NUTRIENT AND ANTI-NUTRIENT CONTENTS OF SELECTED WILD FOOD PLANTS FROM ITHANGA DIVISION, KENYA

D. K. Mugera,[1 4] J. N. Kinyuru,[2] M. W. Mwaniki[3], G. N. Njoroge[4] and C. Onyango[5]
[1,2]Department of Food Science and Technology, Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya
[3]Department of Food Science and Technology, Technical University of Kenya, Nairobi, Kenya
[4]Department of Botany, Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya
[5]Food Technology Divisions, Kenya Industrial Research and Development Institute, Nairobi, Kenya
***Email**: dmugera68@gmail.com*

Abstract
Wild food plants play an important role in the diet of inhabitants of Ithanga Division as famine foods during the lean season. However, there is lack of comprehensive data regarding the nutrient contents of these widely consumed food plants. The study was done to determine nutritional value of selected wild food plants to enhance utilization, identifying the superior ones essential for managing malnutrition and food insecurity. Ten plant species (*Grewia tembensis, Cucumis dipsaceus, Commelina africana, Amaranthus dubius, Grewia bicolor, Lantana camara, Amaranthus Hybridus, Cyperus rotundus, Commelina diffusa* and *Oxygonium sinuatum)* were collected washed, dried at 60^0C for two hours and grounded into powder. They were analyzed for moisture, crude protein, crude fibre, crude ash, β- carotene, vitamin C, zinc, and tannin content. The moisture content ranged from 48.33 % in *Cyperus rotundus* to 90.77% in *Oxygonium sinuatum* while crude fibre content ranged between 6.29 mg/100g dmb in *Lantana camara* and 20.73 mg/100g dmb in *Amaranthus dubius* .The crude protein ranged from 1.68-11.6 mg/100g dmb highest in *Oxygonium sinuatum* and lowest in *Lantana camara*. The ascorbic acid and β carotene content were highest in *Cucumis dipsaceus* (50.39 mg/100g) and *Amaranthus dubius* (5240 µg/100g) respectively, lowest in *Commelina africana* (7.60 mg/100g) and *Lantana camara* (20 µg/100g) respectively. The zinc content was highest in *Oxygonium sinuatum* (28.15 mg/100g dmb) and lowest in *Grewia bicolor* (0.38 mg/100g.dmb). The ash content ranged from 1.03-21.20 % dmb with fruits having the lowest ash content and wild leaves had the highest ash content .The tannin content ranged between 678-3169 mg/100g dmb highest in *Grewia bicolor* and lowest in *Cucumis dipsaceus* r. Based on the preliminary results, we can conclude that wild food plants analysed are good source of macro and micronutrient and can be used to improve food security.

Key words: Wild food plants, crude protein, zinc, tannin, Kenya

1.0 Introduction
Wild food edible plant refers to plant species that are neither cultivated nor domesticated but are available in their natural habitat and used as source of food (Beluhan and Ranogajec, 2010). Ethno-botanical studies have shown that, many wild food plant species are consumed alongside other food sources in developing countries (Getachew et al., 2013). According to Food Agriculture and Organization (FAO, 1999), at least one billion people around the world are thought to use wild food in the diet. They are an important source of vegetables, fruits, tubers, seed and nuts in balancing nutritional diet and curbing food insecurity throughout the world especially in developing countries (Heywood, 2011). In Africa, indigenous wild food plant have played crucial role in tradition diet of African people (Flueret, 1979). Numerous publications provides vast knowledge on wild plants species in various parts of Africa showing they are essential components of many African diet during the drought period (Campbell, 1986; Zemede, 1997; Agea, 2010). In South Africa, Fox and Young (1982) recorded more than one thousand wild indigenous food plant consumed by the locals.

Kenya has a diverse agro ecological zones that contribute to a wide diversity of neglected and underutilized wild food plant species. (Maundu, 1993). Maundu (1996) reported that, about 800 of Kenya total flora of 7000 species of vascular plant are used as food in the wild and out of these 50 % as fruits, 25 % as vegetables, 12.5% as tubers or roots 3-6 % as edible gums or resins with the rest in other kinds of food. About 200 species of plant species that grow naturally in Kenya are used as leafy vegetables. Some of the communities in Kenya that have a record of indigenous leafy vegetables species are the; Giriama (78 species), (Kamba 25 species), (Kikuyu 9 species), (Maasai 13 species), (Turkana 17 species) .These wild food plants play a major part in supplementing other foods especially in the rural communities.

Wild foods plants have potential to provide sustainable and easily affordable solutions for micronutrient malnutrition and food security in Kenya. However they are limited research on nutritional value of these plants except for the indigenous ethnobotanical information of these plants (Bussman, 2006; Njoroge et al., (2006). These food plants play a significant role as famine food in food and nutritional security of the rural poor folk. They are gathered mostly for home consumption and others for sales. The main purpose of this study was to determine the nutritional value of some selected wild food plant species to enhance their utilization and encourage domestication.

2.0 Material and Methods

2.1 Sample Collection and Preparation

Ten wild plant species (i.e. *Grewia tembensis, Cucumis dipsaceus, Commelina africana, Amaranthus dubius, Grewia bicolor, Lantana camara, Amaranthus hybridus, Cyperus rotundus, Commelina diffusa* and *Oxygonium sinuatum*) were collected randomly from Ngelilia, Thungururu, Kwa Mukundi and Mavoloni locations in Ithanga Division. They were then put in cooler box and transported to the laboratory for analysis. The leaves, fruit and tuber were then prepared by washing and dried in oven at 60^0C to moisture content below 12 percent for two hours. The dried materials were grounded separately using a mixer, sieved into powder and stored in airtight polythene bags.

2.2 Proximate Analysis

2.3 Moisture Content

Moisture, crude protein, fibre and ash were determined according to Association of official Analytical Chemists (AOAC) method 925.10-32, 20.87-37 and 920-86.32, 923.03-32 respectively (AOAC, 1995).

2.4 Determination of ß-carotene

ß-carotene was determined by method described by (Imungi and Protter, 1983) Approximately 2 g of fresh material was weighed. It was placed in a mortar with about 10ml of acetone and ground thoroughly. The acetone extract was then transferred to a 100 ml volumetric flask and the residue extracted again with 10 ml acetone and transferred to the volumetric flask. The extraction with acetone was repeated until the residue no longer gives color to acetone. The combined extract was made to 100 ml. 25 millimeters of the extract was evaporated on a rotary vacuum evaporator (Bibby Sterilin Ltd, RE, 100B, UK) and the residue dissolved in about 1 ml petroleum ether and the solution introduced into a chromatographic column then eluted with petroleum ether. β-carotene eluted through as yellow pigment and collected to 25 ml volume in volumetric flask with petroleum ether. Five solutions of standards with concentration between 0.5 µg/ ml and 2.5 µg /ml were prepared from a stock solution containing 2.5 µg/ ml pure β carotene. The absorbance value of the solution was determined at 440 nm using UV-Vis spectrophotometer (UV mini 1240 model, Shimadzu Corp., Kyoto Japan) and plotted against corresponding concentration of the standard curve. The β-carotene content of the sample materials was calculated per 100 g of the material.

2.5 Determination of Ascorbic Acid

It was determined by method described by (Vikram, et al., 2005.) About 10 g of sample was homogenized with 20 ml of 0.8 % metaphosphoric acid for 30 minutes and centrifuged at 10,000 rotation per minute (r.p.m) for 10 minutes using refrigerated centrifuge (model H-2000C Shimadzu, Corp., Kyoto, Japan).The supernatant was filtered using filter paper No. 42, microfiltered with µm 0.45 syringe filter and 20 µl injected into the HPLC (model 10A Shimadzu, Corp., Kyoto, Japan) fitted with PDA Waters 2996 detector. The column used was Supelco C 18 ODS of 150 ×4.6 mm with 5 µm particle size with mobile phase metaphosphoric acid at a flow rate of 0.5 ml/min. Detection was done by Waters PDA 2996 at 266nm.

2.6 Determination of Zinc Content

5g of samples were weighed in crucibles and transferred to hot plates in the fume hood chamber where they were charred to clear all the smoke from the carbonation materials before transferring them to the muffle furnace. The charred materials were incinerated at 550ºC until they were reduced to white ash. The ash was cooled; 20 ml of 1 normal hydrochloric acid (1 N HCl) was added to each of them in the crucibles before transferring them to 100 ml volumetric flasks and topped up with distilled water (AOAC, 1995). Atomic Absorption Spectrophotometer (Model A .6200, Shimadzu, Corp., Kyoto, Japan) was used for analysis of zinc which was subjected to flame emission

2.7 Tannins

Samples of about 5 g each were put in a volumetric flask and 50 ml distilled water was added, shaken for 30 minutes and filtered. Exactly 2 ml of the filtrate was measured into 50 ml volumetric; similarly, 2 ml of standard tannic acid solution and 2 ml of distilled water were measured with separate flasks to serve as standard and blank respectively. 2 ml of Follins-Dennis reagent was added to each of the flask followed by 2.5 ml saturated sodium carbonate solution. The content of each flask was made upto 50 ml with distilled water and incubated for 90 minutes

at room temperature. The absorbance of the developed colour was measured at 760 nm wavelength using Spectrophotometer (UV Mini, 1240 Model. Shimadzu, Corp., Kyoto, Japan). (Kirk and Sawyer, 1998)

2.8 Statistical Analysis

Analysis of the samples was done in triplicate .Data was analysed using one-way analysis of variance (ANOVA) with different plants species as a source of variance. Data was assessed using and Duncan's Multiple Range Tests used to separate means. Significance was determined at (P<0.05).

3.0 Results and Discussion

3.1 Proximate Analysis

Ten different wild food plants (i.e. six leaves, three fruits and one tuber) were collected in Ithanga division and proximate analysis done. The moisture content ranged from 48.33 % in *Cyperus rotundus* to 90.77% in *Oxygonium sinuatum* (table 1). Wild leaves of *Cucumis dipsaceus, Commelina africana, Amaranthus hybridus, Amaranthus dubius, Commelina diffusa* and *Oxygonium sinuatum* had the highest moisture content while *Grewia tembensis, Grewia bicolor, Lantana camara* and *Cyperus rotundus* had the lowest moisture content. Similar results have been reported in South Africa (Afolayan and Jimoh, 2009), where wild leafy vegetables moisture content in range of 57-89 %. The moisture content of fruits and vegetables are in the range of 60-68% (FAO, 1982) and most of the plants studied were within the range (Table 1).

The fruits of *Grewia bicolor Grewia tembensis, Lanatana camara, Cyperus rotundus* root and six wild leaves were analysed for crude protein as (table1). The fruits of *Grewia tembensis* and *Grewia bicolor* had higher protein content with value of 8.53% and 8.17% respectively. These values were comparable with similar results of Grewia species study done by (Mohammed and Yagi, 2010). There was significance difference (P<0.05) in crude protein among the food plants ranging between 1.68-11.60 % (dmb) with *Oxygonium sinuatum* having the highest value and *Lantana camara* the lowest value. The values of the plants were higher than (3.3%) recorded by USDA Nutrient Database for Standard Reference (Hall,1998).These values were comparable with similar studies done for wild plants (3.08-13.78%) as reported by Shad et al., (2013). Comparing the wild and cultivated counterparts (i.e. kales 3.3%, cabbage 1.7% and spinach 2.8%) as reported by (Maina and Mwangi, 2008), most of the selected plants investigated were superior in protein than domesticated ones thus suggesting that they are cheap source of proteins for the locals.

The crude fibre content was high in *Lantana camara* (20.73% dmb) followed by *Grewia bicolor* (19.66 % dmb) and *Amaranthus dubius* (6.29 %dmb) had the lowest fibre content (table 1). Six plant species which included two fruits and four leaves were analysed. There was significance difference (P<0.05) in fruits and leaves which ranged between 6.29-20.73 % dmb. The Fruits had high crude fibre content than the leaves. These finding are similar to studies done by Vishwakarma and Veenapani (2011) where they reported crude fibre content of wild edible plants in the range of 1.21-21.78 % dmb. The ash content ranged from 1.03-21.20 % dmb with fruits having the lowest ash content and wild leaves had the highest ash content (table I). There was significance difference (P<0.05) in ash content among the wild food plants studied. The ash content for wild leaves studied was higher than cultivated *C.nitidissima* leaves (10.7% dmb) as reported by (Zhongchen, et al., 2010). High ash content is associated with the amount of mineral in wild food samples (Nielson, 2003) and this suggest that, leaves contained high levels of minerals than the fruits according to the study. Wild leaves have been shown to have relatively higher mineral content compared to exotic or cultivated vegetables. (Zhongchen et al., 2010)

Table1: Proximate analysis results of selected wild food plants

Botanical Name	English/common Name	Local name ('kamba')	Edible part	Moisture %		*Crude protein %		*Crude fibre %	*Crude ash %
Grewia Tembensis		"Nduva Fruit		62.29	±0.29^{c}	8.5 3	±1.04^{c}	18.67± 0.58^{b}	12.36±0.32^{b}
Cucumis	Hedgeho	Kikungi	Leaves	81.24	±0.11^{e}	4.0	±0.05^{a}	7.41±0.75^{a}	15.88±0.69 ^{b}

	g					f	8	b		
Dipsaceus	cucumber									
Commelina	Yellow		Kikowe	Leaves	83.24	±1.79^{fg}	3.66	±0.15^{a}	11.62±1.13^{a}	16.44±0.58 ^{b}
Africana	commelina									
Amaranthus	Spleen		Telele	Leaves	80.20	±1.39^{e}	9.82	±1.39^{cd}	7.63±1.03^{a}	17.37±0.48 ^{bc}
Dubious	amaranthus		Green							
Grewia bicolor	White	leaved	Ngalawa	Fruit	48.74	±0.52^{a}	8.17	±1.07^{c}	19.66±4.73^{b}	1.03±0.04 ^{a}
	Raisin									
Lantana	Tick berry		Mukite	Fruit	51.72	±0.23^{b}	1.68	±0.31^{a}	20.73±6.35^{b}	0.84±0.04 ^{a}
Camara										
Amaranthus	Red amaranth		Telele Red	Leaves	71.21	±1.63^{d}	11.32± 0.7^{de}		6.29 ±0.77^{a}	21.20±0.9 ^{d}
Hybridus										
Cyperus	Water grass		Ngatu	Tuber	48.33	±0.54^{a}	7.46±	0.06^{bc}	25.73±0.61^{bc}	13.24±0.53^{b}
Rotundus										
Commelina	Spreading		Gitula	Leaves	88.21	±0.35^{h}	6.88	±0.09^{bc}	10.23±0.56^{a}	18.66±0.60 ^{bcd}
Diffusa	dayflower									
Oxygonium	Double thorn		Song'e	Leaves	90.77	±0.26^{i}	11.60±1.15^{de}		6.57±0.89^{a}	18.77±0.7 ^{bcd}
Sinuatum										

*Values are expressed as dry matter basis (dmb) except moisture content Values are expressed as mean, ± standard deviation of triplicate results

3.2 Values in the Same Column with Different Superscripts Letters are Significantly Different (P<0.05)

The levels of ascorbic acid for the six wild leaves (i.e. *Cucumis dipsaceus, Commelina africana, Amaranthus dubius, Amaranthus hybridus, Commelina diffusa* and *Oxygonium sinuatum* (Table 2).There was significance difference (P<0.05) in ascorbic acid content among the wild leaves ranging from 7.60 mg/100g to 50.39 mg/100g highest in *Cucumis dipsaceus* and lowest in *Commelina diffu*sa *(*Table 2*)*.These values of ascorbic acid content observed compares with those reported by Shad et al, 2013 who noted levels ranged between 1.6-52.8 mg/100g on fresh weight basis .The Recommended Daily Allowance (RDA) of vitamin C for children below five years is between 15-25 mg/ day (Food and Nutrition Board, 2000) and wild leaves studied (Table 2) ranged between 18.73-50.39 mg/100g exceeding RDA required. This implies that consumption of these plants will meet the amount of vitamin C required by the children. Vitamin C is a highly effective antioxidant has been documented that it slows the aging process, reduce the risk of certain types of cancer, improve lung function, and reduce complications associated with diabetes (Sebastian et al., 2003).

Table 2 suggests that the investigated plants had reasonable source β-carotene of which ranged from 20 µg/100g to 5240 µg 100g and plants investigated included two wild fruits and six wild leaves. There was significance difference (P<0.05) in β-carotene among the wild food plants lowest in *Lantana camara* and highest in *Amaranthus hybridus*. These values were higher than cultivated cabbage (385 µg/100g) and spinach (3535 µg/100g) (Maina and Mwangi, 2008). The values observed were comparable with amaranth, African night shade and eggplant with value ranging between 40-7540 µg/100g as reported by (Weinberger and Musya, 2004). Higher β-carotene in green leaves could be attributed to close association of chlorophyll to beta carotene suggesting that, leaves were richer in beta carotene than the fruits**.**

Table 2: Ascorbic acid content and β-carotene of selected wild food plants on fresh weight basis

Botanical name	**English/common Name**	**Local name 'Kamba'**	**Edible Part used**	**Ascorbic acid mg/100g**	**β-carotene µg/100g**
Grewia tembensis		Nduva	Fresh Fruit	63. 27±0.06^{e}	2790 ±0.004^{b}
Cucumis dipsaceus	Hedgehog cucumber	Kikungi	Fresh leaves	50.39 ± 5.13^{d}	5110 ± 0.08^{de}
Commelina Africana	Yellow commelina	Kikowe	Fresh Leaves	37.15 ± 0.11^{c}	4830 ± 0.38^{cd}
Amaranthus dubius	Spleen amaranth	Telele green	Fresh Leaves	11.87 ± 0.28^{a}	3690 ± 0.56^{bc}
Lantana camara	Tick berry	Mukite	Fresh fruit	25.34± 0.76^{b}	20 ± 0.01^{a}
Amaranthus hybridus	Red amaranth	Telele Red	Fresh leaves	11.16 ± 0.77^{a}	5240± 1.89^{de}
Commelina diffusa	Spreading dayflower	Gitula	Fresh Leaves	7.60 ± 0.48^{a}	3370 ± 0.10^{b}
Oxygonium sinuatum	Double thorn	Song'e	Fresh Leaves	18.79 ± 1.07^{b}	3870 ± 0.29^{bc}

3.3 Values in the same column with different superscripts letters are significantly different (p<0.05)

Table 3 shows the results for zinc content in two fruits and six leaves of the edible plants parts on dry matter basis. The zinc content varied significantly (p<0.05) among the wild food plants with values ranging from 0.38 mg/100g to 28.15 mg/100g dmb. The highest source of zinc were found in leaves of *Oxygonium sinuatum* followed by *Amaranthus hybridus* and least in *Grewia bicolor* (Table 3) and these show the plants investigated were rich source of zinc. The leaves had higher levels of zinc than the fruits. The value of zinc reported in the study was comparable with or higher than the commonly cultivated cabbage and kales in Kenya (Oyunga et al., 2010).

Botanical name	**English/common Name**	**Local name 'Kamba'**	**Edible part used**	**Zinc mg/100g(dmb)**
Cucumis dipsaceus	Hedgehog cucumber	Kikungi	Leaves	4.17 ± 0.27^{b}
Commelina africana	Yellow commelina	Kikowe	Leaves	2.21 ± 0.30^{ab}
Amaranthus dubius	Spleen amaranth	Telele green	Leaves	11.06 ± 1.32^{c}
Grewia bicolor	White leaved raising	Ngalawa	Fruit	0.38 ± 0.12^{a}
Lantana camara	Tick berry	Mukite	Fruit	1.12 ± 0.32^{ab}
Amaranthus hybridus	Red amaranth	Telele Red	Leaves	17.66 ±2.42^{d}
Commelina diffusa	Spreading dayflower	Gitula	Leaves	8.56 ±1.74^{c}
Oxygonium sinuatum	Double thorn	Song'e	Leaves	28.15 ±4.71^{e}

Values are expressed as mean, ± standard deviation of triplicate results

3.4 Dmb-Dry Matter Basis

3.4.5Values in the same column with different superscripts letters are significantly different (p<0.05)

The tannin content ranged from 677.81 to 3169.40 mg/100g dmb highest in *Grewia bicolor and* lowest in *Cucumis dipsaceus* (Table 4). There was significance difference (P<0.05) among the wild food plants studied. The values were lower or comparable wild and semi wild food plants than reported by (Getachew, et al., 2013)

Table 4: Tannin content of selected wild food plants

Botanical name	Common name	Local name 'Kamba'	Edible Parts used	Tannin mg/100g
Cucumis dipsaceus	Hedgehog cucumber	Kikungi	Leaves	677.81± 42.23[a]
Commelina Africana	Yellow commelina	Kikowe	leaves	698.80 ± 28.42[a]
Grewia bicolor	White leaved raising	Ngalawa	Fruit	3169.40 ± 83.65[c]
Lantana camara	Tick berry	Mukite	Fruit	788.52 ± 33.81[a]
Amaranthus hybridus	Red amaranth	Telele Red	Leaves	2466.46±40.68[b]
Commelina diffusa	Spreading dayflower	Gitula	Leaves	995.65 ± 25.90[a]
Oxygonium sinuatum	Double thorn	Song'e	Leaves	2390.73±502.3[b]

Dmb-dry matter basis
Values are expressed as mean, ± standard deviation of triplicate results
Values in the same column with different superscripts letters are significantly different ($p<0.05$)

4.0 Conclusion

The under-utilized wild food plants are good source of nutrients such as β-carotene, vitamin C proteins and zinc which are comparable or higher than the cultivated counter parts and they are available during different months/seasons of the year. These food plants can act as a cheap source of nutrients for the locals and consumption could help to combat malnutrition. Additionally wild foods studied contain tannin content comparable with other wild food plants species. The results provide useful information on nutritional properties of the wild food plants which can be integrated with indigenous knowledge of the plants by the locals to manage malnutrition .These under utilised plants can be further exploited to mitigate micro and macro nutrient malnutrition improving food security

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