calcium) for infants. Adequate  
288 intake of fruits and vegetables could help in building the structural frame work of the body,  
289 formation of bone, neutralize acidity, clear toxins and help blood stream (34).

#### 290 **4.18 Magnesium (Mg)**

291 The result showed that some of these fruits and vegetables could provide some health benefits  
292 as dietary components because they contain significant quantities of magnesium. *Phyllanthus*  
293 *debilis* (31.82mg) and *Nauclea diderrichii* (26.10mg) has significant quantities of Mg.  
294 Magnesium is required for processing ATP and related reactions, build bone, cause strong  
295 peristalsis, increase flexibility, maintain blood pressure and acid –base balance (34). Magnesium  
296 also helps in maintaining proper muscle functioning and keeping the muscles relaxed, helps in

297 absorbing calcium and phosphorus and is very important for proper functioning of the nervous  
298 system (35).

#### 299 **4.19 Sodium (Na)**

300 The sodium levels of the vegetables (0.27-3.01mg) were lower than the values reported by  
301 Nnamani et al. (36) (7.00-21.00mg) and Taiye and Asiebey-Berko (37) (6.44-21.82mg). The  
302 values (traces-6.20mg) obtained in the fruits were in line with the values observed by Nevo (38)  
303 (0.0-10.00mg) and Musinguzi et al. (39) (1.80-5.00mg) on fruits. Sodium is a very common  
304 electrolyte; not generally found in plant foods and the RNI is 200mg/day (34). The ion is very  
305 common in food as sodium chloride, or common salt.

#### 306 **4.20 Potassium (K)**

307 The potassium levels in the vegetables and fruits were 16.20-104.23mg and 2.43-410.00mg,  
308 respectively. The following fruits and vegetables had high K levels - *Blinghia grandiflora*  
309 (104.23mg), *Hippocretae myrint* (281.00mg), *Napoleana imperialist* (110.00mg), *Spondian*  
310 *mombin* (260.00mg), *Vitex doniana* (130.00mg), *Afromomium daniella* (198.00mg), *Cola*  
311 *gigantean* (110.00mg), *Olox viridis* (240.00mg), *Phyllanthus debilis* (270.00mg), *Sterculia spp*  
312 (180.00mg), *Myristicaceae spp* (156.00mg), *Ficus sur* (126.00mg), *Landofolia dulcis*  
313 (210.00mg), *Parkia clappatonia* (220.00mg), *Gongronema spp* (192.00mg), *Irvingia gabonensis*  
314 (410.00mg). Intake of significant quantities of the fruits and vegetables may be useful in  
315 performing the functions of potassium in the body. Potassium is a common electrolyte that is  
316 required for keeping the heart, brain, kidney, muscle tissues and other important organs of the  
317 human body in good condition. It works in association with sodium to perform a number of  
318 critical body tasks (40).

#### 319 **4.21 Phosphorus (P)**

320 The vegetables studied are good sources of phosphorus (75.40-685.60mg). The values  
321 determined in this study were higher than the values observed by Taiye and Asiebey-Berko (37)  
322 (9.42-48.95mg); Nnamani et al. (41) (37.00-57.00mg). The RNI for phosphorus is 200mg/day.  
323 Consumption of 100g of some of the vegetables like *Boerhavia diffusa* (685.60mg), *Ipomea*  
324 *batata* (257.20mg), *Ficus elsticoides* (375.40mg), *Berlinia grandiflora* (363.22mg), *Vitex*

325 *doniana* (602.00mg), *Vaccinium parvifolium* (339.12mg) and *Ficus fur* (444.25mg) would be  
326 able to meet up with the RNI for phosphorus. Phosphorus is required to build healthy bones and  
327 it is essential for energy metabolism (41).

## 328 **6 Conclusion**

329 The result of the study showed that *Phyllanthus debilis* is a good source of minerals especially  
330 magnesium and calcium. Some of the fruits and vegetables like *psychotria viridis*, *Napoleana*  
331 *imperialist*, *Hippocretae myrint*, *Afromomium daniella*, *Portulace oleraceae*, *Ficus fur* and  
332 *Berlinia grandflora* are good sources of iron. The vegetables could be useful in dietary  
333 formulations to fight iron deficiency anaemia. This important attribute of the vegetables should  
334 be explored. *Vitex doniana* and *Hippocretae myrint* are rich in zinc despite the fact that plant  
335 foods are not good sources of zinc. The high protein levels of some of the fruits and vegetables  
336 like *Ficus elsticoides*, *Irvingia gabonensis* and *Sterculiar spp* suggest that they could be used in  
337 dietary formulation or in supplementing low protein foods in the diet.

338 *Vitex doniana*, *Ficus vogaliana*, *Ceiba pentandra*, *Pterocarpus santalinoides*, *Moraceae spp*,  
339 *Bombaceae spp*, *Blighia unijugata*, *Brillantaisi nitens*, *Vaccinium parvifolium*, *Gssampelus*  
340 *mucanta*, *Nauclea diderrichii*, *Spondian mombin*, *Vitex doniana* fruits, *Afromomium daniella*,  
341 *Myristicaceae spp*, *Irvingia gabonensis* pulp, *Cola parchycarpa* and *Parkia clappatonia* has high  
342 levels of beta carotene. Consumption of the vegetables and fruits in adequate quantity could help  
343 to alleviate the problems associated with vitamin A deficiency. *Portulace oleraceae*, *Artocarpus*  
344 *altilis* and *Ficus sur* fruit are high in ascorbate which is a powerful antioxidant that could help  
345 fight degenerating diseases. If the vegetables and fruits are consumed with iron rich foods, the  
346 high ascorbate level will facilitate iron absorption. *Artocarpus altilis* fruit, *Phyllanthus debilis*  
347 fruit, and *Blighia unijugata* vegetables are rich in vitamin E which is a common antioxidant.

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353 **Fig 1: Portion sizes of hundred gramme (100g) of underutilized vegetables analyzed.**



354 *Boerhavia diffusa*



*Corchorus olitorius*



*Moraceae spp*



355 *Portulence oleraceae*



*Ceiba pentandra*



*Uvaria chamea*

356



361 *Berlinia grandiflora*



*Daniella olivera*



*psychotria viridis*



366

367 *Vitex doniana*



*Bombaceae spp*

368



369 *Ficus vogaliana*



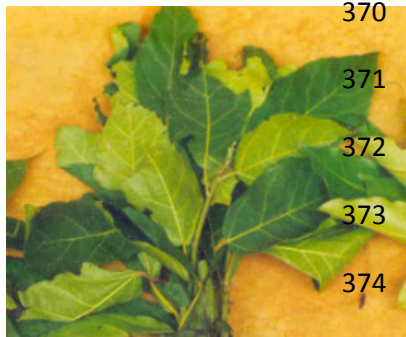
*Brillantaisi nitens*



*Pterocarpus santalinoides*



376 *Ipomea batata*



*Blighia unijugata*



*Gssampelus mucanta*



383 *Ficus elasticoides*



*Ficus fur*

384

385 Figure 1 shows the pictorial record of underutilized vegetables analyzed.

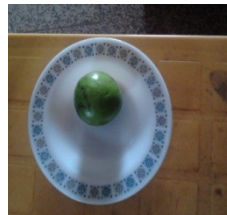
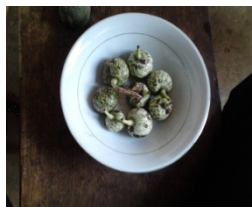
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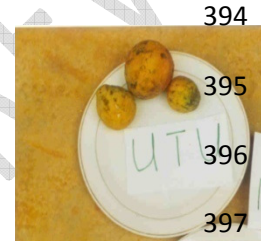
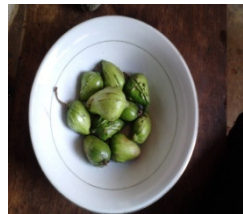
388 **Fig 3: Portion sizes of hundred grammes (100g) of the underutilized fruits analyzed.**



389 *Velvet tamarind* *Afromomium daniella* *Parkia clappatonia* *Artocarpus altilis* *Sterculiar spp*

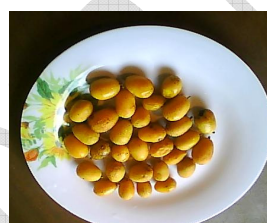


393 *Phyllanthus debilis* *Irvingia gabonensis* *Myristicaceae spp* *Olax viridis*



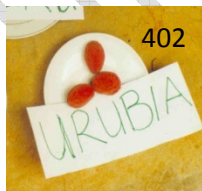
398 *Cola parchycarpa* *Hippocretae myrint* *Cola gingatean* *Landolfolia dulcis*

399



401 *Napoleana imperialist* *Spondian mombin* *Ficus sur* *Nauclea diderrichii*

402 *Icacina trichatha olive*



403

404

405 Figure 3 shows the pictorial record of underutilized fruits analyzed.

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**Table 1: List of underutilized vegetables randomly selected for analysis.**

| Common name   | Igbo name             | Scientific name                  |
|---------------|-----------------------|----------------------------------|
| Vegetable     |                       |                                  |
| Fig tree      | <i>Ogbu ike</i>       | <i>Ficus elasticoides</i>        |
| Hog weed      | <i>Azuigwe</i>        | <i>Boerhavia diffusa</i>         |
| -             | <i>Ogbu</i>           | <i>Ficus vogaliana</i>           |
| Black plum    | <i>Uchakiri</i>       | <i>Vitex doniana</i>             |
| -             | <i>Uturukpa</i>       | <i>Pterocarpus santalinoides</i> |
| -             | <i>Anyazu</i>         | <i>psychotria viridis</i>        |
| Water leaf    | <i>Ntioke</i>         | <i>Portulace oleraceae</i>       |
| -             | <i>Agba</i>           | <i>Daniella olivera</i>          |
| Jute          | <i>Arira/Elegule</i>  | <i>Corchorus olitorius</i>       |
| -             | <i>Akwokwo akpu</i>   | <i>Ceiba pentandra</i>           |
| -             | <i>Okwuruezikemba</i> | <i>Moraceae spp</i>              |
| -             | <i>Ogwuazu</i>        | <i>Bombaceae spp</i>             |
| -             | <i>Okpokuko</i>       | <i>Uvaria chamea</i>             |
| -             | <i>Akuokoro</i>       | <i>Ficus fur</i>                 |
| -             | <i>Ububa</i>          | <i>Berlinia grandiflora</i>      |
| Akee/Ackee    | <i>Uso</i>            | <i>Blighia unijugata</i>         |
| Huckleberry   | <i>Ewa</i>            | <i>Vaccinium parvifolium</i>     |
| -             | <i>Obuako-enwe</i>    | <i>Gssampelus mucanta</i>        |
| -             | <i>Agbolu-uku</i>     | <i>Brillantaisi nitens</i>       |
| Potato leaves | <i>Akwukwo ji nnu</i> | <i>Ipomea batata</i>             |

410 **Table 2: List of fruits randomly selected for analysis.**

| Common name              |                          | Scientific name                |
|--------------------------|--------------------------|--------------------------------|
| Fruits                   | Igboname                 |                                |
| Hog plum                 | <i>Echikara</i>          | <i>Spondian mombin</i>         |
| Black plum               | <i>Mbembe</i>            | <i>Vitex doniana</i>           |
| -                        | <i>Icheku</i>            | <i>Velvet tamarind</i>         |
| -                        | <i>Osiike/Karagu</i>     | <i>Myristicaceae spp</i>       |
| -                        | <i>Urumbia</i>           | <i>Icacina trichatha olive</i> |
| -                        | <i>Mkpuruamunwaebule</i> | <i>Hippocretae myrint</i>      |
| -                        | <i>Aku okoro</i>         | <i>Ficus sur</i>               |
| -                        | <i>Ose ohia</i>          | <i>Afromomium daniella</i>     |
| -                        | <i>Uvuru</i>             | <i>Nauclea diderrichii</i>     |
| -                        | <i>Uvurunwamkpi</i>      | <i>Artocarpus altilis</i>      |
| White rubber vine        | <i>Utu</i>               | <i>Landolfolia dulcis</i>      |
| West African locust bean | <i>Nkpuru ugba</i>       | <i>Parkia clappatonia</i>      |
| -                        | <i>Achicha</i>           | <i>Cola parchycarpa</i>        |
| Bush mango               | <i>Ujuru</i>             | <i>Irvingia gabonensis</i>     |
| -                        | <i>Oji-eyi</i>           | <i>Cola gingatean</i>          |
| -                        | <i>Osenga</i>            | <i>Olax viridis</i>            |
| -                        | <i>Aodo</i>              | <i>Gongronema spp</i>          |
| Gooseberry               | <i>Akpuru</i>            | <i>Phyllanthus debilis</i>     |
| -                        | <i>Nkwukpo</i>           | <i>Sterculiar spp</i>          |
| -                        | <i>Odure</i>             | <i>Napoleana imperialist</i>   |

411 **Table 3a: Proximate composition of some underutilized vegetables on wet weight basis (%).**

| <b>Scientific Name</b>           | <b>Moisture</b>   | <b>Protein</b>   | <b>Fat</b>       | <b>Fibre</b>     | <b>Ash</b>       | <b>CHO</b>        |
|----------------------------------|-------------------|------------------|------------------|------------------|------------------|-------------------|
| <i>Vitex doniana</i>             | 64.10±0.01        | 5.20±0.59        | 2.10±0.00        | 0.40±0.11        | 1.60±0.21        | 26.60±0.88        |
| <i>Ficus elasticoides</i>        | 68.80±0.07        | <b>6.60±0.06</b> | 0.70±0.08        | 2.10±0.13        | 2.90±0.12        | 18.90±0.26        |
| <i>Corchorus olitorius</i>       | 70.20±0.10        | 3.30±0.03        | 0.80±0.53        | 1.00 ±0.20       | 1.80±0.70        | 17.90±0.15        |
| <i>Ficus vogaliana</i>           | 61.60±0.03        | 2.80 ±0.01       | 0.40±0.00        | 2.80±0.15        | 3.70±0.11        | 28.70±0.13        |
| <i>Ceiba pentandra</i>           | 69.70±0.23        | 2.70±0.02        | 0.10±0.00        | 1.20± 0.60       | 0.90±0.030       | 25.40±0.04        |
| <i>Portulace oleraceae</i>       | 80.20±0.05        | 4.80±0.06        | 0.10±0.00        | 1.20±0.04        | 1.40± 0.21       | <b>10.30±0.21</b> |
| <i>Berlinia grandiflora</i>      | 74.20±0.23        | 1.22±0.02        | 1.27±0.64        | 1.92± 0.60       | 1.75±0.30        | 19.64±0.04        |
| <i>Boerhavia diffusa</i>         | 65.90±0.07        | 3.60±0.15        | 0.20±0.02        | 1.60±0.18        | 2.40± 0.12       | 21.30±0.56        |
| <i>Blinghia unijuta</i>          | <b>60.45±0.05</b> | 4.27±0.06        | 1.45±0.81        | 3.22±0.04        | 3.13± 0.21       | 27.48±0.21        |
| <i>Daniella olivera</i>          | 71.10±0.04        | 3.90±0.01        | 0.40±0.04        | 1.70 ±0.01       | 0.90±0.73        | 18.00±0.15        |
| <i>Brillantaisi nitens</i>       | 61.05±0.07        | 5.27±0.15        | 0.20±0.02        | 2.22±0.18        | 0.77±0.12        | <b>30.49±0.56</b> |
| <i>Vaccinium parvifolium</i>     | 77.00±0.04        | 1.00±0.01        | <b>2.19±0.04</b> | 0.12 ±0.01       | 2.78±0.73        | 16.91±0.15        |
| <i>Pterocarpus santalinoides</i> | 60.80±0.04        | 4.20±0.05        | 0.40±0.08        | 4.30±0.02        | <b>4.20±0.90</b> | 26.10±0.31        |
| <i>psychotria viridis</i>        | 66.40±0.14        | 1.40± 0.09       | 1.30±0.02        | 0.60±0.50        | 1.80±0.40        | 23.50±0.18        |
| <i>Moraceae spp</i>              | 66.00±0.01        | 3.03±0.59        | <b>0.02±0.00</b> | 2.11±0.11        | 3.54±0.21        | 25.30±0.88        |
| <i>Bombaceae spp</i>             | <b>91.00±0.07</b> | <b>0.02±0.06</b> | 0.90±0.08        | <b>5.01±0.13</b> | 0.92±0.12        | 2.15±0.26         |
| <i>Uvaria chmea</i>              | 72.24±0.10        | 2.07±0.03        | 0.78±0.53        | 0.78 ±0.20       | 2.44±0.70        | 21.86±0.15        |
| <i>Ficus sur</i>                 | 84.22±0.03        | 0.22±0.01        | 2.11±1.00        | <b>0.04±0.01</b> | 2.24±0.11        | 11.17±0.13        |
| <i>Ipomea batata</i>             | 68.12±0.14        | 2.12± 0.09       | 0.41±0.02        | 2.10±0.50        | <b>0.04±0.00</b> | 27.21±0.18        |
| <i>Gssampelus mucanta</i>        | 80.23±0.04        | 0.48±0.05        | 0.62±0.08        | 1.16±0.02        | 1.11±0.90        | 16.40±0.31        |

Mean±Standard deviation

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415 **Table 3b: Proximate composition of some underutilized fruits on wet weight basis (%).**

| ScientificName                 | Moisture          | Protein          | Fat              | Fibre            | Ash               | CHO               |
|--------------------------------|-------------------|------------------|------------------|------------------|-------------------|-------------------|
| <i>Hippocretae myrint</i>      | 72.40±0.09        | 0.30±0.10        | 0.10±0.09        | 0.28±0.66        | 0.55±0.74         | 26.37±0.30        |
| <i>Nauclea diderrichii</i>     | 59.70±0.04        | 1.01±0.01        | 0.41±1.04        | 1.47±0.27        | 0.80±0.29         | <b>36.61±0.22</b> |
| <i>Icacina trichatha olive</i> | 73.50±0.40        | 0.90±0.06        | 0.37±0.43        | <b>0.11±0.03</b> | 0.73±0.30         | 24.39±0.63        |
| <i>Myristicaceae spp</i>       | 60.90±0.63        | 1.20±0.21        | 0.52±0.36        | 0.93±0.80        | 0.68±0.75         | 35.77±0.35        |
| <i>Artorcarpus altilis</i>     | 61.15±0.01        | 3.00±0.59        | 0.46±0.00        | 7.94±0.11        | 6.84±0.21         | 20.61±0.88        |
| <i>Landolfolia dulcis</i>      | 70.40±0.07        | 2.08±0.06        | 1.52±0.08        | 1.48±0.13        | <b>11.05±0.12</b> | 13.47±0.26        |
| <i>Cola parchcarpa</i>         | 59.27±0.03        | 4.57 ±0.01       | 1.03±1.00        | 3.67±0.15        | 5.72±0.11         | 25.74±0.13        |
| <i>Gongranema spp</i>          | 75.40±0.23        | 2.60±0.02        | <b>Trace</b>     | 1.38± 0.60       | 0.66±0.0.30       | 19.96±0.04        |
| <i>Irvingia gabonensis</i>     | 67.42±0.05        | <b>6.21±0.06</b> | 1.65±0.81        | 7.80±0.04        | 4.80± 0.21        | 12.12±0.21        |
| <i>Olox viridis</i>            | 73.10±0.33        | 0.72±0.71        | 0.39±0.01        | 0.39±0.10        | 0.71±0.52         | 25.08±0.44        |
| <i>Napoleana imperialist</i>   | 70.90±0.28        | 0.70± 0.03       | 0.31±0.24        | 0.40±0.11        | 0.39±0.47         | 27.30 ±0.12       |
| <i>Parkia clappatonia</i>      | <b>54.34±0.10</b> | 3.02±0.03        | <b>3.08±0.53</b> | 2.74 ±0.20       | 3.91±0.70         | 32.91±0.15        |
| <i>Afromomium daniella</i>     | 71.30±0.36        | <b>0.27±0.07</b> | 0.27±0.26        | 1.01±0.60        | 0.65±0.78         | 26.50±0.16        |
| <i>Vevet tamarind</i>          | 72.80±0.50        | 0.31±0.03        | 0.47±0.49        | 0.36±0.09        | 0.44±0.83         | 25. 62±0.53       |
| <i>Cola gigantean</i>          | 71.02±0.04        | 2.11±0.01        | 2.38±0.04        | 1.17 ±0.01       | <b>0.33±0.73</b>  | 22.99±0.15        |
| <i>Ficus sur</i>               | 63.85±0.04        | 5.52±0.05        | 2.05±0.08        | <b>8.58±0.02</b> | 9.52±0.90         | 10.48±0.31        |
| <i>Phyllanthus debilis</i>     | <b>80.30±0.14</b> | 3.42± 0.09       | 2.00±0.02        | 4.20±0.50        | 1.00±0.40         | <b>9.08±0.18</b>  |
| <i>Spondian mombin</i>         | 67.20±0.30        | 1.20±0.20        | 0.20± 0.06       | 2.02±0.02        | 3.00±0.62         | 26.38±0.74        |
| <i>Vitex doniana</i>           | 61.70±0.04        | 1.30±0.30        | 2.50 ±0.41       | 0.76 ±0.06       | 2.79±0.13         | 30.95 ±0.0        |
| <i>Sterculia spp</i>           | 68.92±0.07        | 6.04±0.15        | 1.46±0.02        | 5.27±0.18        | 3.36± 0.12        | 14.95±0.56        |

416 Mean±Standard deviation

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421 **Table 4a: Mineral composition of some underutilized vegetables on wet weight basis (mg/100g).**

| Scientific name                  | Fe                | Cu               | Zn               | Mn               | Ca                 | Mg                | Na               | K                  | P                  |
|----------------------------------|-------------------|------------------|------------------|------------------|--------------------|-------------------|------------------|--------------------|--------------------|
| <i>Vitex doniana</i>             | 2.90±0.04         | 0.40±0.01        | <b>9.40±0.22</b> | 1.70±0.72        | 134.04±0.16        | 37.70±0.56        | 1.65±0.11        | 92.24±1.42         | 602.50±4.22        |
| <i>Ficus elsticoides</i>         | 6.40±0.22         | 1.30±0.79        | 4.30±0.03        | 3.80±0.03        | 101.60±0.54        | 18.20±0.10        | 1.92±0.76        | 96.01±0.93         | 375.40±0.79        |
| <i>Corchorus olitorius</i>       | 1.60±0.01         | 0.66±0.39        | 6.90±0.08        | 2.32±0.04        | 238.00±0.67        | 17.50±0.34        | 2.30±0.36        | 83.33±0.16         | 128.20±2.22        |
| <i>Ficus vogaliana</i>           | 6.20±0.19         | 1.22±0.77        | 2.90±0.15        | <b>4.80±0.09</b> | 240.60±0.44        | 20.10±0.80        | 1.88±0.72        | 53.87±0.23         | <b>75.40±7.06</b>  |
| <i>Pterocarpus santalinoides</i> | 3.10±0.14         | 0.40±0.66        | 1.80±0.56        | 0.30±0.12        | 343.40±2.08        | 17.70±0.45        | 1.02±0.16        | 80.11±0.49         | 85.00±10.30        |
| <i>psychotria viridis</i>        | <b>11.80±0.23</b> | 1.30±0.43        | 7.00±0.55        | 1.32±0.88        | 116.20±0.96        | 22.60±0.64        | 3.01±0.20        | 76.27±0.78         | 134.60±6.13        |
| <i>Moracae spp</i>               | 2.60±0.04         | <b>0.02±0.01</b> | <b>Trace</b>     | 0.60±0.72        | 180.40±0.16        | 32.14±0.56        | 0.64±0.11        | 96.14±0.23         | 154.28±1.22        |
| <i>Bombaceas spp</i>             | <b>1.40±0.22</b>  | 0.60±0.79        | 2.10±0.03        | 4.30±0.03        | 252.00±0.54        | 25.60±0.10        | 2.33±0.76        | 70.92±0.93         | 220.91±0.79        |
| <i>Uvaria chamea</i>             | 6.80±0.01         | 0.90±0.39        | 1.70±0.08        | 3.60±0.04        | 220.00±0.67        | <b>47.20±0.34</b> | <b>3.01±0.36</b> | 48.00±0.16         | 161.45±1.22        |
| <i>Ficus sur</i>                 | 10.60±0.19        | 0.40±0.77        | 0.40±0.15        | 1.30±0.09        | <b>18.19±0.44</b>  | 42.26±0.80        | 2.13±0.72        | 54.00±0.23         | 444.25±0.06        |
| <i>Berlinia grandiflora</i>      | 8.80±0.11         | 0.30±0.32        | 1.60±0.27        | 0.20±0.49        | 340.00±0.63        | 18.34±0.16        | 1.98±0.65        | <b>104.23±0.17</b> | 363.22±0.14        |
| <i>Blighia unijugata</i>         | 3.45±0.54         | 2.28±0.17        | 2.06±0.32        | 0.74±0.07        | 96.20±0.24         | <b>4.38±0.74</b>  | 0.72±0.42        | 23.23±0.01         | 126.22±5.02        |
| <i>Brillantaisi nitens</i>       | <b>1.40±0.23</b>  | 0.20±0.04        | 1.40±0.81        | 2.60±0.43        | <b>400.00±5.38</b> | 41.00±0.28        | <b>0.27±0.31</b> | <b>16.20±0.03</b>  | 216.00±0.70        |
| <i>Ceiba pentandra</i>           | 3.60±0.11         | 0.10±0.32        | 5.30±0.27        | 0.60±0.49        | 261.50±2.63        | 15.17±0.16        | 2.10±0.65        | 46.20±0.17         | 154.10±3.14        |
| <i>Boerhavia diffusa</i>         | 6.10±0.15         | 0.95±0.018       | 5.20±1.02        | <b>0.07±0.31</b> | 219.60±0.42        | 28.22±0.05        | 1.44±0.01        | 61.92±0.14         | <b>685.60±9.53</b> |
| <i>Daniella olivera</i>          | 2.00±0.23         | 0.93±0.04        | 1.30±0.81        | 4.02±0.43        | 281.90±38          | 16.19±0.28        | 0.92±0.31        | 56.13±0.03         | 187.90±2.70        |
| <i>Vaccinium parvifolium</i>     | 5.27±0.14         | 1.62±0.66        | 0.78±0.56        | 2.27±0.12        | 43.00±0.08         | 38.40±0.45        | 1.10±0.16        | 71.21±0.49         | 339.12±1.30        |
| <i>Gssampelus mucanta</i>        | 2.76±0.23         | 0.98±0.43        | 3.21±0.55        | 0.91±0.88        | 374.00±2.96        | 16.10±0.64        | 2.15±0.20        | 57.20±0.78         | 122.20±0.13        |
| <i>Ipomea batata</i>             | 1.91±0.15         | <b>3.14±0.18</b> | 3.96±1.02        | 1.67±0.31        | 140.00±0.42        | 20.11±0.05        | 2.02±0.01        | 49.61±0.12         | 257.20±16.53       |
| <i>Portulace oleraceae</i>       | 10.50±0.54        | 0.33±0.17        | 1.40±0.32        | 1.71±0.07        | 144.40±0.24        | 27.14±0.74        | 1.62±0.42        | 52.10±0.01         | 152.90±1.02        |

422 Mean ± Standard deviation

423

424

425 **Table 4b: Mineral composition of some underutilized fruits on wet weight basis (mg/100g).**

| Scientific name                | Fe               | Cu               | Zn                | Mn               | Ca                | Mg                | Na               | K                  | p                 |
|--------------------------------|------------------|------------------|-------------------|------------------|-------------------|-------------------|------------------|--------------------|-------------------|
| <i>Hippocretae myrint</i>      | 9.60±0.16        | 0.03±0.00        | <b>10.30±0.04</b> | <b>6.60±0.20</b> | 13.04±0.02        | 3.00±0.03         | 1.00±0.03        | 281.00±6.18        | 20.00±0.93        |
| <i>Nauclea diderrichii</i>     | 4.80±0.29        | 0.02±0.00        | 1.70±0.03         | 2.80±0.18        | 9.20±0.11         | 26.10±0.13        | 3.00±0.01        | 60.00±0.17         | 9.00±0.83         |
| <i>Icacina trichatha olive</i> | 2.10±0.11        | 0.04±0.01        | 2.80±0.21         | 5.40±0.47        | 20.70±0.03        | 10.40±0.14        | 3.00±0.19        | 29.42±0.08         | 13.00±0.42        |
| <i>Napoleana imperialist</i>   | 9.40±0.43        | 0.02±0.01        | 0.60±0.13         | 0.30±0.07        | 28.10±0.08        | 9.60±0.10         | 3.00±0.55        | 110.00±2.08        | 21.00±0.40        |
| <i>Spondian mombin</i>         | 2.12±0.22        | 0.01±0.00        | 6.03±0.09         | 3.10±0.11        | 17.91±0.10        | 15.00±0.06        | 4.50±0.18        | 260.00±4.14        | 39.00±0.02        |
| <i>Vitex doniana</i>           | 3.40±0.35        | 0.12±0.01        | 4.40±1.04         | 2.61±0.24        | 12.16±0.06        | 9.27±0.41         | 4.00±0.26        | 130.00±0.49        | 19.00±0.01        |
| <i>Afromomium daniella</i>     | 8.40±0.09        | 0.01±0.00        | 0.40±0.04         | <b>0.10±0.03</b> | 17.20±0.03        | 2.04±0.15         | <b>Trace</b>     | 281.00±3.04        | 14.00±0.05        |
| <i>Vevet tamarind</i>          | <b>9.80±0.27</b> | 0.04±0.03        | 8.60±0.11         | 0.50±0.02        | 14.71±0.06        | 18.12±0.07        | 1.55±0.05        | 198.00±0.01        | 18.00±0.21        |
| <i>Irvingia gabonensis</i>     | 2.00±0.54        | 0.30±0.17        | 2.20±0.32         | 1.21±0.07        | 30.00±0.24        | 3.00±0.74         | <b>6.20±0.42</b> | <b>410.00±1.01</b> | <b>1.70±0.02</b>  |
| <i>Cola gingatean</i>          | 1.70±0.23        | 0.04±0.01        | 0.10±0.00         | 0.32±0.43        | 27.00±0.38        | 8.64±0.28         | 1.17±0.31        | 110.00±0.03        | 12.34±0.70        |
| <i>Ficus sur</i>               | 1.43±0.14        | 0.02±0.66        | 1.29±0.56         | 2.27±0.12        | 31.20±0.08        | 3.25±0.45         | 1.61±0.16        | 240.00±1.49        | 39.42±0.30        |
| <i>Phyllanthus debilis</i>     | 3.20±0.23        | 1.00±0.43        | 0.20±0.55         | 0.42±0.08        | <b>46.50±0.96</b> | <b>31.82±0.64</b> | 0.20±0.20        | 270.00±0.78        | 37.10±0.13        |
| <i>Sterculiar spp</i>          | 1.04±0.15        | Trace            | 0.42±0.02         | 0.11±0.01        | 22.50±0.42        | 18.03±0.05        | 2.00±0.01        | 180.00±0.14        | 20.13±0.53        |
| <i>Myristicaceae spp</i>       | 6.40±0.59        | 0.04±0.02        | 2.30±0.35         | 4.40±0.74        | 19.09±0.17        | 14.72±0.14        | 2.00±0.11        | 156.00±0.18        | 12.00±0.19        |
| <i>Olox viridis</i>            | 3.60±0.35        | 0.00             | 0.10±0.61         | 0.30±1.09        | 18.47±0.22        | 12.88±0.56        | 1.00±0.40        | 126.00±0.60        | 14.00±0.26        |
| <i>Artocarpus altilis</i>      | 4.76±0.04        | 0.02±0.01        | 1.42±0.22         | 3.17±0.72        | 11.30±0.16        | 4.60±0.56         | 2.17±0.11        | <b>2.43±0.23</b>   | 11.46±0.22        |
| <i>Landolfolia dulcis</i>      | 3.85±0.22        | 0.03±0.01        | <b>0.02±0.03</b>  | 0.98±0.03        | <b>5.42±0.54</b>  | 3.02±0.10         | 1.80±0.76        | 210.00±0.93        | 3.85±0.79         |
| <i>Parkia clappatonia</i>      | 2.90±0.01        | 0.06±0.03        | 0.80±0.08         | 0.40±0.04        | 18.00±0.67        | 0.21±0.04         | 3.70±0.36        | 220.00±0.16        | 28.21±0.22        |
| <i>Cola parchycarpa</i>        | 3.40±0.19        | 2.01±0.77        | 1.82±0.15         | 1.38±0.09        | 32.10±0.44        | 1.71±0.80         | 4.12±0.72        | 96.00±0.23         | 6.79±0.06         |
| <i>Gongronema spp</i>          | <b>0.10±0.02</b> | <b>4.06±0.32</b> | 2.43±0.27         | 1.72±0.49        | 9.96±0.63         | 16.63±0.16        | 4.47±0.65        | 192.00±0.17        | <b>44.66±0.14</b> |

426 Mean ± Standard deviation

427

428 **Table 5a: Beta-carotene and Vitamin composition of some underutilized vegetables on wet**  
 429 **weight basis.**

| Scientific name                  | $\beta$ -carotene (RE) | VitaminC (mg)       | VitaminE (mg)    |
|----------------------------------|------------------------|---------------------|------------------|
| <i>Vitex doniana</i>             | <b>1933.33±21.59</b>   | 12.10±0.35          | 0.96±0.11        |
| <i>Ficus elsticoides</i>         | <b>15.20±0.29</b>      | 32.90±0.09          | 0.11±0.01        |
| <i>Corchorus olitorius</i>       | 16.00±0.35             | 3.60±0.02           | 1.92±0.76        |
| <i>Ficus vogaliana</i>           | 1633.33±8.74           | 6.50±1.00           | 1.24±0.40        |
| <i>Ceiba pentandra</i>           | 1866.67±18.17          | 12.20±0.26          | 3.11±0.01        |
| <i>Portulace oleraceae</i>       | 31.20±0.14             | <b>38.40 ± 0.62</b> | 2.10±0.46        |
| <i>Daniella olivera</i>          | 22.40±0.11             | 3.04±0.14           | 0.87±0.19        |
| <i>Pterocarpus santalinoides</i> | 1233.33±6.18           | 11.20 ±0.22         | 2.41±0.02        |
| <i>psychotria viridis</i>        | 25.67±0.01             | 29.90±0.14          | 2.63±0.56        |
| <i>Boerhavia diffusa</i>         | 1366.67± 0.19          | 16.10 ±0.60         | 1.86±0.08        |
| <i>Moraceae spp</i>              | 450.00±0.59            | <b>2.40±0.35</b>    | Trace            |
| <i>Bombaceae spp</i>             | 6161.67±1.29           | 12.80±0.09          | 1.24±0.91        |
| <i>Uvaria chemea</i>             | 200.00±0.35            | 14.30±0.02          | 0.08±0.06        |
| <i>Ficus sur</i>                 | 356.67±2.74            | 11.60±1.00          | 0.67±0.40        |
| <i>Blinghia unijugata</i>        | 591.67±1.14            | 4.12 ± 0.62         | <b>6.67±0.46</b> |
| <i>Brillantaisi nitens</i>       | 700.00±0.11            | 14.20±0.14          | 1.12±0.19        |
| <i>Vaccinium parvifolium</i>     | 451.67±2.18            | 5.27 ±0.22          | 3.25±0.02        |
| <i>Gssampelus mucanta</i>        | 266.83±0.01            | 19.60±0.14          | 4.98±0.56        |
| <i>Ipomea batata</i>             | 701.67± 0.19           | 8.67 ±0.60          | 5.57±0.08        |
| <i>Berlinia grandflora</i>       | 356.67±1.17            | 11.40±0.26          | 3.36±0.01        |

430 Mean±Standard deviation

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440 **Table 5b: Beta-carotene and Vitamin composition of some underutilized fruits on wet**  
 441 **weight basis.**

| Scientific name                | VitaminC<br>(mg)  | VitaminC<br>(mg)  | B-carotene<br>(RE)  |
|--------------------------------|-------------------|-------------------|---------------------|
| <i>Hippocretae myrint</i>      | 22.70±0.09        | 22.70±0.09        | Trace               |
| <i>Nauclea diderrichii</i>     | 13.40±0.05        | 13.40±0.05        | 1233.33±6.62        |
| <i>Icacina trichatha olive</i> | 4.90±0.42         | 4.90±0.42         | 16.67±0.94          |
| <i>Napoleana imperialist</i>   | 3.80±0.14         | 3.80±0.14         | Trace               |
| <i>Spondian mombin</i>         | 9.30±0.07         | 9.30±0.07         | 2000.00±9.71        |
| <i>Vitex doniana</i>           | 14.29±0.03        | 14.29±0.03        | 1333.33±0.76        |
| <i>Afromomium daniella</i>     | 14.80±0.01        | 14.80±0.01        | 566.67±0.73         |
| <i>Vevet tamarind</i>          | 8.60±0.16         | 8.60±0.16         | Trace               |
| <i>Myristicaceae spp</i>       | 14.90±0.07        | 14.90±0.07        | 4333.33±11.03       |
| <i>Olax viridis</i>            | 2.40± 0.11        | 2.40± 0.11        | 16.67± 0.09         |
| <i>Artocarpus altilis</i>      | <b>48.82±0.35</b> | <b>48.82±0.35</b> | 199.83±4.59         |
| <i>Irvingia gabonensis</i>     | 35.80 ± 0.62      | 35.80 ± 0.62      | 416.67±2.14         |
| <i>Cola gigantean</i>          | <b>1.20±0.14</b>  | <b>1.20±0.14</b>  | 46.67±0.11          |
| <i>Ficus sur</i>               | 40.22 ±0.22       | 40.22 ±0.22       | 665.00±1.18         |
| <i>Phyllanthus debilis</i>     | 14.26±0.14        | 14.26±0.14        | 141.67±0.01         |
| <i>Sterculia spp</i>           | 13.68 ±0.60       | 13.68 ±0.60       | 60.00± 0.19         |
| <i>Landolfolia dulcis</i>      | 17.40±0.09        | 17.40±0.09        | 48.33±0.29          |
| <i>Parkia clappatonia</i>      | 18.90±0.02        | 18.90±0.02        | 970.67±1.35         |
| <i>Cola parchycarpa</i>        | 11.61±1.00        | 11.61±1.00        | <b>5666.67±2.74</b> |
| <i>Gongronema spp</i>          | 14.48±0.26        | 14.48±0.26        | 17.5±0.17           |

442 Mean ± Standard deviation

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## 445 5. CONCLUSION

446

447 The result of the study showed that *Phyllanthus debilis* is a good source of minerals especially  
 448 magnesium and calcium. Some of the fruits and vegetables like *psychotria viridis*, *Napoleana*  
 449 *imperialist*, *Hippocretae myrint*, *Afromomium daniella*, *Portulace oleraceae*, *Ficus fur* and  
 450 *Berlinia grandiflora* are good sources of iron. The vegetables could be useful in dietary  
 451 formulations to fight iron deficiency anaemia. This important attribute of the vegetables should  
 452 be explored. *Vitex doniana* and *Hippocretae myrint* are rich in zinc despite the fact that plant

453 foods are not good sources of zinc. The high protein levels of some of the fruits and vegetables  
454 like *Ficus elsticoides*, *Irvingia gabonensis* and *Sterculiar spp* suggest that they could be used in  
455 dietary formulation or in supplementing low protein foods in the diet.

456 *Vitex doniana*, *Ficus vogaliana*, *Ceiba pentandra*, *Pterocarpus santalinoides*, *Moraceae spp*,  
457 *Bombaceae spp*, *Blighia unijugata*, *Brillantaisi nitens*, *Vaccinium parvifolium*, *Gssampelus*  
458 *mucanta*, *Nauclea diderrichii*, *Spondian mombin*, *Vitex doniana* fruits, *Afromomium daniella*,  
459 *Myristicaceae spp*, *Irvingia gabonensis* pulp, *Cola parchycarpa* and *Parkia clappatonia* has high  
460 levels of beta carotene. Consumption of the vegetables and fruits in adequate quantity could help  
461 to alleviate the problems associated with vitamin A deficiency. *Portulace oleraceae*, *Artocarpus*  
462 *altilis* and *Ficus sur* fruit are high in ascorbate which is a powerful antioxidant that could help  
463 fight degenerating diseases. If the vegetables and fruits are consumed with iron rich foods, the  
464 high ascorbate level will facilitate iron absorption. *Artocarpus altilis* fruit, *Phyllanthus debilis*  
465 fruit, and *Blighia unijugata* vegetables are rich in vitamin E which is a common antioxidant.

466

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