Nutrients and mineral contents of the fresh and dried cakes pulps of *Vitellaria paradoxa* Gaertn. Of Gulu District, Uganda

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**ABSTRACT**

*Vitellaria paradoxa* locally known as ‘Yaa’ in Acholi, is a valuable edible indigenous wild fruit in Gulu District, northern Uganda. It is a multipurpose fruit tree hence highly favoured by the inhabitants of this district. Its fruit pulps are eaten both in a fresh and dried cake forms. This study determined the nutrients and mineral compositions of the fresh and dried pulp cakes of *V. paradoxa*. Specifically, laboratory analyses were undertaken to screen for iron, zinc, potassium, sodium, magnesium and Calcium, vitamin C, vitamin A, fats, proteins, fibre, ash and phytates using standard procedures and protocols. The zinc, potassium, sodium, and Calcium contents of the fresh pulps on fresh matter (FM) basis were respectively below 1.00mg/100g, 38mg/100g, 73mg/100g and 234mg/100g compared to their contents in the dried pulp cakes. Iron (6.8mg/100g) and magnesium (92.01mg/100g) contents on FM basis were the highest in the dried cakes. The fresh pulps also had higher moisture (70.50g/100g), Fibre (5.95g/100g) and Vitamin A (228.30µg/100g) contents. Phytates were absent in both fresh and dry pulps on both FM and Dry matter basis. Both the fresh and dry pulp cakes have appreciable nutrient compositions to be used as supplements hence the need to test for their availability in the body after consumption.

**Keyword:** Edible wild fruits, proximate, macro and micronutrients compositions.

**INTRODUCTION**

Poor dietary quality and inadequate intake of micronutrients are widespread problems (Steward et al., 2010). WHO (2009) reported vitamin A deficiency as a major nutritional concern in poor societies, especially in lower income countries. High mortality and disease burden resulting from nutrition-related factors enhances a compelling case for the urgent implementation of interventions to reduce their occurrence (Black et al., 2008). Shrimpton et al. (2001) recommended interventions during early periods of life as important. Development of effective interventions to stop critical stunting in children from birth to 24 months is important (de Onis et al., 2003). This calls for an urgent need for nutrition programmes to alleviate micronutrient deficiencies.

Indigenous fruit trees although undomesticated play many important roles in many rural areas (Mojeremane and Tshwenyane, 2004). Plants are major components of the human diets with many types and parts eaten (Hamilton and Hamilton, 2006). Fruits are important in an adequate diet, and serve as food supplements, and appetizers (Adepoju, 2009). Edible wild fruit species in particular are common and easily accessible in most rural communities and are very important for food and nutritional security. Although widely consumed in many communities during famines and/or periods of food shortages (Adepoju, 2009), the long period of insurgency in northern Uganda between 1986 and 2006 interrupted the consumptions of such edible wild fruits among the community of Gulu district. Malnutrition became rampant in this community especially among the children as the community relied heavily on maize flour and beans supplied by humanitarian aids. Musinguzi et al. (2007)
recognized that, most foods eaten by the majority of Ugandans lack micronutrients. The Ministry of Agriculture, Animal Industries, and Fisheries (MAAIF) and Ministry of Health (MOH) (2005) of Uganda reported over 40% of deaths among Ugandan children as being attributed in part to malnutrition. Caulfield et al. (2004) noted generally that 52.5% of all deaths in young children are attributable to inadequate nutrition. Nalwoga et al. (2010) observed that a number of cases of chronic childhood diseases in Uganda are due to under nutrition. Edible wild fruits can be one of the solutions to the problem of nutrient inadequacies if appropriately eaten. These fruits are generally acceptable as good source of nutrients and supplements for food in a world faced with problem of food scarcity (Adepoju, 2009).

Since Gulu District has a number of favoured but underutilized edible wild fruit trees (Oryema et al., 2013), there is need to investigate the nutritional compositions of the edible wild fruits mostly preferred by the community. In light of this background, this study was designed to determine and provide information on the nutrients compositions of the fresh and dried pulp cakes of the fruits of *V. paradoxa*. This information is to be used to create awareness on the importance of the edible wild fruits to the community.

**MATERIALS AND METHODS**

Gulu district is one of the districts of Uganda, and is bordered by the districts of Lamwo to the northeast, Pader to the east, Nwoya to the southwest and Amuru to the west and northwest. It also shares a border with Southern Sudan. The district comprises Omoro and Aswa Counties and has a total of 12 Sub counties and 294 villages (RIC-NET 2012-2013). The sub counties included in the study were Ongako, Bobi and Lalogi from Omoro county, and then PATIKO, Awach and Paicho from Aswa County.

Both the fresh fruits and dried pulp cakes made from the fruit pulps of *V. paradoxa* were purposively collected from Ngom-Iac Village, Omel A Parish, Paicho Sub-County Aswa County. The fresh fruits were collected, sorted, transported in a coolant to the laboratory and refrigerated at -4°C (Okullo et al., 2010). The edible parts of the refrigerated fruits were then manually separated from the kernel using a stainless steel knife, packed in a polythene bag and kept back in the refrigerator. The dried pulp cakes on the other hand were brought as was made by local community and tied in a polythene bag then stored in the refrigerator. Composite and analytical portions were prepared from these samples. The nutrients and minerals compositions under investigation included fats, crude fibre, moisture content, ash and carbohydrates and iron, zinc, manganese copper, sodium, potassium, Magnesium and calcium respectively. The analyses were done in the laboratories of Food and nutrition Department, Makerere University, Uganda and the Department of Human nutrition, Faculty of Life Science, University of Copenhagen, Denmark.

**Moisture contents**

The moisture content was determined according to a force draft-air oven method (AOAC, 1990; Saka and Msonthi, 1994).

**Minerals and proteins analysis**

Samples for minerals and proteins were digested under a Fume hood (Selecta Block Digest μ40, ISO 9001-2000 CERTIFIED Co.).

**The crude proteins:** These were determined using the Micro-Kjeldahl method No. 960 (AOAC, 1990). The digested sample was distilled using an auto-distillation machine (2200 Kjeltec, Foss-Tecator, Sweden). The crude protein contents were then obtained by determining the organic nitrogen content of the sample using a factor of nitrogen by a constant multiple 6.25N (Amarteifio and Mosase, 2006; Nnamani et al., 2009; Efficient and Udo, 2010).

**Minerals:** All minerals were determined using Atomic Absorption Spectrophotometer (AAS).

**Vitamin C contents:** These were determined following the procedures outlined by Rodriguez-Amaya and Meiko Kimura (2004). The contents in the pulps were determined by titration with 2, 6-dichlorophenol-indophenol solution (Sohn, 2009).

**Crude fat:** Crude fat was analysed using Swedish made Soxtect system HT-1043 extraction unit following the procedures by AOAC, (1990).

**Total carbohydrates:** These were estimated using the method of Knowles and Watkins (1950) called the hot water extraction method.

**Ash contents:** These were determined by incineration of the samples in a muffle furnace (Ugese et al., 2010).

**Crude fibre:** This was determined by the procedures outlined by Kirk and Sawyer (1973) whereby the samples were extracted sequentially with concentrated sulphuric acid and sodium hydroxide.

**Energy contents:** This was determined using a bomb calorimeter (Miller and Payne, 1959).

**Phytates:** These were analysed on a high-performance liquid chromatography systems, and the details of the methods were described by Bohn et al. (2008).
Table 1. Macro and micro minerals contents of the fresh and dried pulp cake of V. paradoxa on Dry matter (DM basis).

<table>
<thead>
<tr>
<th>Edible states</th>
<th>Fe (Iron)</th>
<th>Zn (Zinc)</th>
<th>K (Potassium)</th>
<th>Na (Sodium)</th>
<th>Mg (Magnesium)</th>
<th>Ca (Calcium)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh pulps</td>
<td>2.88 (0.17)</td>
<td>0.56 (0.03)</td>
<td>126.60 (6.70)</td>
<td>24.40 (6.60)</td>
<td>51.20 (1.80)</td>
<td>329.08 (8.80)</td>
</tr>
<tr>
<td>Dried pulp cake</td>
<td>8.00 (0.05)</td>
<td>0.67 (0.04)</td>
<td>94.90 (8.40)</td>
<td>42.20 (0.30)</td>
<td>108.10 (5.80)</td>
<td>198.23 (10.94)</td>
</tr>
</tbody>
</table>

Values in brackets are standard deviations (Std.Dev.) of triplicate measurements (n=3).

Table 2. Macro and micro minerals contents of the fresh and dried pulp cake of V. paradoxa on fresh matter (FM basis).

<table>
<thead>
<tr>
<th>Edible states</th>
<th>Fe</th>
<th>Zn</th>
<th>K</th>
<th>Na</th>
<th>Mg</th>
<th>Ca</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh pulps</td>
<td>0.86 (0.08)</td>
<td>0.40 (0.02)</td>
<td>38.00 (2.00)</td>
<td>7.30 (2.00)</td>
<td>21.90 (0.76)</td>
<td>234.90 (6.30)</td>
</tr>
<tr>
<td>Dried pulp cake</td>
<td>6.80 (0.01)</td>
<td>0.09 (0.01)</td>
<td>13.30 (1.20)</td>
<td>5.90 (0.00)</td>
<td>92.10 (5.00)</td>
<td>29.21 (1.60)</td>
</tr>
</tbody>
</table>

Values in brackets are standard deviations (Std.Dev.) of triplicate measurements (n=3).

DATA ANALYSIS

Data were analysed using STATA 12 (StataCorp LP, College Station, and Texa, USA). Analysis of Variance (ANOVA) was used in the determination of means and standard deviations. All results are presented in different tables for nutrients and minerals on dry (DM) and fresh matter (FM) basis respectively.

RESULTS AND DISCUSSION

Potassium (K) contents

The K contents of the fresh pulps of V. paradoxa on DM basis (126.60 mg/100 g (Table 1) is below the mean value reported by Maranz et al. (2003) on DM basis. This content is higher than the reported values by Okullo et al. (2010) for the districts of Lira (47.9±0.2 mg/100 g), Katakwi (52.0±0.3 mg/100 g), and Pader (63.6±0.3 mg/100 g) and Arua (42.0±0.3 mg/100 g). The K content of the fresh pulps on FM basis (38.00 mg/100 g) (Table 2) is similar to that of pineapple (37 mg/100 g) though lower than that of Psidium guajava (91 mg/100 g) and Carica papaya (69 mg/100 g) (Nazarudeen, 2010). The contents on FM basis for both the fresh and dried pulp cakes constitute respectively 1.3 and 0.35% daily value (DV) of the 3800 mg/d based on 2000 Kcal/100 g (FAO/WHO, 2005; FNB, 2005). These percentages are all below the RDA/AI for all age groups and categories of persons hence favouring their consumption (Figure 1 and 2).

Sodium (Na) contents

The fresh pulps of V. paradoxa on dry matter basis contain higher Na contents (24.40 mc/100 g) (Table 1) than the content reported for the fresh pulps in the districts of Lira (8.9 mg/100 g), Pader (9.0 mg/100 g), and Arua (7.1 mg/100 g) although closer to that of Katakwi (18.1 mgk/100 g) by Okullo et al. (2010). On FM basis, the sodium contents (7.30mg/100g) (Table 2) are however lower than the contents in Apple (28 mg/100 g), pineapple (34.7 mg/100 g) and Mangnifera indica (26 mg/100 g) and similar P. guajava (5.5 mg/100 g) reported by Nazarudeen (2010). Unlike the K contents, the sodium content (7.30mg/100g) on FM basis (Table 2) is lower compared to that of the pineapple (34.7mg/100g) reported by (Nazarudeen, 2010). This same content on FM basis constitutes 0.3% daily value (DV) of the 3800mg/d total dietary energy based on 2000 Kcal per day; for adults and children four or more years (FNB, 1997; 2000; 2001; 2004), a percentage similar to that of the dried pulp cakes (0.24% percentage DV). These low concentrations of Na in these edible parts/forms makes them as favourable for consumptions as the introduced fruits, this mineral being important in regulating high blood pressure (Alinnor and Akalezi, 2010).

Magnesium (Mg) contents

The Mg content of the fresh pulps of V. paradoxa on DM basis (51.20 mg/100 g) (Table 1) is much higher than the contents reported by Okullo et al. (2010) for the districts of Lira (18.1 mg/100 g), Katakwi (23.8 mg/100 g), Pader (24.2 mg/100 g) and Arua (21.0 mg/100 g). The same content is higher than the mean value reported by Maranz et al. (2003) and the contents (1.23 mg/100 g) reported by Mbaiguinam et al. (2007) for Kamane variety on DM basis. On FM basis, the Mg content of the fresh pulps (Table 2) constitutes 5.6% DV for adults or children aged 4 or older.
Maranz et al. (2003). Its contents on DM basis are similar to the value for the fresh pulps reported by Mbaiguinam et al. (2007) from Southern Chad. On FM basis its contents (234.90 mg/100 g) (Table 2) is much higher than the introduced variety of mango, the Dodo mango and Viringe mango reported by Othoman (2009) hence it makes them a better source of Ca. This value on FM basis constitutes up to 23.5% daily nutritional requirements for adults or children aged 4 or older based on a 2,000 Kcal reference per day (FAO/WHO, 2005) compared to only 2.9% DV for the dried pulps. These percentage daily values are however all below the RDA for Ca for all categories of persons hence are suitable supplements, calcium being very important for aiding the development of strong bones, improving nerve impulses and blood clotting and muscle contractions (Agatemon and Ukhun, 2006).

Iron (Fe) contents

The iron content of the fresh pulps of *V. Paradoxa* on DM basis (2.88 mg/100 g) (Table 1) is only slightly lower than the values reported by Okullo et al. (2010) for the districts of Lira (3.6 mg/100 g), Katakwi (3.4 mg/100 g), Pader (3.8 mg/100 g) and Arua (3.8 mg/100 g). Its content on FM basis (0.86 mg/100 g) (Table 2) is also much lower than the average value reported by Maranz et al. (2003). This content is however similar to the values reported by Mbaiguinam et al. (2007) from Southern Chad. The same value is similar to that of papaya (0.10 mg/100 g), banana (0.26 mg/100 g) and mango (0.13 mg/100 g) (Mahapatra et al., 2012) with all values below 1.00 mg/100 g. For the fresh pulps, the Fe contents on FM basis (Table 2) accounts for 4.6% DV for adults or children aged 4 or older based on a 2,000 Kcal reference diet (USDA, 2008) compared to the higher DV of the dried pulp cakes. The higher contents of iron in the dried pulp cakes of *V. paradoxa* on both DM and FM basis could be due to contamination from the tools used during preparation of the dried cakes while still in the community or from the soil where the fruits were collected and/or dried from the field. The absence of phytates (an anti-nutrient) in both the fresh pulps and dried pulp cakes makes them more suitable sources of Fe. This is because there will be no interference with the mineral. Increased consumption of all these edible parts can increase the iron level in the body and reduce the prevalence of anaemic conditions especially among children and/or teenagers.

Zinc (Zn) contents

The fresh pulps of *V. paradoxa* on both DM (0.56 mg/100 g) and FM basis (0.40 mg/10/ g) (Table 1) are similar to the lowest content (0.3 mg/100 g) of Fe reported by Maranz et al. (2003). This content is similar to the content of mango (0.04 mg/100 g) and guava (0.23 mg/100 g) reported by Mahapatra et al. (2012) with all values below 1 mg/100 g.

**Calcium (Ca) contents**

The Ca values for the fresh pulps of *V. paradoxa* on DM basis (329.08 mg/100 g) (Table 1) is much higher than contents reported from the Shea districts of Lira (69.4 mg/100 g), Katakwi (79.0 mg/100 g), Pader (95 mg/100 g) and Arua (37.3 mg/100 g) in Northern Uganda (Okullo et al., 2010). The Ca contents on both DM and FM basis for the fresh pulps are all within the ranges of values reported by
The same contents of the fresh pulps on FM basis (Table 2) constitute 2.6% DV based on total dietary energy intake of 2000 Kcal per day; for adults and children four or more years of age per day (USDA, 2008) higher than the DV of the dried pulp cakes (0.6% DV) based on total dietary energy intake of 2000 Kcal per day; for adults and children four or more years of age per day (FAO/WHO, 2005; FNB, 2005). These DV values are below the RDA for all ages and categories of persons. These make them desirable for consumption across different individuals in the community.

The compositions of Zn on DM basis are generally low in both the edible forms (Table 1). The Fe contents in the dried pulps are much higher than in the fresh pulps. Potassium and Calcium contents are however higher in the fresh pulps compared to that in the dried cakes.

The compositions of Fe and Zn on FM basis are generally low in both the edible forms although with strikingly higher values of Fe in the dried cakes (Table 2). This high content is followed by that of Na and Ca contents in the fresh pulps.

**Moisture content (MC)**

The moisture contents of the fresh pulps of *V. paradoxa* on FM basis (70.5%) (Table 4) is closer to the contents reported for the districts of Lira and Katakiwirin Northern Uganda by Okullo et al. (2010). To the contrary, the dried pulps have low MC but very high dry matter. The possible reasons for the differences in the MC in these different edible states could be due to the differences in the states in which they are eaten and/or brought in the laboratory. For example, the high dry matter of the dried pulp cake could have been because it was brought for analysis while already in a dry state and ready for storage. The disadvantage of the high moisture contents of the fresh pulps explains their susceptibility to infection, decreased ability for storage and their short life span for preservation.

**Crude Fibre (CF) contents**

The crude fibre content of the fresh pulps of *V. paradoxa* on DM basis (13.30 g/100 g) (Table 3) is similar to the contents reported for the districts of Lira (14.5 g/100 g), Kataki (14.4 g/100 g), and Arua (14.6 g/100 g) in Northern Uganda reported by Okullo et al. (2010). On FM basis the CF contents (5.95 g/100 g) (Table 4) of the fresh pulps is higher than the contents in Apple (1 mg/100 g), pineapple (0.5 mg/100 g), jack fruits (1.1 mg/100 g), mango (0.7 mg/100 g) and papaya (0.8 mg/100 g) but similar to that of guava (5.5 mg/100 g) (Nazaruudeen, 2010). These make them as favourable for consumptions as the introduced fruits. The content on FM basis constitutes 23.8% DV of the 25% crude fibre based on total dietary energy intake of 2000 Kcal per day; for adults and children four or more years of age per day (FAO/WHO, 2005). The dried pulp cakes on FM basis the other hand contains fibre contents which account for only 7.08% DV (FAO/WHO, 2005). Fresh pulps are therefore better sources of fibre compared to its dried pulp cakes.

The fibre, fats, proteins and carbohydrates contents are similar in both the fresh and the dried pulps (Table 3). The fresh pulps however on DM basis contain higher contents of Vitamin A (740.80 µg/100 g) (85.30 g/100 g), Vit. C (83.20 mg/100 g) compared to the dried pulps.

The moisture contents (MC), Crude fiber and Vitamin A contents are higher in the fresh pulps than in the dried cake pulps (Table 4). Crude fats, ash and proteins compositions are all lower than 2 g/100 g. Both the pulp states do not have phytates.

**Crude fats**

The fresh pulps of *V. paradoxa* on DM basis has similar crude fat contents (3.30 g/100 g) (Table 3) as the lipid contents reported for the Shea pulps from the districts of Pader (3.5 g/100 g) and Arua (2.5 g/100 g) (Okullo et al., 2010). Its content on FM basis (0.98 g/100 g) (Table 4) is similar to the contents of the different types of papaya reported by Nwofia et al. (2012). This same content on FM basis constitutes 1.5% daily value, of the 65% total fat based on total dietary energy intake of 2000 kcal per day; for adults and children four or more years of age per day (FAO/WHO, 2005). The dried pulp cake on the other hand on FM basis (Table 4) has fat content which accounts for 2.05% of the DV of the 65% total fats (FAO/WHO, 2005). This content is higher than for the fresh pulps, making it a better source of the natural fats.

**Ash contents**

The fresh pulps of *V. paradoxa* on DM basis has similar ash contents (5.10 g/100 g) (Table 3) as those reported by Okullo et al. (2010) for the districts of Pader (5.9 g/100 g), Kataki (5.5 g/100 g) and Arua (4.6 g/100 g) and only slightly lower than that of Lira (3.6 g/100 g). Its content on FM basis (1.53 g/100 g) (Table 4) is however higher than the contents of all the papaya types reported by Nwofia et al. (2012). The ash content of the dried pulp cakes on FM basis is (1.33 g/100 g) is only slightly higher than for the fresh pulps (0.98 g/100 g). Although the ash contents are low, their importance is conveyed by the available amounts of minerals they have hence are potential as good sources of minerals, these being important in various ways in determining the health status of human beings.

**Proteins contents**

The protein content of the fresh pulps of *V. paradoxa* on DM
Table 3. Proximate contents of the fresh and dried pulps cakes of *V. paradoxa* on dry matter (DM) basis.

<table>
<thead>
<tr>
<th>Edible states</th>
<th>Proximate contents</th>
<th>g/100 g</th>
<th>kcal/100g</th>
<th>mg/100g</th>
<th>µg/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry matter</td>
<td>Fibre</td>
<td>Fat</td>
<td>Ash content</td>
<td>Proteins</td>
</tr>
<tr>
<td>Fresh pulps</td>
<td>29.50 (0.87)</td>
<td>13.30 (1.29)</td>
<td>3.30 (1.1)</td>
<td>5.10 (0.26)</td>
<td>6.61</td>
</tr>
<tr>
<td>Dried pulp cake</td>
<td>85.30 (0.02)</td>
<td>12.20 (1.4)</td>
<td>1.60 (0.15)</td>
<td>2.70 (0.86)</td>
<td>4.64</td>
</tr>
</tbody>
</table>

The values are expressed as mean (Std.Dev.) of triplicate measurements (n=3) except for phytates (n=2) in respective SI units. Carb. = Carbohydrates.

Table 4. Proximate compositions of the fresh and dried pulp cakes of *V. paradoxa* on fresh matter (FM) basis.

<table>
<thead>
<tr>
<th>Edible states</th>
<th>Proximate compositions</th>
<th>g/100 g (%)</th>
<th>kcal</th>
<th>mg/100 g</th>
<th>µg/100 g</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MC(Moisture content)</td>
<td>Fibre</td>
<td>Fat</td>
<td>Ash</td>
<td>Proteins</td>
</tr>
<tr>
<td>Fresh pulps</td>
<td>70.50 (0.87)</td>
<td>5.95 (0.14)</td>
<td>0.98 (0.35)</td>
<td>1.53 (0.08)</td>
<td>1.98 (0.32)</td>
</tr>
<tr>
<td>Dried Pulp cake</td>
<td>14.70 (0.02)</td>
<td>1.77 (0.41)</td>
<td>1.33 (0.13)</td>
<td>2.33 (0.74)</td>
<td>3.95 (0.11)</td>
</tr>
</tbody>
</table>

The values are expressed as mean (Std) of triplicate measurements (n=3) except for phytates (n=2).

Proximate contents of the fresh and dried pulps cakes of *V. paradoxa* on dry matter (DM) basis:

- **Fibre** contents (6.61 g/100 g) (Table 3) are higher than the values reported for the Shea pulps from Lira (3.1 g/100 g), Pader (3.2 g/100 g) and Arua (3.7 g/100 g) by Okullo et al. (2010). The concentrations are however within the range reported by Maranz et al. (2003). It is also within the range of the contents (6.52 to 9.35 g/100 g) reported by Mbaiguinam et al. (2007) from Mbandoul, Southern Chad. On FM basis its contents (1.98 g/100g) (Table 4) is similar to the mean values reported by Maranz et al. (2003). This same content on FM basis is higher than that for Ananas comosus (0.2 g/100g), M. indica (0.6 g/100 g) and *C. papaya* (0.6 g/100 g) but similar to that of *Artocarpus heterophyllus* (1.9 g/100 g) reported by Nazarudeen et al. (2010). Its values on FM is however higher than for banana, orange, lemon though lower than for guava as reported by Mahapatra et al. (2012). This difference was minor to make the community to ignore the pulps of *V. paradoxa*. Its contents on FM basis constitutes 3.96% DV of the 50% crude proteins based on total dietary energy intake of 2000 kcal per day; for adults and children four or more years of age per day (FAO/WHO, 2005) compared to the 7.9% DV of the dried pulp cakes. The higher contents in the dried cakes could be because they are made up from different fruits with varied mounts of proteins.

**Carbohydrates contents**

The carbohydrates content of the fresh pulps of *V. paradoxa* on DM basis (27.50 g/100 g) (Table 3) is higher compared to the contents reported for the Shea pulps from Lira (3.1 g/100 g), Pader (3.2 g/100 g) and Arua (3.7 g/100 g) by Okullo et al. (2010). The concentrations are however similar to the mean Shea values reported by Maranz et al. (2003) for the Parkland area of northern Uganda.
The same content is also within the range of 6.52 to 9.35 g/100 g reported by Mbaiguinam et al. (2007) from Mandoul, Southern Chad. The content of the fresh pulps on FM basis (8.25 g/100 g)(Table 4) is also similar to the mean values reported by Maranz et al. (2003). This same content is however higher than that for A. comosus(0.2 g/100 g), M. indica (0.6 g/100 g) and C. papaya (0.6 g/100 g) but similar to that of A. heterophyllus(1.9 g/100 g) reported by Nazarudeen et al. (2010). The content on FM basis is similar to that of banana, orange and lemon (Mahapatra et al. 2012). The similarities and the low disparities of the the carbohydrates contents of the pulps makes them as favorable for consumptions as the introduced fruits for the same purpose of energy production.

Vitamin C Contents

The vitamin C contents of the fresh pulp the V. paradoxa contents on DM basis (83.30 mg/100 g)(Table 3) is higher than the contents reported for all the districts of Northern Uganda of Lira (19.4 g/100 g), Katakwi (14.2 g/100 g), Pader (12.6 g/100 g) and Arua (14.9 g/100 g) reported by Okullo et al. (2010) and that reported by Mahapatra et al. (2007). The vitamin C content on FM basis (25.01 mg/100g) (Table 4) is higher than that of banana (22.84 g/100 g), mango (17 g/100 g), and orange (11.54 g/100 g) reported by Mahapatra et al. (2012). The same content on FM basis constitutes 2.8% DV of the 300 g/d carbohydrates based on the 2000 kcal/d (FAO/WHO, 2005) compared to the DV for the dried pulp cakes 8% DV of the 300 g/d (FAO/WHO, 2005). Visibly the pulps are a better source of Vitamin C compared to most introduced fruits.

Carotenoid contents

The carotenoids (Vitamin A) contents of the fresh pulps of V.paradoxa on both DM basis 8890 µg/100 g (Table 3) and FM basis 2740 µg/100 g (Table 4) is higher than the contents in the dried pulp cakes both on DM and FM basis. The differences observed could be because a lot of carotenoids were lost at the time when the cakes were being prepared due to exposure to direct sunlight. The different colors in most foods make them more or less attractive to the eyes but are also attributed to the amounts of carotenoids present. The orange colors in any given food substance is most times an indication of the amount of carotenoids available in it. According to Chen et al. (1995), colors are an important attribute of quality food. Carotenoids are very important chemicals in the plants thus making each of them very important. For humans, vitamin A is important for the treatment of people suffering from eye problem (Agatemor and Ukhn, 2006, Rao and Rao, 2007) and also important for: night vision, healthy skin, gums and teeth. Some other literatures acknowledge it as an essential element in the prevention of human diseases such as cancer, cardiovascular diseases, and Osteoporosis, diabetes and eye diseases. It also plays important roles in mobilizing iron from its storage sites hence making it available in the body. For these reasons, these edible parts become very important and their consumptions should be promoted widely.

Energy contents

The energy content of these pulps on DM basis (399.40 kcal/100g) (Table 3) is only slightly higher than that of the dried cakes (391.60 kcal/100g). On FM basis, the energy content of the dried pulps is much higher 333.85 kcal/100 g compared to that of the fresh pulps on FM basis (119.90 kcal/100 g) (Table 4). This indicates the strength of the dried pulps in provision of energy when consumed. The energy difference is probably dependent on the available fats, carbohydrates and proteins in each. The high water contents, in addition to the available fibre contents in the edible parts could have negatively impacted on the energy contents.

Phytate contents

Phytates is one of the anti-nutrients that when available in foods can interfere with the availability of minerals. Lack of phytates in both the fresh and dried pulp cakes (Tables 3 and 4) are of added advantage to the availability of minerals in them. Phytates have also been implicated in decreasing protein digestibility by forming complexes and also by interacting with enzymes such as trypsin and pepsin (Reddy and Pierson, 1994) in Embaby and Mokhtar (2011).

Conclusion

Both the edible states of the pulps of V.paradoxa contain appreciable contents of the nutrients and minerals although with variable contents. Most of the compositions are similar to those of the introduced fruits. Since all mineral and nutrients contents are below the RDA, both these edible states are thus important. The dried cakes are especially important during the periods of fresh fruit shortages or when there are food shortages.

RECOMMENDATIONS

There is need for sensitization of the community on the nutritive values of these edible parts so as to enhance consumptions of the fruits, sustainable utilization and conservation of the wild fruits. There is also need to
carryout nutritional study to assess the availability of these nutrients/minerals in the body after consumption. More members of the communities are encouraged to prepare more of the dry cakes to prepare for periods of shortages instead of leaving the fresh fruits to rot.

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REFERENCES


Mapongnetsem PM, Kapchie VN, Telempa BH (2012). Diversity of local fruit trees and their contribution in sustaining the rural livelihood in the Northern Cameroon. Ethio. J. Environ Stud. Manage. 5:1


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