Nutritional values of some tropical vegetables

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ABSTRACT
Objective: To investigate nutrition values of fruits of Lycoperscon esculentum Mill, Abelmoschus esculentus L.Moench, L. Solanum macrocarpon Linn. and the seeds of Vigna unguiculata (Linn.)Walp. and Arachis hypogea Linn.

Methodology and results: The fruits of L. esculentum, A. esculentus S. macrocarpon and seeds of V. unguiculata and A. hypogea were bought from a local market in Ibadan. The fruits and seeds were dried and analyzed for proximate, mineral and vitamin contents. L. esculentum fruits had the highest total soluble ethanol sugars (15.65g/100g dry matter) and 1.7% crude fibre content. However, the fruits of A. esculentus had the highest amount of starch (38.42g/100g dry matter), 2.0% protein while lipid content of 0.2% was recorded in both fruits of A. esculentus and L. esculentum. The highest moisture content of 18.0% was in fruits of S. macrocarpon. The highest glucose (0.03%), arabinose (0.14%), fructose (0.14%), raffinose (0.13%), sucrose (0.11%) and xylose (0. 05%) were in the fruits of A. esculentus. The highest mineral element levels were in fruits of A. esculentus: Ca 800mg/kg, K 912mg/kg, and Zn 296mg/kg dry matter. L. esculentum had 208mg/kg Mn and 76mg/kg Ca. The highest Na (16 20), Fe (250) and P contents (1060) mg/kg dry matter were in fruits of S. macrocarpon. Highest vitamin A (425mg/100g) and vitamin B12 (0.6mg/100g) levels were in L. esculentum while the highest vitamin B6 levels (1.2mg/100g), vit. B2 (1.13mg/100g), vit. D (0.07mg/100g) and vit. K (1.0mg/100g) were in A. esculentum. The lowest values of vitamins A, D, and K were in fruits of S. macrocarpon. These results revealed that the fruits of A. esculentum are more nutritious than L. esculentum and S. macrocarpon. The proximate analysis of V. unguiculata and A. hypogaea seeds showed that the protein contents of the two seeds were similar. However, the lipids content was higher in A. hypogaea. Further analysis revealed that V. unguiculata was richer in crude fibre, starch and soluble sugars than A. hypogaea.

Conclusion and application of findings: The results showed a wide variation in the nutritional values of the fruits and seeds. This indicates that fruits and seeds need to be combined with other foods to make a good diet. This study shows that these local plants are good as food for both man and animals.

Keywords: Nutrient contents, proximate analysis, vegetables, vitamins

INTRODUCTION
Leafy vegetables are generally eaten in many parts of Africa, especially in the Eastern, Central and Southern regions. They are eaten at least once daily in many areas and some of them have been found to have high crude protein content (Imbamba, 1973, Nkafamiya, 2010). Vegetables are good sources of oil, carbohydrates, minerals and vitamins depending on the vegetable consumed (Ihekoronye and Goddy, 1985). Vegetable fats and oils lower blood lipids thereby reducing the occurrence of disease associated with the damage of the coronary artery and are precursors of prostaglandins which are known to perform the role of vasoconstriction and
vasodilation of the blood vessels. Vegetable fats and oils are known to serve as precursors of thromboxane which facilitate blood clotting in humans (Ononogbu, 2002). They thus provides an important source of protein, minerals, and vitamins for numerous people. Information is therefore needed on their nutritional qualities and the conditions affecting these qualities. Many agricultural and domestic vegetable growers believe that it is a simple matter for anyone to produce vegetables for himself and family use not minding the nutritional qualities of these vegetables.

Vegetables are annual or perennial herbaceous plants whose edible parts are characterized by very high moisture content of least 80%. There are many ways of retaining sufficient moisture for adequate growth for vegetables such as mulching of the soil. The nutritional content of vegetables varies considerably though generally they contain a small proportion of protein and fat and a relatively high proportion of vitamins, provitamins, dietary minerals, fiber and carbohydrates. Many vegetables also contain phytochemicals which may have antioxidant, antibacterial, antifungal, antiviral and anticarcinogenic properties (Steinmetz, 1996).

As a food, groundnut is one of the most concentrated products, since it is rich in calories due to its high fat and protein content. After the extraction of the oil from the nut, the residual cake is richer in protein than the whole kernel and it forms one of the most valuable livestock cakes. The proportion of protein in groundnut is higher than that of most of the oil seed cakes and this protein possesses a high biological value. The principal protein of groundnut is arachin and conarchin and they are rich in vitamin B and E (Purseglove, 1974). Groundnut contains about 50% oil from which good quality cooking and salad oil, margarine and peanut butter are obtained. The oil is also used as soaps, lubricant and in pharmaceutical industries.

Some ailments such as diabetes, heart related diseases and obesity among the people in the tropics are diet related. There is contrasting information on some nutritional status of many vegetables in the tropics (Ladeji et al. 2004; Nkafamiya, 2010). Therefore the objective of this study was to determine the nutritive values of some tropical vegetables to provide more authentic information.

MATERIALS AND METHODS

**Plant materials:** The fruits of *Lycopersicon esculentum* (common tomato), *Hibiscus esculentus* syn. *Abelmoschus esculentus* (okra) and *Solanum macrocarpon* (African eggplant) and the dry seeds of *Vigna unguiculata* (cowpea) and *Arachis hypogaea* (groundnut) were bought from Bodija market Ibadan, Nigeria.

**Preparation of samples:** Fruit samples were sliced into small pieces and sun-dried for eight (8) days. They were subsequently dried in oven at 70°C for 48 h. When completely dried, the samples were milled to powder using a milling machine. The dry seeds samples were washed to remove the seed coat, sun-dried for about a week, and dried in the oven at 70°C for 48 h. Thereafter, the seeds were milled into powder using a milling machine and sieved, and samples were kept in dessicator at 28 ± 0°C pending analysis.

**Proximate and quantitative analysis:** Each sample was analyzed proximately and quantitatively to determine their total soluble sugar, starch/glycogen, crude protein, lipid, crude fibre, moisture content, dry matter, mineral elements; calcium, potassium, sodium, manganese, zinc, iron, phosphorus, and copper contents as described by A.O.A.C (2003), vitamin A, B₁, B₂, B₁₂, D and K were determined using the method of Harold et al. (1987).

**Reducing Sugar:** The phenol-sulphuric acid method of Dubois et al. (1956) was used.

**Starch/Glycogen:** The diastase hydrolysis method of Shriner (1932) and Barnell (1936) was adopted for starch analysis with some modification. One hundred grammes of sample of the dried ethanol insoluble residue of each sample were weighed into separate sterilized McCartney bottles followed by the addition of 5 ml distilled water. The bottles were then covered with lids and heated in a boiling water bath for about an hour to gelatinize the starch. The bottles were allowed to cool before 5 ml of 1% (w/v) diastase in phosphate buffer solution (pH 6.2) was added into each bottle and the bottles incubated at 37°C for 24 h. The blank was...
prepared using 5ml of 1% (w/v) diastase in phosphate buffer solution (pH 6.2). After incubation, the mixture was heated to boiling in water bath and was centrifuged. The insoluble materials were washed with hot distilled water. The two filtrates were then cleared with 1% (w/v) basic acetate method of Eastham (1949) and Bacon and Edelman (1951). The excess lead ions were removed with methanol. The same treatment was applied to the blank. The quantity of hydrolyzed starch was determined using phenol-sulphuric method of Dubois et al. (1951). The amount of starch was estimated from the calibration curve prepared from glucose. The starch value obtained was multiplied by 0.9 according to the method of Hassid & Neufield (1964). Each sample was replicated.

**Crude Protein:** The crude proteins in the residue were determined using Kjeldahl’s method (1968). This consists of 3 techniques of analysis namely digestion, distillation and titration.

**Crude Fibre, Moisture Content and Dry Matter:** These were determined using the method of Akpapunam and Markakis (1981).

**Phosphorus:** A 0.2g portion of each sample was weighed into a dried crucible, put inside a furnace set at 600°C and allowed to ash for 2h. The ash was washed by pipetting 10ml of 1N HCl into the ash sample and placed on a hot plate. It was evaporated to dryness, then added 10ml more of 1N HCl and removed from hot plate. This was then cooled, and washed into a 100ml volumetric flask using filter paper and funnel then made to 60 – 100ml level with diet water. Into a 500ml volumetric flask, 10ml from 100ml was pipetted and 10ml of vanadate yellow was added made up with distilled water. It developed for 15, and the absorbance was read at 170nm. Standard phosphorus was prepared and read first before the sample. Phosphorus level was determined using vanadate-molybdate colorimeter.

**Calcium (Ca), Potassium (K) and Sodium (Na):** From the washed sample (100ml), flame photometer was used to read the level of Calcium (Ca), Potassium (K) and Sodium (Na), after been standardized with respective minerals.

**Magnesium (Mg), Zinc (Zn), Iron (Fe) and Copper (Cu):** Dilution 1:25 were made for Mg level determination from the washed sample. After dilution, it was then read on atomic absorption spectrophotometer (AAS), after standardizing it with Mg standard. Zn, Fe and Cu were read from the solution that remained in the 100ml flask, also read on AAS after standardizing with respective mineral elements. The percentage individual elements were calculated in parts per million (ppm) using the formula:

\[
\text{ppm} = \frac{\text{Meter reading X Average gradient X dilution factor}}{\text{Weight of sample}}
\]

**Determination of Vitamins:** Vitamins were determined using the method of Harold et al (1987).

**Vitamin A:** Five gram samples were weighed into a 250ml volumetric flask. Fifty ml of 3N alcohol and 5ml of 75% potassium hydroxide solution was added. A standard taper reflux condenser was placed on the flask and saponified on a steam bath for 30 minutes. The flask was occasionally swirled to prevent sticking. After saponification, the flask was cooled to room temperature and using the condenser pipette, 100ml of this mixture was pipette into the flask, and placed on a mechanical shaker at 200 rpm for 15 minutes. The flask was allowed to stand so as to allow four-layer separation. A portion of the upper layer (hexane) was pipetted into a 50ml volumetric flask; the absorbance of the sample was read at 325nm, 310nm, and 334nm using Isopropanol as reference solution. The vitamin A value was determined spectrophotometrically by saponification extraction and measuring the absorption of an Isopropyl extraneous material which absorbs within this region. Readings were done at 310nm and 334nm and the Mortions-stubbs mathematical correction applied.

**Vitamin B₂:** Two gram of the sample was weighed into 250ml flask, 5ml of 2N acetic acid was added, 5ml of dichloromethane was also added and 90ml of distilled water was added. This mixture was put in water bath for 20 minutes, cooled, and centrifuged; the first 10ml of the aliquot was discarded. Two ml was pipetted into 200ml volumetric flask and made up to mark with distilled water. Standards were prepared by dissolving 20g into 100ml of distilled water and preparation of 1.5ppm; 2.0ppm, 2.5ppm, and 3.00ppm were prepared from stock solution. The standards were first read on the spectrophotometer at 575nm wavelength before the sample.

**Vitamin B₂:** 0.5 (half) gram of the sample was weighed into 200ml flask, 5ml of dichloromethane was added and 90ml of deionized water was added, put on the steam bath for 20 minute, so that all the vitamins go into solution. It was cooled and made up with water. Five ml of this was pipette into hot 250ml volumetric flask and made up to mark with water. Standard solution was prepared by dissolving 50g of vitamin B₂ into 500ml of distilled water and further dilution of
2 ppm, 4 ppm, 6 ppm, 8 ppm, and 10 ppm. They were read on spectrophotometer at 520 nm wavelength. Calculations were done using the formula:

\[
\text{Mg of Vitamin B}_{12} = \frac{\text{Sample reading} \times \text{Standard weight} \times \text{Dilution factor}}{\text{Standard reading} \times \text{Sample weight}}
\]

**Vitamin B_{12}:** Two gram of sample was weighed into a 150 ml flask. Five ml of 5 N HCl, 5 ml of dichloroethane and 90 ml of deionized water were added. Put on the steam bath for 30 minutes so that all vitamin B_{12} goes into solution. It was then cooled and made up with water, filtered, discarding the first 20 ml of aliquot, 2 ml of it was pipetted into a 200 ml volumetric flask and made up to mark with water. Standard solution was prepared with dissolved 50 g of B_{12} in 500 ml of distilled water, a further dilution of 5 ml into 150 ml and 5 ml into 100 ml followed.

Readings were taken on spectrophotometer at 520 nm wavelength and calculated follows:

\[
\text{Mg of Vitamin B}_{12} = \frac{\text{Sample reading} \times \text{Standard weight} \times \text{Dilution factor}}{\text{Standard reading} \times \text{Sample weight}}
\]

**Vitamin D:** Five gram of sample was dissolved in 5 ml of chloroform, 0.31 ml of acetic anhydride added, followed by 0.01 ml of concentrated H_{2}SO_{4} and shaken vigorously. A red coloration through violet to blue to green indicated the presence of vitamin D.

**Vitamin K:** Five gram of sample was weighed into 200 ml flask and 5 g of menadione and 50 ml of (methanol) MeOH were added and mixed gently for 10 minutes and let to stand for 5 minutes. The mixture was then cooled and made up with water, filtered, discarding the first 20 ml of aliquot, 2 ml of it was pipetted into a 200 ml volumetric flask and made up to mark with water. Standard solution was prepared with dissolved 50 g of B_{12} in 500 ml of distilled water, a further dilution of 5 ml into 150 ml and 5 ml into 100 ml followed.

Readings were taken on spectrophotometer at 520 nm wavelength and calculated follows:

\[
\text{Mg of Vitamin B}_{12} = \frac{\text{Sample reading} \times \text{Standard weight} \times \text{Dilution factor}}{\text{Standard reading} \times \text{Sample weight}}
\]

**RESULTS**

The results showed that the fruits of *L. esculentum* had the highest total soluble sugar, while the lowest total soluble sugar was in *S. macrocarpon*. The starch/glycogen content was highest in *A. esculentus* and lowest in *L. esculentum* (Table 1). The fruit of *A. esculentus* contained the highest amount of crude protein, crude fibre and dry matter, while *S. macrocarpon* contained the lowest amount of crude fibre. The lipid contents of the fruits of *L. esculentum* and *A. esculentus* were similar. Moisture content was higher in *S. macrocarpon*, while *A. esculentus* had the least.

<table>
<thead>
<tr>
<th>Table 1: Proximate Analysis of Fruit and Seed Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>g/100g dry matter</strong></td>
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<tr>
<td>------------------------</td>
</tr>
<tr>
<td><strong>Fruits</strong></td>
</tr>
<tr>
<td>L.E</td>
</tr>
<tr>
<td>A.E</td>
</tr>
<tr>
<td>SM</td>
</tr>
<tr>
<td><strong>Seeds</strong></td>
</tr>
<tr>
<td>V.U</td>
</tr>
<tr>
<td>A.H</td>
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</tbody>
</table>

The values were means of ten replicates. The means with the same letter in the same column in each sample are not significantly different at P<0.05. The means were separated using the t-test.


Other sugars, glucose, arabinose, fructose, raffinose, sucrose and xylose were present in all the three fruits, although *A. esculentus* tend to have contained higher amounts of these sugars, but had the same amount of raffinose with *S. macrocarpon*. *L. esculentum* had the lowest in all the sugar except for glucose which was higher than that of *S. macrocarpon*. Xylose contents of *L. esculentum* and *S. macrocarpon* fruits were similar (Table 2).
Table 2: Sugar Contents (mg/100g dry matter) of the Fruit and Seed Samples

<table>
<thead>
<tr>
<th>Samples</th>
<th>Glucose</th>
<th>Arabinose</th>
<th>Fructose</th>
<th>Raffinose</th>
<th>Sucrose</th>
<th>Xylose</th>
</tr>
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<tbody>
<tr>
<td>Fruits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L.E</td>
<td>0.03b</td>
<td>0.01b</td>
<td>0.03b</td>
<td>0.02b</td>
<td>0.08a</td>
<td>0.04a</td>
</tr>
<tr>
<td>A.E</td>
<td>0.10a</td>
<td>0.14a</td>
<td>0.14a</td>
<td>0.13a</td>
<td>0.11a</td>
<td>0.05a</td>
</tr>
<tr>
<td>SM</td>
<td>0.02b</td>
<td>0.04c</td>
<td>0.11a</td>
<td>0.13a</td>
<td>0.10a</td>
<td>0.04a</td>
</tr>
<tr>
<td>Seeds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V.U</td>
<td>0.14b</td>
<td>0.08b</td>
<td>1.40a</td>
<td>2.50a</td>
<td>0.48a</td>
<td>0.35a</td>
</tr>
<tr>
<td>A.H</td>
<td>0.20a</td>
<td>0.20a</td>
<td>0.13b</td>
<td>0.15b</td>
<td>0.10b</td>
<td>0.18b</td>
</tr>
</tbody>
</table>

The values were means of ten replicates. The means with the same letter in the same column in each sample are not significantly different at P<0.05. The means were separated using the t-test. L. E – Lycopersicon esculentum, A.E – Abelmoschus esculentus, S.M – Solanum macrocarpon, V.U – Vigna unguiculata, A.H – Arachis hypogea.

The mineral element analysis of the fruits showed that the highest amount of Calcium, Potassium and Zinc were in A. esculentus and lowest in S. macrocarpon, but Iron and Phosphorus were highest in S. macrocarpon and lowest in L. esculentum, while Sodium was highest in S. macrocarpon and lowest in A. esculentus (Table 3).

Table 3: Mineral Elements contents (mg/kg) of the Fruit and Seed Samples

<table>
<thead>
<tr>
<th>Samples</th>
<th>Ca</th>
<th>K</th>
<th>Na</th>
<th>Mn</th>
<th>Zn</th>
<th>Fe</th>
<th>P</th>
<th>Cu</th>
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<tbody>
<tr>
<td>Fruits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L.E</td>
<td>2200b</td>
<td>836ab</td>
<td>1548a</td>
<td>208a</td>
<td>256b</td>
<td>120b</td>
<td>760b</td>
<td>76a</td>
</tr>
<tr>
<td>A.E</td>
<td>8000a</td>
<td>912a</td>
<td>1368b</td>
<td>196a</td>
<td>296a</td>
<td>220a</td>
<td>960a</td>
<td>30b</td>
</tr>
<tr>
<td>SM</td>
<td>2000b</td>
<td>798b</td>
<td>1620a</td>
<td>76b</td>
<td>240b</td>
<td>250a</td>
<td>1060a</td>
<td>24b</td>
</tr>
<tr>
<td>Seeds</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V.U</td>
<td>8800a</td>
<td>1064a</td>
<td>1548b</td>
<td>116a</td>
<td>226b</td>
<td>1000a</td>
<td>1760a</td>
<td>20a</td>
</tr>
<tr>
<td>A.H</td>
<td>8600b</td>
<td>874b</td>
<td>2016a</td>
<td>150a</td>
<td>300a</td>
<td>820a</td>
<td>1260b</td>
<td>36a</td>
</tr>
</tbody>
</table>

The values were means of ten replicates. The means with the same letter in the same column in each sample are not significantly different at P<0.05. The means were separated using the t-test. L. E – Lycopersicon esculentum, A.E – Abelmoschus esculentus, S.M – Solanum macrocarpon, V.U – Vigna unguiculata, A.H – Arachis hypogea.

Vitamin A was highest in L. esculentum and lowest in S. macrocarpon; Vitamins B6 and B2 were highest in A. esculentus and lowest in L. esculentum; Vitamin B12 was highest in L. esculentum and lowest in A. esculentus; Vitamin D and K were highest in A. esculentus and lowest in S. macrocarpon (Table 4).

Table 4: Vitamins Contents (mg/100g dry matter) of Fruit and Seed Samples

<table>
<thead>
<tr>
<th>Samples</th>
<th>A</th>
<th>B6</th>
<th>B2</th>
<th>B12</th>
<th>D</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L.E</td>
<td>425a</td>
<td>0.06b</td>
<td>0.04b</td>
<td>0.60a</td>
<td>0.06a</td>
<td>0.17b</td>
</tr>
<tr>
<td>A.E</td>
<td>83b</td>
<td>1.20a</td>
<td>1.13a</td>
<td>0.13b</td>
<td>0.07a</td>
<td>1.00a</td>
</tr>
<tr>
<td>SM</td>
<td>25b</td>
<td>0.08ab</td>
<td>0.05b</td>
<td>0.50a</td>
<td>0.03b</td>
<td>0.02c</td>
</tr>
<tr>
<td>Seeds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V.U</td>
<td>18a</td>
<td>1.05a</td>
<td>2.20a</td>
<td>0.21a</td>
<td>0.14b</td>
<td>0.31a</td>
</tr>
<tr>
<td>A.H</td>
<td>21a</td>
<td>0.87b</td>
<td>0.25b</td>
<td>0.17b</td>
<td>0.31a</td>
<td>0.12b</td>
</tr>
</tbody>
</table>

The values were means of ten replicates. The means with the same letter in the same column in each sample are not significantly different at P<0.05. The means were separated using the t-test. L. E – Lycopersicon esculentum, A.E – Abelmoschus esculentus, S.M – Solanum macrocarpon, V.U – Vigna unguiculata, A.H – Arachis hypogea.

The proximate analysis of seeds showed that total soluble sugar, starch, crude fibre and moisture contents were higher in V. unguiculata while crude protein, lipids, and dry matter were higher in A. hypogaea (Table 1). Glucose and arabinose were higher in A. hypogaea, while fructose, sucrose, raffinose and xylose were higher in V. unguiculata (Table 2). The mineral elements Calcium, Potassium, Iron, and Phosphorus contents were higher in V. unguiculata, while Sodium, Manganese, Zinc, and Copper were higher in A. hypogaea (Table 3). Vitamins A and D contents were higher in A. hypogaea, while Vitamins B6, B2, B12, and K were higher in V. unguiculata (Table 4).
DISCUSSION

These results revealed that the amount of lipid content in A. esculentus and L. esculentum were similar to 1.60±0.02 % crude lipids recorded in undefatted A. hybridus (Ihenacho and Udebani, 2009). The amount of crude protein found in A. esculentus compared favorably Shukla and Naik 1993. Sugars such as glucose, fructose, arabinose, raffinose, sucrose and xylose were present in all the fruits. The main sugars obtained from the fruits samples were raffinose in S. macrocarpon; fructose, arabinose, sucrose, glucose and xylose in A. esculentus. This differed from the findings of Horbowicz et al. (1980) who reported that the main sugars in most vegetables are fructose, glucose, and sucrose. The higher starch content in A. esculentus could be attributed to the mucilage made up of d-galactose, l-rhamnose and d-galactose that abounds in this vegetable (Burkill, 1997). Ifon and Bassir (1987) reported that the mineral contents of some Nigerian vegetables were adversely affected by high content of phythates, oxalates and cyanogenic glycosides. This reason may be responsible for the low values of mineral elements recorded in the fruits of S. macrocarpon. L. esculentum contained the highest amount of vit. A among the three fruits. This could be due to high content of β-carotene in tomato which is a precursor of Vitamin A. George (1985) reported that sun-drying as a form of preservation, particularly in the fruits of okra caused over 80% loss in the ascorbate and β-carotene content.

It however had only negligible effect on thiamine, riboflavin and pyridoxine contents. This corroborated our findings where A. esculentus contained the highest amount of vitamins B₂ and B₆. The lipid content was low in the three fruits. This makes them suitable for obese and diabetic people.

The proximate analysis of the seeds of V. unguiculata and A. hypogea, showed that there was little variation in their crude protein contents (23.00 and 24.94%, respectively), which compared favorably with the result obtained from the work of Ogunsua and Adebona (1983) on Tetracarpidium conophorum nuts protein (23.5%). The seeds of V. unguiculata contained less lipid content (1.40%) and this is an implication that the two seeds can be interchanged in the diet of the people of the tropics to lower the blood cholesterol level.

From the results obtained in the investigation, V. unguiculata fruit was found to be rich in crude fibre, starch, moisture content and soluble sugars while A. hypogea is richer in protein and lipids contents. These results indicate that V. unguiculata and A. hypogea are good sources of protein and carbohydrate for man and animals particularly in the dry season. V. unguiculata could be recommended for diabetic patients.

This study shows that there is a wide variation in the levels of the chemicals investigated in those seeds and fruits. The values are high enough and are either close or above the recommended levels needed in the body.

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