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Promoting indigenous wild edible fruits to complement roots and tuber crops in alleviating vitamin A deficiencies in Uganda

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Abstract. Micronutrients lack in most of the foods eaten by majority of Ugandans and consequently, micronutrient malnutrition is so high in Uganda. Due to low incomes, many people cannot afford to buy exotic sources of these nutrients. Local sources of nutrients should be sought, as a food-based approach to complement supplementation and fortification efforts that currently leave a lot of 'hard to reach people' not served. Indigenous fruits could be such nutrient sources. Unfortunately the nutrient content for most of them is not known. Chemical analyses were carried out on *Physalis minima* and *Carissa edulis* fruits and indicated that they are rich sources of micronutrients especially minerals. These indigenous fruits compared well with the exotic ones (mangoes, paw paws and *Physalis peruviana)* in nutrient content.

Introduction

Like many developing countries, Uganda has nutritional problems. The food on which the majority of Ugandans feed lacks essential nutrients. Consequently, many people especially children, suffer from malnutrition. Uganda, ranks 30th among countries with the highest under- five year's child mortality rates in the world (UNICEF, 1998). According to UDHS (2000/01), 28% of children in Uganda below 5 years of age suffer from vitamin A deficiency (VAD), 64% suffer from iron deficiency anaemia (IDA) and 60% suffer from various iodine deficiency disorders (IDD). Over 50 percent (52%) of women of reproductive age suffer from vitamin A deficiency and 30% from iron deficiency anaemia. Reddish, yellow and orange fruits provide carotene and many contain folic acid, calcium, iron, vitamin C and anthocyanins (FAO, 1988). Fortunately, Uganda is endowed with many varieties of such indigenous food plants (WWF, 1993) that have an outstanding potential to alleviate nutritional deficiencies among vulnerable groups. Unfortunately, utilisation of indigenous food plants has steadily declined mainly due to lack of knowledge on their nutrient value resulting from limited research done (Kiremire *et al*., 2002). These fruits are further threatened by population pressure in the country and man's activities like clearance of forested areas to set up farmlands. A large proportion of Ugandans cannot afford to produce or buy exotic fruits due to input costs and price implications respectively. This could partly be responsible for the observed high malnutrition especially in micronutrients. Apart from providing nutrition to the diverse bird community, these indigenous nutritious fruits have not yet been given serious attention in Uganda. This paper presents the nutrient content of two wild edible fruits wild plums (*Carissa edulis)* and goose berries *(Physalis minima)* as a deliberate effort to promote consumption of locally available and easily accessible indigenous fruits in alleviating vitamin A deficiencies. The dietary

diversity that will be created could go along way in alleviating the nutritional problems that are facing Uganda and Africa in general. Comparison of nutrient content of these wild fruits with the cherished exotic ones like mangoes and paw paws revealed a fair comparison.

The aim of this study was to highlight the potential of fighting malnutrition in Africa using the locally available and easily accessible food plants by determining the nutrient content and promoting utilisation of indigenous fruits.

Materials and methods

The fruits that were studied were got from the wild in Rukungiri District, South Western Uganda.

Nutrient content analyses. Proximate analyses on crude protein, crude fat, dietary fibre and micro nutrient determination of β-carotene, vitamin C and minerals (calcium, iron phosphorus, magnesium and potassium) were carried out.

Moisture content. Moisture content (MC) determination of the samples was carried out following procedures in Kirk and Sawyer (1973). Aluminium dishes were washed, dried in the oven, removed and allowed to cool in a desiccator. The dishes were weighed empty (A) and after adding the samples (B). The sample- containing dishes were placed in the oven and the oven temperature adjusted to 65°C and left overnight. The samples were then removed, placed in a desiccator to cool and weighed again (C) and the MC of the sample was calculated.

Crude protein determination: The Kjeldahl method that is outlined in Pearson's laboratory techniques (1973) and AOAC (1990) was followed. Samples were macerated in a blender and about 1g of each sample weighed in previously washed and dried Kjeldahl flask. One tablet of Kjeldahl catalyst was added to the flask. 10mls of 98% H_2SO_4 were added to Kjeldahl flask and the flask was heated starting lightly (350°C) and finally heating strongly (500°C). Heating was continued until the sample in the flask turned colourless. Distillation was carried out using a semi auto Kjeldahl machine (2200 Kjeltec auto distillation). The sample was quantitatively transferred to the distillation tube. Kjeldahl flasks were washed twice with 25ml portions of distilled water adding the washings to the distillation flask. 30mls of 2% boric acid were measured into a 500ml conical flask and the conical flask was placed in position to collect the distillate making sure that the air condenser was immersed in boric acid. The distillation was continued until the colour of boric acid changed from purple to green. The distillate was titrated against standard hydrochloric acid solution (0.05N) and results were computed based on titres.

Crude fat determination. The Soxhlet method (AOAC 1990) was followed using Soxtec equipment for determination of fat content. The sample was weighed in a dry thimble (Swt), a pad of cotton wool was inserted into the thimble to prevent the sample from overflowing through frothing. A 200ml beaker was weighed (W_1) and 30mls of petroleum spirit (boiling point 40-60) were added. The sample-containing thimble and the beaker were placed on the soxtec machine (Soxtec system HT). Boiling was started with the thimble immersed in solvent for 15 minutes. The thimble was raised and extraction carried out for 45 minutes. Stop corks of the machine were closed and solvent distilled off the extracted oil in the beaker. The beaker was removed, put in the oven at 100°C for 30 minutes to drive off any water. The beaker was put in a dessicator and allowed to cool before weighing it (W_2) and the percentage fat content was calculated.

Dietary fibre determination. The dietary fibre was determined using Acid Detergent Fibre (ADF) solution following procedures outlined by Kirk and Sawyer (1973). The solution was prepared as follows: 28mls of 98% H_2SO_4 were

carefully added to and mixed with 600 ml of distilled water. 20g of Cetyl trimethyl ammonium bromide (CTAB) were added and stirred until it dissolved. The acid detergent was made up to 1 litre with distilled water mixed thoroughly. The sample was macerated and 1.0g of the sample were weighed in an l litre beaker. 100mls of the acid detergent solution were added to the beaker followed by 2.0ml of dekalin. The mixture was heated to boiling under reflux for 1 hour. Heating was controlled to minimise foaming by adjusting the control knob. The sample digest was filtered with a crucible previously dried in the oven at 100°C. The beaker was washed with boiling distilled water filtering the content through the same crucible 3 times. The final washing was done with acetone and the residue was collected into a clean crucible dried at 100°C for 8 hours in the oven. Dietary fibre of the sample was calculated. 2.1.5 Vitamin C determination: Vitamin C was determined following procedures in Kirk and Sawyer (1973). 5g of sample were weighed into a clean mortar. The sample was macerated in a mortar using a pestle with 5ml portions of 5% trichloro acetic acid (TCA) being added at a time. The extracts were quantitavely transferred into a clean 50ml volumetric flask and made up to volume with TCA. The flask was stoppered, shaken to ensure thorough mixing and the mixture was filtered using a filter paper (Watman no.1). 2,6-DCPIP Solution was standardised using ascorbic acid standard solution of concentration 1.08 mg/ml. 2mls of standard ascorbic acid were titrated with DCPIP until a pink colour that persisted for 3-5 seconds was seen. 5mls of extract were pipetted into a clean conical flask and carefully titrated against the standard DCPIP solution until a pink colour that persisted for 3-5 seconds was observed. The volume of DCPIP solution used was read from the burette and used to calculate the vitamin C content of the sample.

β-carotene determination. β-carotene was determined following procedures outlined byRitterand Purcell (1981).

Extraction of β-carotene. Samples were separately weighed out and placed in a mortar; 5-7mls of hexane-acetone mixture in a ratio of 1:1 were added. A pestle was used to stir the sample-solvent mixture to facilitate extraction. The extract was transferred to a 50ml volumetric flask and extraction was repeated 5 times with 5-7ml portions of solvent mixture adding the extract of volumetric flask each time to the flask contents. When the sample was free of beta-carotene, the volume of the extract was made up to 50mls with the solvent mixture. The volumetric flask was kept away from light by wrapping it with aluminium foil to prevent photo degradation of beta-carotene.

Concentration of beta-carotene. The extract was placed in a clean, dry 100ml beaker and the beaker was heated gently on a hot plate in the fume cupboard with the fan on until all the solvent evaporated. The beaker was then removed and allowed to cool after which 2.0mls of pure solvent mixture were added to dissolve the residue; 1.0ml of the dissolved extract was pipetted and transferred to a packed column of magnesium oxide. Afresh solvent mixture was used to elute the extract from the column. The deep coloured band of beta-carotene was collected in a 50ml volumetric flask until the eluate was colourless, the extract was made up to volume, with the extracting mixture, shaken to dissolve and put in the dark ready for absorbance reading. 15mg capsules of beta-carotene were dissolved in 100mls of hexane to make stock solutions. Using a spectrophotometer (SP 20), the absorbencies of the stock solutions were read at 450nm. A standard curve of absorbance Vs concentration (microgram/ml) was plotted. Using a spectrophotometer (SP 20), absorbencies of the samples were read. By using their absorbencies, the beta-carotene concentrations of the samples were read off the previously prepared standard curve.

Mineral content determination. The mineral content of the samples was determined

following procedures by Kirk and Sawyer (1973) and AOAC (1990). Samples were digested with the digestion mixture prepared as outlined: 0.42g of selenium powder were weighed into a beaker. 14g of lithium sulphate were added followed by 350ml 30% hydrogen peroxide and mixed well. 420ml of conc. H_2SO_4 were added slowly and carefully while cooling in an ice bath. 0.2g of ground sample was added into a dry clean digestion tube and 5mls of digestion mixture were added to the tube. The mixture was digested at 360°C for 2 hours until the solution turned colourless. The contents were allowed to cool and 25mls of distilled water were added and shaken until no more sediment dissolved. The volume was made up to 50ml with water and shaken. They were allowed to settle and the clear solution was decanted off for phosphorus, calcium, sodium, Iron, magnesium and potassium analyses.

Phosphorus determination. 12g of ammonium molybdate were dissolved in 100mls of warm distilled water and then cooled. 0.291g of antimony potassium tartrate were separately dissolved in 100mls of distilled water. Both solutions were made to 2l with distilled water. The mixture was shaken thoroughly to ensure proper mixing. Ascorbic acid reducing reagent was prepared by dissolving 2.108g of ascorbic acid into 400mls of ammonium molybdate/ antimony potassium tartrate. Working standard solutions of 0.1, 0.2, 0.4, 0.6 and 0.8-ppm concentration were prepared. 0.5 ml aliquots of the working standard solutions were transferred to a 25ml volumetric flask and diluted with distilled water followed by 5mls of the ascorbic acid reducing reagent. The mixture was made to the mark with distilled water and mixed thoroughly. The mixture was left to stand for 40 minutes prior to absorbance reading on a spectrophotometer (SP20). Similar procedures were followed to take absorbance reading of the samples. A calibration curve of absorbance against concentration was plotted using the working standard solutions. Phosphorus concentrations (ppm) in the samples were read from the calibration curve using the previously obtained sample absorbencies. The phosphorus concentrations in the samples were then computed to mg / 100g of the edible plant portion. In the analysis of magnesium, sodium, calcium, potassium and iron, working standard solutions were prepared for each element from the stock solutions. Standard solutions and samples were prepared in a solution containing lanthanum chloride to overcome the problem of chemical and ionisation interferences. Working standards were then aspirated on the Atomic Absorption Spectrophotometer (Pearkin-Elmer 2380) so as to calibrate the machine to give its readings in milligrams per litre. Samples were aspirated on the calibrated Atomic Absorption Spectrophotometer and the concentration of each element in the sample solutions was read directly from the machine in milligrams per litre. The phosphorus concentrations in the samples were then computed to read in mg/ 100g of edible plant portion.

Statistical data analysis. Data were analysed using a one way Analysis of variance (ANOVA) using Genstat Version 5, Release 3.2 (Lawes Agricultural Trust Roth amsted experimental Station, USA).

Results and Discussion

Nutrient content of *Carissa edulis* and *Physalis minima*. Results of chemical analyses done on gooseberries (*Physalis minima*) and wild plums (*Carissa edulis*) indicate that they compare well with mangoes and paw-paws (Table 1, Figure 2). *Physalis minima* compares very well with its exotic counterpart, *Physalis peruviana*, in sodium, iron, phosphorus, calcium, beta-carotene, phosphorus and dietary fibre content. *Physalis minima* is however higher in protein content than *Physalis peruviana* and lower in potassium content (Figure 1). No significant difference in minerals like calcium, sodium, potassium, phosphorus, iron and other nutrients like dietary fibre and beta-carotene were observed between these two

fruits. *Carissa edulis* was equally high in minerals. People fear to get embarrased by harvesting and consuming wild fruits. Malnutrition has taken advantage of this and left many of them either severely or chronically malnourished. Malnutrition leads to an un-productive population that cannot ensure its food security and this exacerbates poverty. Tackling malnutrition on the African continent will go a long way in ensuring food security and improving the economic well being of the Africans. Domestication and conservation of the currently wild, nutritionally sound, environmentally adapted and locally available fruits along with the exotic ones will go along way in alleviating malnutrition and will ensure dietary diversity that is a close correlate to household food security.

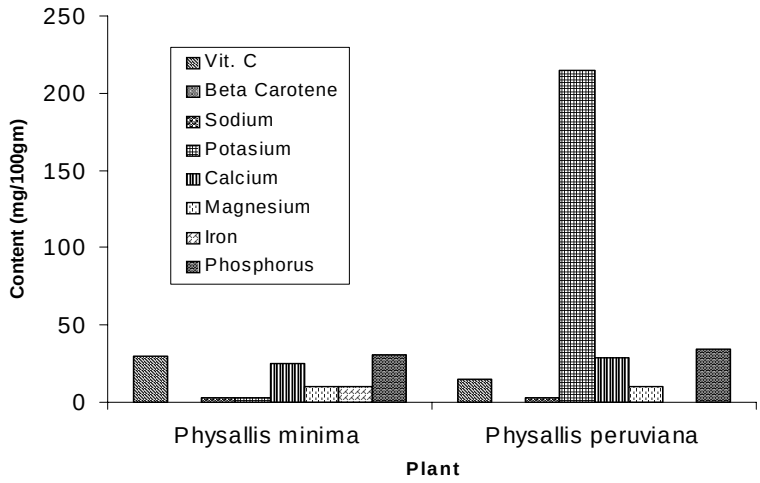

Figure 1: Nutrient content in *Physalis minima* and *Physalis peruviana.*

Table 1: Nutrient contents of *Physalis minima*, *Carissa edulis*, *Physalis peruviana,* mango and paw paw fruits (ripe and fresh) compared.

Nutrient	Content per 100g				
	Mango	*Physalis peruviana*	Paw paw	*Physalis minima*	*Carissa edulis*
Moisture content (%)	84.6	90.1	88.5	89.9	84.6
Crude protein (g)	0.5	1.1	0.5	2.04	0.3
Fat (g)	0.2	14	0.1	0.056	Trace
Vitamin C (mg)	37	114	60	29	3.24
Retinol equivalent (ig)	300-3000	18.3	810	28.9	256
Sodium (mg)	2	2	5	1.8	1.79
Potassium (mg)	180	210	200	2.43	198
Calcium (mg)	12	28	23	25	10
Magnesium (mg)	13	7	11	7.8	4
Iron (mg)	0.7	0.3	0.5	0.28	0.56
Phosphorus (mg)	16	34	13	30	24
Dietary fibre (g)	2.6	2.4-2.9	2.2	2.7	2.65

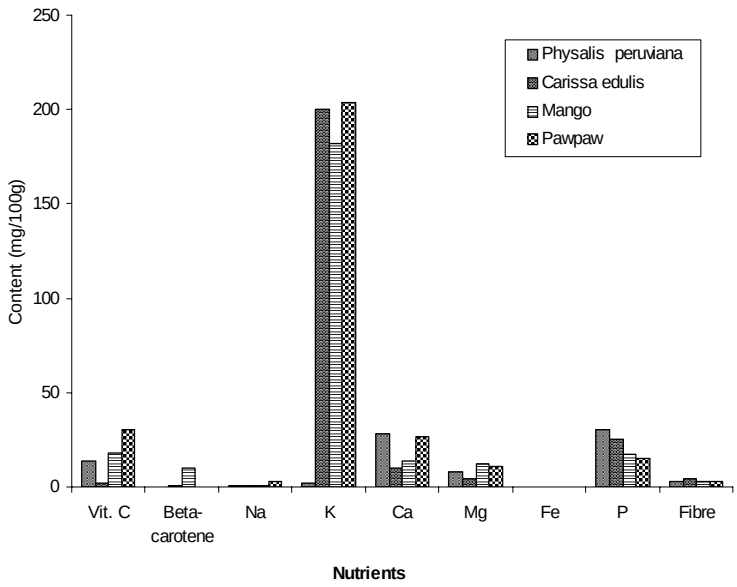

Figure 2: Nutrient content of *Carissa edulis, Physalis minima*, mango and pawpaw.

Conclusion and Recommendations

Carissa edulis and *Physalis minima* are as nutritionally important as the exotic fruits. There is too much stigmatization on indigenous fruits due to the notion that they are nutritionally inferior and are a poor man's food. Such stigmatization can be broken down with proper sensitization of the public. Research therefore should be done on more indigenous fruits and results of such studies be disseminated to the public. This will ensure dietary diversity and food security of marginalized and poor communities that make up the majority of the developing world.

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