Time Journals of Biological Sciences and Technology
Vol. 1(1) 1-11 August 2013
www.timejournals.org/tjbst


# Domestication Potential and Nutrient Composition of Wild Orchids from Two Southern Regions in Tanzania

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Accepted Date: 20 August, 2013

## ABSTRACT

**Edible orchids have been under severe harvesting and unfortunately some of the species harvested are about to disappear. The study was conducted to explore the domestication potential and composition of edible orchids. Household questionnaires, field visits and documentary review were used to collect data. Orchid tubers were collected for analyses of nutrient content. Quantitative data were analysed using the Statistical Package for Social Sciences (SPSS) orchid rubbers dissolved with Hydrochloric acid for food composition and proximate analysis. Analyses on nutrient composition revealed that edible orchids had 5.36g protein content; 2.7% fiber content; 2.2% minerals (ash) content; 1.57% fat and 0.09mg vitamins C and 0.02µg bête-carotene content. Proximate analyses of samples from Ibaga indicated higher nutrient content than samples from Kikondo village. Ash (3.67±0.26mg/100g), carbohydrate (5.97±1.22mg/100g), and crude fiber (3.36±0.04mg/100g). Sample from Kikondo had significantly ($p<0.05$) higher ß-carotene concentration (0.03±0.005mg/100g) than sample from Ibaga (0.01±0.003mg/100g). Sample from Kikondo had the higher calcium content (33574±11.62mg/Kg). Considering the valuable contribution of edible orchids to human nutrition and the indications that its availability is decreasing interventions focusing on domestication is needed. Based on the results of the nutrient composition a detailed investigation has to be done to determine the nutritional potential.**

**Key words:** Edible orchids, Orchidaceae, Nutrient content, Kitulo National Park, Tanzania

## INTRODUCTION

Orchids are mostly known for their beautiful flowers which make them a resource of great economic importance in the global horticultural industry (Byers, 2001; Bingham, 2004; Mugasha et al., 2005). The attractive colour and shape of their flowers has made them very popular and as a result, these plants have great ornamental value, in the Southern African region (Williamson, 1977; Nguni et al., 2001; Kasulo et al., 2009; Niet and Gehrke, 2005).Early studies on orchids in Southern Africa concentrated on taxonomic aspects (Williamson, 1977; La Croix et al., 1983; 1991; Linder and Kurzweil, 1999; Ruffo et al., 1996). In recent years, however, a number of researchers (Golding, 2001; 2003; Nguni et al., 2001; Hamisy, 2007; Bingham and Kokwe, 2001; Bingham and Smith, 2002; Davenport and Ndangalasi, 2003 ), have focused on the dramatic rise in demand for edible orchids which has led to an increase in cross- boarder trade thereby raising concerns about its sustainability as high exploitation pressure threaten its future existence. In Tanzania, Zambia, and Malawi, for instance, orchids are mostly important for their tubers which are used as a source of food and income, and are, therefore, traded

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within and across the countries (Davenport and Ndangalasi 2003; Hamisy, 2005; Nyomora, 2005; Ruffo et al., 2002; Lovett et al., 1995; Kasulo et al., 2009; Temu and Chihongo, 1998).Orchids falls under flowering plant groups belonging to the family Orchidaceae under monocotyledons and are widely distributed (Ruffo et al., 1996; Nguni et al., 2001; Mugasha et al., 2005; Niet and Gehrke, 2005). In Tanzania, "edible Orchids" are terrestrial species of the family growing wildly, particularly in mountainous parts of the Southern Highlands, where their tuberous roots are dug up from the ground for human consumption and trade (Davenport and Ndangalasi 2003; Hamisy, 2005; Lovett et al., 1995; Nyomora, 2005; Ruffo et al., 2002; Temu and Chihongo, 1998). Edible orchids represent more than 80 species belonging to the genera Disa, Satyrium, Habenaria and Brachycorythis amongst others. These plants are abundant in upland or Montane grassland areas 1 200–2 700 m above sea level (Cribb and Leedal, 1982; Ruffo et al., 2002).

Considerable numbers of orchid species have been reported from Tanzania, including 21 species of the genus Disa, 77 of Habenaria and 33 of Satyrium found mostly in the southern highlands part of the country (Hamisy, 2005; 2007). Hamisy (2005) identified about five and four species used as food in Makete and Mbinga districts Tanzania respectively. These genera are the Satyrium, Disa, Habenaria and Roeperachian.Davenport and Ndangalasi (2001; 2003) estimated that as many as 85 species of orchids in Iringa and Mbeya regions in particular are at risk as a result of the escalating tuber trade. Niet and Gehrke (2005) think southern highlands could be considered as the centre of diversity for Disa, Habenaria and Satyrium, as they are represented by large numbers of species. Kitulo plateau which is located at the borders of Iringa and Mbeya Regions is famous for its floristic diversity, and the area has long ago been recognized as an area of outstanding conservation potential (Davenport and Ndangalasi, 2003; Lovett and Prins, 1994; Lovett et al., 1995; Mwasumbi, 1999; Ndangalasi, 1999; Nyomora, 2005).

Orchid populations are overexploited in the Southern Highlands of Tanzania due to trade with Zambia. Some of the species are claimed extinct (Lovett, 1990; Lovett and Prins, 1994; Lovett et al., 1995; Davenport and Ndangalasi, 2001; 2003). It has been reported that there are 21 species that are endemic. All together 58 species have been preliminary placed on the National Red List Data Book. Seventeen species are near endemic. In Malawi it is estimated that there are 400 species belonging to 58 genera. Out of this number of species 180 are epiphytic orchids while the rest are ground orchids (Nguni et al., 2001; Kasulo et al., 2009). Orchid tubers are used in different ways. According to Byers (2001), more than 2.2 million wild orchids are being harvested annually for food and trade from the southern highlands, notably Kitulo Plateau, Tanzania. Some of the orchids are endemic and may soon become extinct (Davenport and Ndangalasi, 2001; 2003; Hamisy, 2007; Mapunda, 2007).While the use of orchids as a food is less popular in Tanzania (Davenport and Ndangalasi,2003; Nyomora, 2005; Hamisy, 2007; Mapunda, 2007 ) they are widely consumed in some districts in Malawi and Zambia where a number of orchid species (mostly belonging to the genera of Disa, Herbanaria and Satyrium are intensively used in the preparation of meatless cake locally known as "Chikanda", "Chikande", "Chinaka" or "Kinaka"(Davenport and Ndangalasi, 2003; Kurzweil, 2000). The dwindling supplies of orchids in Zambia and Malawi have necessitated rather an informal export trade of orchids from southern highlands of Tanzania (Davenport and Ndangalasi, 2003; Hamisy; 2007). This is posing great threats to Tanzanian orchid species. Domestication measures and sustainable harvesting of Tanzanian orchids are imperative. Convention of the forest / grassland areas into agricultural land has been the most common phenomenon in Tanzania. As a result of this practice, most of the orchid habitats have been converted into agricultural land and plantation forestry land, hence displacing the orchids. Most of the available research information is in the form of hard scientific documents with little information in domestication and nutrition quality of orchids. For domestication purposes, the establishment of optimum conditions for growth and production of orchids is vital. Furthermore, the potential for cultivation of orchids needs to be established. This seems to suggest that there is a need for documentation, propagation, conservation interventions and assessment of nutrition quality.The main objective of the study was to explore the domestication potential and determine the nutrient composition in southern highlands of Tanzania. Specifically, the study assessed the domestication techniques and factors hindering domestication of orchids in the study area; identified ecosystems where orchids are harvested most; investigated the food composition of wild orchids; and compare the nutrient content of wild orchids from Ibaga ana Kikondo villages in Makete and Mbeya Rural Districts in, Tanzania.

## METHODS

### The study area

The study was carried out in four villages i.e. Ibaga and Ujuni villages in Makete District, and Kikondo and Shango villages in Mbeya Rural District (Figure 1).Makete District is located between $8^0$ 45' and $9^0$ 45' E and $33^0$ 45' and $34^0$ 50' S (Mapunda, 2007). The district has two agro ecological zones, namely the Highlands and the Lowlands. And Mbeya Rural District lies between Latitudes 7° and 9° South of Equator and between longitudes 33° and 35° East of Greenwich. Criteria for the selection of the study areas are and

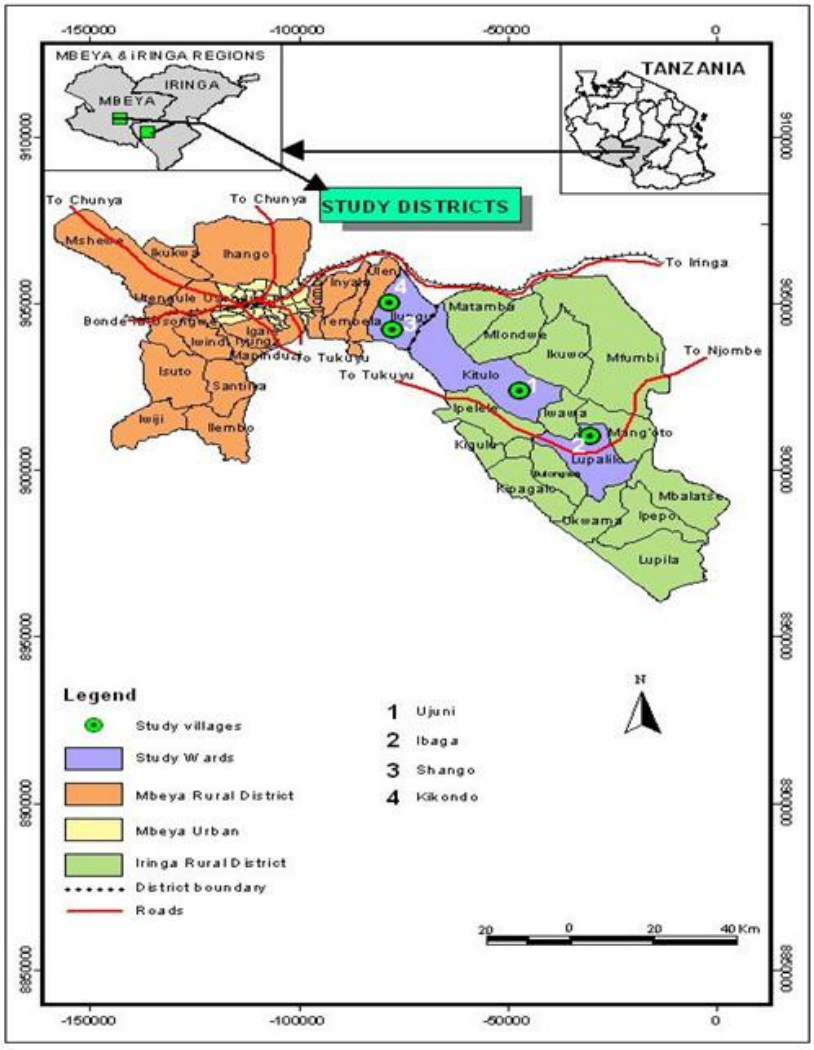


**Figure 1:** Location of study villages in Njombe and Mbeya Regions, Tanzania

proximity to Kitulo plateau (KNP). Furthermore, the plateau since long time been known as a paradise, as it harbours many endemic species. For instance, some 31 species of Orchids that are endemic to Tanzania, 16 out of them are endemic to Kitulo/Kipengere and 10 restricted to Kitulo/ Poroto (Davenport Ndangalasi, 2003).

**Sampling and data collection**

Households engaging in orchids harvesting, consumption or buying were the main target for the study. Purposive sampling was used in chosing villages bordering Kitulo National Park (KNP) and random sampling was then used in selecting households. One hundred and twenty (120) respondents were selected for interview, thirty (30) respondents from each village (Table 1). According to Bailey (1994), thirty (30) cases is a minimum and recommended sample size one could take for household surveys.The list of villagers for sampling was obtained from the village register where appropriate. Random sampling was used to select respondent at household level and whenever possible both male and female were involved during an interview. At village level, orchid agents/middlemen were identified and sampled for interviews.Household questionnaires, checklist of questions for key informants and participant observation were the main method for data collection. Field visits and documentary review were also used to gather data and information. Furthermore, orchid root tubers were collected (from Ibaga and Kikondo villages from Makete and Mbeya Rural Districts respectively), packed in special containers and transported to Sokoine University of Agricultural for analyses on nutritional quality.

**Data analysis**

**Socio-economic data**

Both qualitative and quantitative methods were used in data analysis. Quantitative data collected through household questionnaires were analysed using the Statistical Package for Social Sciences (SPSS) software. The data was first coded, screened and explored for distribution of responses, frequencies and percentages. Thereafter, MS excel was used to produce figures. Qualitative data from key informants was analysed using the content and structural-functional analysis techniques. Content analysis was used to analyse the components of verbal discussions held with different respondents.

**Food composition and nutrient content**

Orchid tubers were washed with water and left to drain for 18 hours at room temperature. Thereafter, they were packed in clean

**Table 1:** Total number of households interviewed using the structured questionnaire

| District | Village | Total households | Interviewed |
|---|---|---|---|
| | Shango | 250 | 30 |
| Mbeya Rural | Kikondo | 300 | 30 |
| | Ibaga | 272 | 30 |
| Makete | Ujuni | 380 | 30 |
| **Total** | | **1202** | **120** |


**Figure 2a:** Orchids tubers from Ibaga and Kikondo villages, Southern Highlands
Tanzania

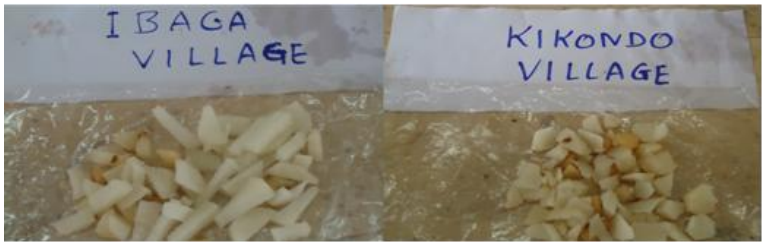


**Figure 2b:** Samples of peeled orchid tubers from Ibaga and Kikondo villages, Southern Highlands Tanzania

polythene bags and stored in the fridge at $4^{O}$C (Figure 2a). Ten to twelve tubers from Ibaga village and five to seven tubers from Kikondo village were randomly selected, peeled and homogenized to obtain the representative sample from each site (Figure 2b).The peeled orchids were crushed (Figure 3a), dissolved with about 2mls concentrated Hydrochloric acid (HCl) filtered and finally diluted with de-ionizedwater to 50mls (Figure 3b).Afterwards the moisture content, ash content, specific minerals, crude fat, crude protein, crude fibre, carbohydrate content, sugars, vitamin C and β-carotene contents were analyzed from edible orchid solution using different methods as recommended by AOAC (1990; 2000) , Helrick (1990) and Seki (1990).

## RESULTS

### Domestication techniques of wild orchids

Of all respondents interviewed, only twelve smallholder farmers engage themselves in orchid cultivation. It was found further that two main domestication techniques were in place in the study area i.e. line planting and broadcasting (Table 2).A number of factors hindering smallholder farmers' participation in orchid domestication were identified during this study. They include lack of knowledge, natural propagation, smaller quantity of harvest, lack of seeds, prohibition by Tanzania National Park (TANAPA) and fear from thieves (Figure 4).Majority of smallholder farmers who were interviewed said that orchid trade was a lucrative business around and contribute immensely to household income and improved livelihoods. It was further reported that only edible orchids referred to as "Manseke" or "Vinseke" and "Lidala"or "Sidala" implying "female" were harvested for commercial

**(a)**Peeling and grinding **(b)** Dissolving in HCl

**Figure 3** Analyses of nutrient content of orchids at Sokoine University of Agriculture, Tanzania

**Table 2:** Orchid domestication techniques in Makete and Mbeya Rural Districts, Tanzania.

| Domestication Techniques | Frequency (n) | Percentage (%) |
|---|---|---|
| Line planting | 9 | 75 |
| Broadcasting | 3 | 25 |
| **Total** | **12** | **100** |

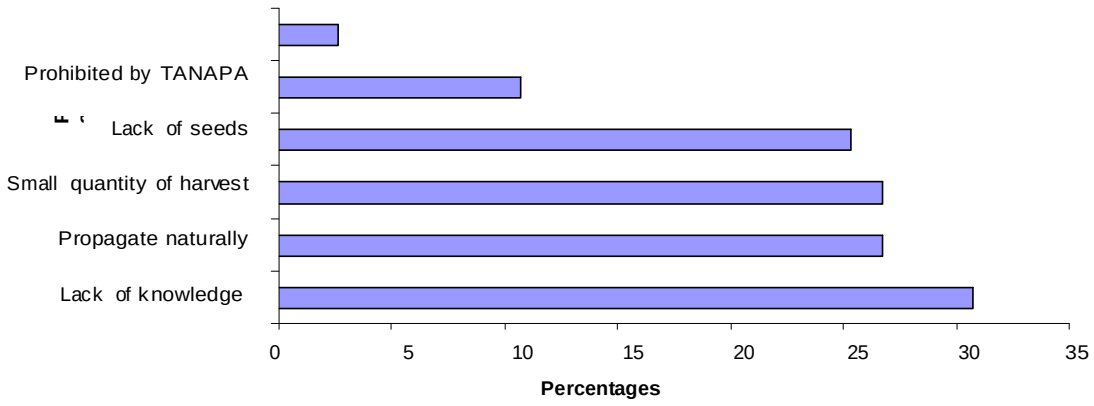


**Figure 4:** Factors precluding domestication of orchids in Makete and Mbeya Rural Districts, in Tanzania

purposes.Lack of skills and knowledge was reported to hinder smallholder farmers from participating fully in orchid domestication. Other respondents claimed that there was the need to domesticate them as they occurred naturally in the wild. Small quantities of harvest (i.e. one tuber per stem) discouraged smallholder farmers from orchid propagation. However, interviews with key informants indicated that propagated orchid produced large tuber as compared to naturally occurring orchids. But it was not

**Figure 5:** Orchids seeds identified in Ibaga village Makete District Tanzania.

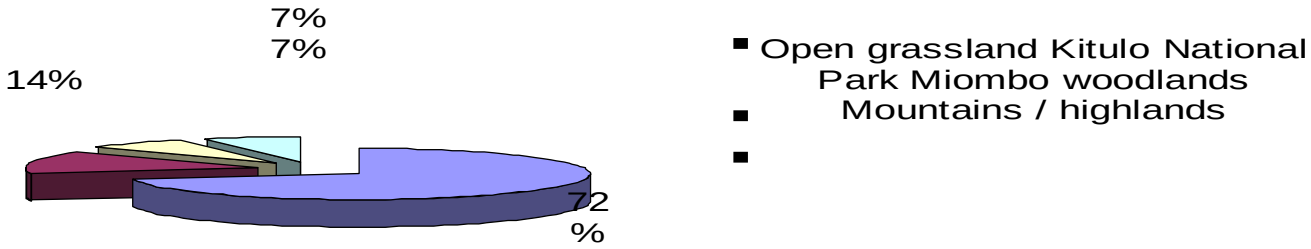


**Figure 6:** Areas where orchids is harvested in Makete and Mbeya Rural Districts, Tanzania

known how whether palatability and nutrient content would differ from wild orchids.Lack of seeds was another factor wich discouraged smallholder farmers from domestication. However, field surveys identified orchids seeds (Figure 5) in Ibaga village and there were possibilities of orchid domestication using seeds.The success of orchid propagation has also been documented by Mapunda (2007) who found positive growth of orchids in Ilindiwe village in Makete District Tanzania. Other documented information on orchid propagation has been reported by Hamisy (2005), that farmers from other villages tried to grow orchid tubers with fertilizer and they found good response in terms of the size of the tuber which they observed to be bigger than a tuber from the wild.

**Ecosystems where orchids are harvested**

Orchids were harvested at open grasslands, Kitulo National Park (KNP), mountains / highlands and miombo woodlands (Figure 6). Harvesting involved the use of a small hand hoe by digging-up root tubers. Harvesting were done by male,females, and both sex (i.e. males and females). We identified four areas where orchids were harvested (Figure 6). Open grassland (72%) and KNP (14%) were the areas where majority of smallholder farmers harvest orchids (Figure 6). The harvesting period started from March to August and in some years started from February to October. Discussion with Mr. Tobeko Mtumishi Msigwa (Ibaga village chairperson) indicated that May and June were the highest harvesting months all orchids harvested are sold to Zambia and Tunduma through local agents who act as middlemen (Davenport and Ndangalasi, 2004).

**Nutrient composition of wild orchids**

Food composition extracted from edible orchids from the southern highland of Tanzania is indicated in table 3. Results indicated that moisture content was 76.14 The orchids (Disa ukingensis) tuber had average protein content of 5.36% as indicated in Table 3. This amount is too high and differs from other studies (Burgess et al., 1994) as the recommended dietary allowance ranges from 0.45 – 0.8g/kg body weight. Fortification by other ingredients can be done during preparation of orchid food. Table 3 shows that fibre content is 2.7% on average. This is a reasonable amount as compared to other root/tuber crops. Fibre is a mixture of carbohydrates which are not digestible or absorbed in some way as sugars although some kinds fermented in the large intestine and absorbed and used for energy. Other nutrient contents found in orchids from Ibaga and Kikondo villages were minerals / ash content (2.2%), fat (1.57%) and vitamins C (0.09mg)

**Table 3.** Nutrient composition of edible orchids from Kikondo and Ibaga villages in Southern Highland of Tanzania

| Food Component | Composition (in %) of edible | portions Measure |
|---|---|---|
| Moisture | 76.14 | Percent |
| Ash content | 2.2 | Grams |
| Crude fat | 1.57 | Grams |
| Crude Protein | 5.36 | Grams |
| Crude fiber | 2.7 | Grams |
| Carbohydrates | 4.015 | Grams |
| Vitamin C | 0.09 | Milligrams |
| Beta carotene | 0.02 | µgrams |
| Iron | 0.56 | Milligrams |
| Zinc | 0.36 | Milligrams |
| Calcium | 22.12 | Milligrams |

**Table 4:** Proximate composition of edible orchids from Kikondo and Ibaga Villages, Tanzania

| Village | Nutrient content g/100g | | | | | |
|---|---|---|---|---|---|---|
| | Moisture | Ash content | Crude Fat | protein | Crude fibre | Carbohydrate |
| Kikondo | 75.51 ± 1.21 | 0.48 ± 0.07 | 1.04 ± 0.05 | 4.05 ± 0.02 | 2.04 ± 0.07 | 2.06 ± 1.29 |
| Ibaga | 76.77 ± 1.12 | 3.67 ± 0.26 | 2.09 ± 0.15 | 6.67 ± 0.05 | 3.36 ± 0.04 | 5.97 ± 1.22 |

and bête-carotene (0.02µg).

**Proximate composition and nutrient content of orchids**

The results of the proximate composition of the sample from Kikondo and Ibaga villages are presented in Table 4, 5, 6 and 7.Sample from Ibaga village had the highest nutrients contents as compared to that from Kikondo village. The highest nutrient content was ash (3.67±0.26mg/100g) followed by carbohydrate (5.97±1.22mg/100g) and crude fibre (3.36±0.04mg/100g). The low ash content of (0.48±0.07mg/100g) was in the sample from Kikondo village (Table 4). Significant difference ($p<0.05$) in nutrient composition was noted between two samples from the two villages. The results in Table 5 shows that the two samples had the same value of vitamin C (0.09±0.01mg/100g). The ß-Carotene of 0.03±0.005mg/ in the sample from Kikondo. was significantly ($p<0.05$) higher than sample from Ibaga (0.01±0.003mg/100g).Table 6: Amount of sugar in edible orchids from Kikondo and Ibaga Villages, Tanzania.

The mean sugar content of samples from Kikondo and Ibaga were 3.02±0.04mg/g and 3.07±0.06mg/g respectively. There was no significant difference ($p<0.05$) between sugar concentration of the samples from Kikondo and Ibaga villages.The mineral content are depicted in Table 7. Potassium was the most abundant mineral for both samples. Phosphorus ranked next to potassium followed by Magnesium and Calcium, while sodium ranked fith. Sample from Kikondo had the highest Calcium content (33574±11.62mg/Kg). The lowest was Manganese present in sample from Ibaga (0.81±0.01mg/Kg) and Kikombo (1.09±0.01mg/Kg). Significant difference ($p<0.05$) in Magnesium, Copper, Iron, Phosphorus, Potassium and Sodium was established between samples (Table 7). The Zinc content was higher than the amount of manganize present in all the samples.

**DISCUSSION**

Generally, there is potential for domestication of orchids as revealed in this study. The identified domestication methods offer room for the villagers to engage in orchid

**Table 5:** Vitamin C and beta carotene of edible orchids from Kikondo and Ibaga Villages, Tanzania.

| Sample | Village | Vitamin content (mg/100g) | |
|---|---|---|---|
| | | Vitamin C | ß-Carotene |
| 1 | Kikondo (K) | 0.09 ± 0.01 | 0.03 ± 0.005 |
| 2 | Ibaga (I) | 0.09 ± 0.01 | 0.01 ± 0.003 |

**Table 6:** revealed that there was a slightly difference in sugar levels in both samples from both villages.

| Sample | Village | Sugars (mg/g) |
|---|---|---|
| 1 | Kikondo | 3.02 ± 0.04 |
| 2 | Ibaga | 3.07 ± 0.06 |

**Table 7:** Mineral contents of edible orchids from Kikondo and Ibaga villages, Tanzania.

| | Mineral values in mg/Kg | |
|---|---|---|
| **Mineral** | **Kikondo** | **Ibaga** |
| Calcium | 33574 ± 11.62 | 106.62 ± 1.91 |
| Magnesium | 215.04 ± 4.60 | 155.93 ± 2.62 |
| Copper | 0.77 ± 0.04 | 1.13±0.04 |
| Zinc | 3.92 ± 0.03 | 3.28 ± 0.05 |
| Manganese | 1.09 ± 0.01 | 0.81 ± 0.01 |
| Iron | 7.72 ± 0.03 | 3.40 ± 0.04 |
| Phosphorous | 250 ±0.1 | 341.65 ± 1.09 |
| Potassium | 2417.13 ± 13.48 | 2437.53 ± 2.09 |
| Sodium | 33.09 ± 0.02 | 22.22 ± 0.04 |

cultivation. However, the fact that orchids are very site-specific to special ecosystems and need optimum conditions to thrive in a given ecosystem, is a challenge that needs a thoroughly investigation before embarking on cultivation. In addition propagation techniques that yield multiple tubers need to be investigated.The study did not cover the soil analysis of the suitable soil type for orchid cultivation. But from personal conversation with some of the respondents, orchid flourishes in fertile soils with little disturbances form other plants and a soil with high water capacity. This is in line with the study by Davenport and Ndangalasi (2003) who found out that tubers grown in more fertile soils and free from weed competition produces larger bulb.Harvesting of orchids (Figure 6) is not new in the study villages and the length of harvesting season varies and the sizes of orchids tubers differs at different time of the year. The influx of middlemen and escalating orchid trade in Makete and Mbeya Rural Districts is responsible for the degradation and loss of valuable and endemic orchid species. This observation is supported by Davenport and Ndangalasi (2003) who estimated that as many as 85 species of Orchids in the Southern Highlands may be at risk as a result of the growing tuber trade. Niet and Gehrke (2005) suggested that the area could be considered as the centre of diversity for varieties of orchid species e.g. Disa, Habenarqia and Satyrium as they are represented by large numbers of species.

Harvesting of orchids is carried out mainly in open graslands and KNP. Setting fire and failure to replant the stem after taking the tubers threaten the future of this threatened wild plant. In view of the increasing trade

of aorchid tubers in southern higlands of Tanzania (Davenport and Ndangalasi, 2003) deliberate efforts and stern measures needs to be taken in order to cease harvesting in KNP. Although the main reason for orchid harvesting is for generating income, orchid is used ad food and medice. The finding concur with the study carried out in Malawi by Kasulo et al. (2009) who found that out of the households interviewed, 61% indicated that they used orchids to treat a number of diseases including coughing, abdominal pains, heart attack, eye sores, ring worm, rheumatism and kidneys. The potential of orchids for treating human diseases was also reported by Ngaga et al. (2010) who contended that edible orchids from Nkasi District Tanzania cures heart disease (chembe ya moyo). But both studies did not indicate the prescribed amount of orchids to be taken. This creates an avenue and possibilities for further investigation in the future.Food with high moisture content (water) is important for human health. Biologically, water plays an important role in excretion through urine which carries wastes from the body. It also keep the lining of the mouth gut eyelids, lungs wet and healthy; and make cells and fluids such as tears, digestive juices and breast milk. Results in Table 3 indicate that edible orchids from Ibaga and Ikonda villages contains higher moisture content (76.14%) that those from Malawi (70%) as reported by Wu Leung et al. (1968) in Kasulo e tal., (2009). Therefore, orchids from Ibaga and Ikonda are recommended for use as they are essential for human health. The amount of protein content presented in Table 3 seems to be higher. It is known that when protein is consumed in excess the body can convert it and used as energy when the body is depleted with carbohydrates (Ndabikunze et al., 2011). Also when consumed in excess can be excreted from the body through urine. Food rich in starch are important for energy. Orchids are found in different colours, textures and tastes and mixing during preparation can improve the quality of the meal (Burgess et al., 1994). Starches are the most important energy giving nutrient because are usually cheap. Fibre can help to prevent obesity because it replaces fat and other energy giving nutrients in meals. It shows digestion so a person does not feel hungry quickly. Fibre decreases the absorption of iron and other minerals and makes food bulky.

Table 3 shows that orchids from Kikondo and Ibaga contain some 1.57% of fat although in some research work indicate that orchid do not contain fat (Mugasha et al., 2005; Kasulo et al., 2009). This can be due to different species, location and analytical methods (Kasulo et al., 2009). Hence, orchid's roots/tubers could be mixed with weaning foods and taken by pregnant and lactating women so as to improve their health and embryo as well.

The minerals shown in Table 3 are useful for thyroid hormone, normal growth and development as well as protect the body from diseases or abnormalities. Orchid contains macro and micro elements and can be used as a supplementary food for the vulnerable groups including children and old people. The vitamin C and bête-carotene, which is the precursor for vitamin A, are important for absorption of some nutrients and eye vision. Therefore, the edible orchids can provide vitamin C for the people (elderly and refugees) who live in the areas where fresh fruits are limited (Kasulo et al., 2009).

The differences in terms of nutrient content between samples from the two villages as indicated in Table 4 may be attributed to the a number of factors: Ibaga village is at a higher altitude compared to Kikondo. So the altitude might have influenced orchids from Ibaga to be much richer in nutrient content. Similary, it was observed that Ibaga had moist soil which is one of the conditions for orchids growth. The significant differences ($p<0.05$) in the nutrient composition of the two samples from Ibaga and Kikondo villages might be due to location of the areas where the orchid samples were taken. This concurs with the study by Odedumni et al. (2007), Ibiyemi and Faloye (1988), Ibiyemi et al. (2002) and Kissan (2004) who asserted that geographical location might contribute to to the chemical composition of plant materials and root tubers. Other factors that might have contributed to the specie or variety of orchid investigated include season of harvesting and soil types.In Table 5 and in the samples had the same value of vitamin C (0.09±0.01mg/100g) but the sample from Kikondo had significantly ($p<0.05$) higher ß-carotene concentration (0.03±0.005mg/100g) than sample from Ibaga (0.01±0.003mg/100g). The reasons for this variation / differences may be due to a number of factors including storage; packaging materials; transportation; analytical methods; cleanliness of the laboratory utensils; accuracy of measurements.

Despite the differences in nutrient composition of the two samples (Table 5), orchids are recommended for food on daily basis as it has enough vitamins for human health. Root crops have good quality protein, and in terms of the balance of essential amino- acids present are quite high and important and can be compared to that of standard animal proteins in beef, egg or milk (Njoku and Ohia, 2007). Most root crops contain a reasonable amount of lysine, though less than in legumes, but the sulphur amino-acids are limiting. Schoeninger et. al. (2000) and Walter et al. (1983), reported that incidence of kwashiorkor were high in yam consuming areas. His emphasis on the need to supplement a yam-based diet with more protein-rich foods in order to support active growth in infants is a point case in point for promoting edible orchids. FAO (1990) observed that nutritional composition of roots and tubers varies from place to place depending on

the climate, the soil, the crop variety and other factors. To some extent the protein content of root crops is influenced by variety, cultivation practice, climate, growing season and location (Woolfe, 1987).
The high percentage of potassium in edible orchids as indicated in Table 7 shows that the tuber are important to be eaten by children for building up the bones. The absence of some toxic elements like lead and cadmium in all the samples is desirable for their edibility. Findings from the study by Ndabikunze et al. (2011), on proximate and mineral composition of cocoyam revealed similar observation that consumption of micronutrient rich foods such as cocoyam is important for building a strong immune system that help the body to utilize protein, carbohydrates and other nutrients.

**Conclusions and Recommendations**

The line planting and broadcasting techniques of orchids domestication implies that the future of orchid domestication is bright and training small holder farmers will definitely improve their knowledge on orchid domestication. If this is achieved, it will definitely relieve the encroachment pressure of orchid harvesting within KNP and in open grasslands as well.Edible orchids from the southern highland of Tanzania contains mainly of moisture content, calcium, crude protein, carbohydrates, crude fiber and ash content. In terms of nutrient contents, the sample from Ibaga village had the highest nutrients than the one from Kikondo. But the two samples had the same value of vitamin C where as ß-Carotene in the sample from Kikondo was significantly higher than sample from Ibaga. We, however, failed to establish how much should be taken for human nutrition. Thus, a thoroughly analysis of nutrient content and food composition per orchid type/species has to be undertaken so as to come up with a scientific argument for its contribution to human health. Considering the valuable contribution of edible orchids to human nutrition and the indications that its availability is decreasing against consumption, interventions focusing on its conservation are needed. These include identification of different eating habits, storage methods / conditions and various recipes. The fact that large quantity of edible orchids is harvested in open grasslands necessitates extension to of KNP in order to protect orchids. Basing on food composition analysis, a detailed investigation has to be done to determine its potential contribution to human health as compared to other root tubers.Given that root crops have the potential to provide more dietary energy per hectare than cereals; it is high time for the government to invest on orchid research for domestication and some root crops to be grown all the year round to provide increased food security. This is of particular importance during the pre harvest period of cereal crops, when other foods are expensive or unavailable.The government, the ministry responsible for natural resources through TANAPA should make sure that laws and regulations on natural resources protection as stipulated by CITES are in place so as to protect edible orchids from the escalating and illegal international trade.

**ACKNOWLEDGEMENT**

This study was possible through financial support from the International Foundation for Sciences (IFS). This financial support is highly appreciated. Authors are thankful to Dina Anderson, the IFS scientific coordinator - social sciences for her logistical support and coordination before and during the research. Smallholder farmers ought to have a special mention for their willingness to participate in this research despite their busy schedules. Authors are grateful to the anonymous reviewers for their guidance and constructive comments.

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