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Nutritional content of certain indigenous vegetables for food insecurity and malnutrition reduction in Kiambu County, Kenya

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Abstract

Indigenous vegetables are important for food insecurity, malnutrition reduction and therapeutic in sub-Saharan Africa countries. Most of indigenous vegetables are tolerant to climate change variability than exotic vegetables. In most of developing countries, indigenous vegetables are underutilized or neglected where some nutritional content are known and others are unknown. Leaves are the most preferred parts of indigenous vegetables for consumption. The study was conducted to evaluate nutritional content (protein and minerals) in leaves and young stems of six indigenous vegetables sold in local market, Kiambu County, Kenya. The results showed that minerals and protein content in indigenous vegetables significantly differ depend on vegetables types and parts. Spider plant had highest protein content (32.33%) relative to other vegetables analyzed. Mean moisture ranged from 82.11% African nightshade to 90.77% African kale and 82.33% slender leaf to 90.30% spider plant respectively in leaves and young stems. The highest minerals content per kg (DW) were recorded as follows: African nightshade (256.3mg Na), slender leaf (991mg Fe), spider plant (483.3mg P), Malabar spinach (3867mg K), African nightshade (3491mg Ca) and African kale 1259mg Mg). The results from current study showed that indigenous vegetables are good sources of protein and minerals which can reduce malnutrition and micronutrient deficiencies and also improve food security in climate change scenario. It recommended that young stem should be consumed together with leaves to increase nutrients content in daily diet and also reduce nutrient wastage.

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Introduction

Malnutrition remains a public health challenge worldwide. Malnutrition and poor diets are the leading causes of poor child growth and development, stunting and micronutrient deficiencies in the developing countries (Hakim, 2016, Müller and Krawinkel, 2005). Malnutrition leads to increased morbidity and mortality particularly in developing countries. Globally, about 45% of child deaths are attributed to malnutrition (International Food Policy Research Institute 2016). In low- and middle-income countries, under-nutrition leads to nearly 3.1 million deaths of children every year (Oruamabo 2015).

In Kenya, malnutrition continues to be a public health challenge. According to the 2014 Kenya Demographic and Health Survey (KDHS, 2014), 26% of the children under age 5 are stunted, while 4% are wasted and 11% are underweight (Kenya National Bureau of Statistics 2015). Local studies have found various rates from different regions of the country. A study done in urban poor setting in Kenya found a prevalence of 46%, 11 % and 2.5% for childhood stunting, underweight and wasting, respectively (Kimani-murage *et al.* 2015). Study conducted in Narok county among 350 children revealed that 31%, 22% and 8% of the children were stunted, underweight and wasted, respectively (Tankoi *et al.*, 2016). Poverty and food insecurity among these countries are among the main factors associated with the increase of malnutrition in the developing countries (Hakim, 2016; Oruamabo, 2015). These factors lead to inadequate intake of balanced diet resulting in macronutrients and/or micronutrients deficiencies. According to global nutrition report 2016, about 2 billion of population is affected by micronutrient malnutrition (International Food Policy Research Institute 2016). The Global Nutrition Report (2017) described that in six countries (Nigeria, Ethiopia, Yemen, South Sudan, Kenya and Somalia) 38 million people, 1.796 million children under five and 4.96 million people have severely food insure and severe acute malnutrition respectively. It is also reported that droughts contribute to food insecurity and malnutrition in Kenya and Ethiopia (Global Nutrition Report 2017).

Above 80% of land in Kenya are located in semiarid and arid areas (Muthoni and Nyamongo, 2010). However, dryland in Kenya continue to increase due to inadequate rainfall. The production of exotic vegetables in this scenario is declining year by year. According to Muthoni and Nyamongo, (2010), Exotic vegetables prices in Kenya are unaffordable to the poor households due to high production cost. The indigenous vegetables have been reported as important commodities for poor farmers than other food crops (Kwenin *et al.*, 2011). Vegetables are important sources of vitamins, fiber, minerals, protein and fat required in daily human diets. Khan and Hamid, (1986), reported that vegetables contain digestible cellulose fiber, amino acids fat, energy, vitamins and different minerals. The consumption of vegetables has a positive effect on human health (Marowa-wilkerson *et al.*, 2007, Hyson, 2011). Dias, (2012), reported that daily consumption of vegetables in diets improve vision, health of gastrointestinal and reduce the risk of stroke, heart disease and chronic diseases. Digestible fiber from vegetables reduces mortality caused by ischemic heart (Khan and Hamid, 1986). The authors also reported that the remarkable decrease in consumption of fiber might result to different chronic diseases such cancer of the large intestinal, appendicitis, hiatus hernia and haemorrhpids. Consumption of indigenous vegetables can help to reduce malnutrition and micronutrient deficiencies. The indigenous vegetables are available in all communities but due to lack of information on nutritional value are underutilized (Muthoni and Nyamongo, 2010). The information on nutritional value of indigenous vegetables is still scanty. The current study aimed to evaluate nutritional content in leaves and young stem of six indigenous leafy vegetables sold in local market of Kiambu County, Kenya.

Materials and methods

Six indigenous vegetables (Table 1) were collected from local markets in Kiambu County, Kenya. After sample collection, Dry mass, protein, phosphorus, Iron, Magnesium, Potassium, sodium, calcium, copper and Manganese were analyzed in Chemistry Laboratory of Land Resources Management Faculty of Agriculture, University of Nairobi.

Table 1. List of certain indigenous vegetables evaluated for nutrient content.

Local Name	English name	Scientific name
Nderema	Malabar spinach	*Bacella alba*
Mtoo	Slender leaf	*Crotalaria brevidens*
Kanzira	African kale	*Brassica carinata*
Mlenda	Jute mallow	*Corchonus tritocularies*
Isaga	Spider plant	*Cleome gynandra*
Mnavu	African nightshade	*Solanum scabrum*

Moisture content

Leaf or young stem packed in paper bags per each type of vegetables were weighed before and after drying by using oven at 70ºC until constant weight. The moisture content was calculated as follow:

$$\text{Moisture content} = \frac{\text{Fresh weight} - \text{dry weight}}{\text{Fresh weight}} \times 100$$

Minerals analysis

Dried vegetables sample were grinded using POLYMIX PX-MFC 90D grinder. After grinding 0.3 g of each sample was put in clean digestion tube and mixed with 5ml digestion mixer contains 350ml of Hydrogen peroxide 30%, 0. 42g of Selenium, 420 ml of H_2SO_4 Concentrated and 14g of lithium sulphate as described by Okalebo *et al.,* (2002) and then digested for 2.5 hours at 350ºC using DK Heating Digester (Velp), UK. 25ml of distilled water was added after digested samples became cool and mixed well and then were topped up 50ml of distilled water. Phosphorus, Nitrogen and metal elements were analyzed after digesting grinded indigenous vegetables leaf and young stem samples.

Phosphorus

The 2 ml of digested solution sample were put into 50 ml volumetric flask, and 5 ml of ascorbic acid added and topped up to 50 ml with distilled water. The total phosphorus (P) content in either leaf or soft vegetables stem were then analyzed using UV Visible Spectrophotometer.

$$\text{P} \left(\frac{\text{mg}}{\text{Kg}}\right) = \frac{(\text{a} - \text{b}) * \text{volume extracted} * 50}{0.3 * 0.2}$$

Where a= concentration of phosphorus in the solution; b= concentration of phosphorus in the value of the blank; 0.3= weight of the sample taken; 0.2= aliquot taken (ml); 50= volume developed

Metal elements analysis

Atomic absorption spectrophotometer (AA500 Pg) was used to analyze metal elements (Iron, Magnesium, Potassium, sodium, calcium, copper and Manganese) by absorbing radiation from an element specific hallow cathode lamp and flame of atomic absorption Spectrophotometer and absorbance measured at a wavelength of 248.3nm, 324.7nm, 422.7 nm and 766.5nm depend on element. Before each element measurement, the AA500 Spectrophotometer was calibrated depending on the element and absorbencies curve of the standard series absorbencies were plotted. The concentration of every metal elements were calculated using the formula reported by Okalebo *et al.*, (2002) as follows:

$$\text{Metal element} \left(\frac{\text{mg}}{\text{Kg}}\right) = \frac{(\text{a} - \text{b}) * \text{V} * \text{f}}{0.3}$$

Where Metal element are either Iron, Magnesium, Potassium, sodium, calcium, copper and Manganese; a= Concentration of metal element in the solution; b= Concentration of metal element in the value of blank; V=Volume of the digest; 0.3= weight of the sample taken; f=Dilution factor

Crude protein determination

Crude protein was determined from total nitrogen. Total nitrogen was determined by using Kjeldahl method where three drops of indicator (phenolphthalein) added in Kjeldahl distilling flask contain 10 ml of digested sample was mixed with 5 ml of sodium hydroxide 40% and connected to nitrogen distilling unit G (Gerhardt) and distillate was collected in 2% boric acid During titration using 0.01N of H_2SO_4, the initial titer and final were recorded for every vegetables sample. The crude protein were calculated as follows:

$$\text{Protein (\%)} = \frac{(\text{Titre} - \text{Blank}) * 14 * \text{Volume extracted} * 0.01 * 100 * 6.25}{0.3 * 1000 * \text{Volume distilled}}$$

Result and discussion

Crude protein content significantly varied with type and part of indigenous vegetables analyzed. The leaves had high crude protein content relative to young stem (Table 2).

Shih *et al.* (2011) reported *Moringa oleifera* leaves to have higher protein content than stem. Results of the current study showed that crude protein content in leaves ranged from 17.55% in slender leaf to 32.33% in spider plant while young stem crude protein content ranged from 8.26% slender leaf to 18.03% in African kale (Table 2). Food plant protein content of more than 12 % can be considered as good source of protein (Hassan and Umar 2006). The results showed that indigenous vegetables are a good sources of protein in diet and consumption of leaves together with young stem could increase protein caloric value.

Considering on indigenous vegetables preparation by throwing away young stems during preparation; 8.26% to 18.03% crude protein ranged are lost depending on the type of vegetables. Leaves and young stem moisture content ranged from 82.11 % African nightshade leaf to 90.77% African kale. Crude protein of analyzed vegetables was remarkably high (5.65-20.43% and 15.61-30.39%) when it is compared to the result reported in *Brassica spp.*(Rajadevan and Schramm 1989) and *Brassica oleracae* Var. Capitata L. (Ogbede *et al.* 2015) respectively.

Mineral contents results (table 3 and table 4) in leaves and stem analysed showed that indigenous vegetables are rich in different macro and micronutrients. The results showed that phosphorus, potassium and calcium content are higher in leaves and stem relative to the other minerals analysed. Potassium content ranged from 2153mg/kg DW in slender leaf young stem to 4549mg/kg DW in spider plant young stem. Phosphorus ranged from 833mg/kg DW Jute mallow young stem to 4833mg/kg DW spider plant leaves, Calcium ranged from 718mg/kg DW slender leaf leaves to 3491mg/kg DW African nightshade leaves. The composition of magnesium (747mg/kg DW to 1259mg/kg DW), Iron (45mg/kg to 991mg/kg DW) and sodium (45mg/kg DW to 339 mg/kg DW) were lower other minerals analysed; nevertheless, very high compared to the results reported by Ogbede *et al.* (2015) in *Brassica oleracae* Var. Capitata L. leaves. This indicated that indigenous vegetables are good sources of different minerals. Potassium, sodium, calcium and magnesium recorded in vegetables used in current study were significantly higher compared to results obtained in five cultivars of leaf lettuce (Koudela and Petříková, 2008).

Table 2. Crude protein and moisture content of certain indigenous vegetables.

Vegetables	Crude protein (%)		Moisture (%)	
	Leaves	Young stem	Leaves	Young stem
Slender leaf	17.55^{f*}	8.26^{b}	84.63	82.33
African kale	30.47^{b}	18.03^{a}	90.77	87.61
Malabar spinach	28.53^{c}		89.02	
Spider plant	32.33^{a}	11.47^{b}	84.69	90.30
Jute mallow	25.33^{d}	15.27^{a}	83.93	86.67
African nightshade	22.90^{e}	16.83^{a}	82.11	85.02
P value	<.001	<.001		
$LSD_{0.05}$	0.57	3.64		

*Mean data are mean value of three replicates and Means followed by similar superscripts within a column were not significantly according to Fisher's protected $LSD_{0.05}$.

Table 3. Minerals compositions (mg/Kg DW) in leaves of certain indigenous vegetables.

Vegetables	Na	Fe	P	K	Ca	Mg
Slender leaf	45^{f}	991.0^{a*}	2375^{f}	3296^{e}	718^{f}	822^{f}
African kale	270.7^{b}	630.7^{b}	3458^{c}	3596^{d}	3104^{b}	1259^{a}
Malabar spinach	339^{a}	45.0^{e}	3750^{b}	3867a	2371^{e}	1207^{b}
Spider plant	212.3^{d}	90.2^{d}	4833^{a}	3774^{b}	2845^{c}	894^{e}
Jute mallow	83.8^{e}	585.7^{c}	3000^{e}	3654^{c}	2816^{d}	1075^{d}
African nightshade	256.3^{c}	630.7^{b}	3333^{d}	3596^{d}	3491^{a}	1170^{c}
P value	<.001	<.001	<.001	<.001	<.001	<.001
$LSD_{0.05}$	0.064	0.09	52.42	0.045	0.26	0.13

*Mean data are mean value of three replicates and Means followed by similar superscripts within a column were not significantly according to Fisher's protected $LSD_{0.05}$

Table 4. Minerals compositions (mg/Kg DW) in young stem of certain indigenous vegetables.

Vegetables	Na	Fe	P	K	Ca	Mg
Slender leaf	50.5^{e}	540.5^{a}	2542^{c*}	2153^{e}	948^{e}	919^{d}
African kale	305.2^{a}	270.3^{c}	3417^{b}	4273^{b}	2543^{d}	1192^{b}
Spider plant	246.7^{b}	180.2^{e}	3875^{a}	4549^{a}	3477^{a}	747^{e}
Jute mallow	101.8^{c}	225.2^{d}	833^{e}	4098^{c}	2974^{b}	1200^{a}
African nightshade	52.5^{d}	450.5b^{b}	1833^{d}	4022^{d}	2917^{c}	1140^{c}
P value	<.001	<.001	<.001	<.001	<.001	<.001
$LSD_{0.05}$	0.01485	0.01050	0.809	0.2441	0.1050	0.0664

*Mean data are mean value of three replicates and Means followed by similar superscripts within a column were not significantly according to Fisher's protected $LSD_{0.05}$

Conclusion

Based on current study, we conclude that indigenous vegetables are good sources of protein and minerals which can replace exotic vegetables in current climate change scenario. Consumption of leaves together with young stem increase protein and micro and micronutrients consumed. Indigenous vegetables could be useful to combat malnutrition, mineral deficiencies and meet human nutritional needs.

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