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Nutritional Analysis of the South African Wild Vegetable *Corchorus olitorius* L.

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Abstract: In this study, the nutrient levels and phytate content of the leaves, fruits and stems of *Corchorus olitorius* were determined using standard analytic methods and the results were compared with those of cabbage (*Brassica oleracea* L.) and spinach (*Spinacea oleracea* L.). There was no significant difference in the crude protein contents between *C. olitorius* (16.3%) and spinach leaves (18.7%). There was no significant difference in the lipid contents of wild okra leaves, cabbage and spinach. The intra-nutritional contents of *C. olitorius* revealed that, its leaves showed superior nutritional quality when compared to the fruits and stems except the lipid content in which the fruits had the highest value. *Corchorus olitorius* had higher magnesium content than cabbage and spinach. Although, its phytate content was lower than that of spinach, the value was higher than that of cabbage. Generally, present findings revealed that the wild okra contained more nutritional qualities than cabbage and spinach.

Key words: *Corchorus olitorius*, bioavailability, phytate, micronutrients, proximate composition

INTRODUCTION

Indigenous vegetables play important roles in human diets. They supply the body with minerals, vitamins and certain hormone precursors in addition to protein and energy (Antia *et al*., 2006). Despite the consumption of exotic vegetables, some indigenous vegetables have been reported to be more nutritious and less expensive than the exotic ones. Many indigenous vegetables are collected from the wild. The research and development strategies on wild species are the fruitful topics in South Africa, encouraging food reservation from the enriched genetic resources (van Vuuren, 2006).

Corchorus olitorius L., commonly known as wild okra, belongs to the family Tiliaceae. It is widely consumed as a vegetable among rural communities in most parts of Africa (Velempini *et al*., 2003). In West Africa it is commonly cultivated and very popular among people of all classes especially in Nigeria (Oyedele *et al*., 2006). The plant is also eaten in some parts of Asia (Furumuto *et al*., 2002). According to Zakaria *et al.* (2006), wild okra is used in folklore medicine in the treatment of gonorrhea, chronic cystisis, pain, fever and tumors. *Corchorus olitorius* is known to contain high levels of iron and folate which are useful for the prevention of anemia (Oyedele *et al*., 2006). Ecologically, the crop grows more easily in rural subsistence farming systems when compared to exotic species like cabbage and spinach (Modi *et al*., 2006).

In South Africa *C. olitorius* grows in the wild in KwaZulu Natal, Mpumalanga, Limpopo and Gauteng provinces. However, it is only eaten in Limpopo where it is harvested from the wild and consumed either fresh or dried (Modi *et al*., 2006). Although the vegetable has the potential to be developed as a valuable crop, very little is known about its role in the overall food acquisition system in different parts of South Africa especially in relation to its contribution to the intake of important micronutrients (van Vuuren, 2006). The nutritive value, as well as micronutrient bioavailability of *C. olitorius* has not been well researched in South Africa.

Indigenous dark green leafy vegetables are believed to have high antinutrient levels (Flyman and Afolayan, 2006). The importance of vegetables as a source of dietary zinc, calcium and iron depends upon the total mineral content and other constituents in the diet like phytate, oxalate, hydrocyanic acid and tannins that affect bioavailability. Phytate is known to reduce bioavailability of dietary zinc by forming chelates at physiological pH while calcium potentiates the inhibitory effect of phytate on zinc absorption even at low amounts of dietary phytate (Akindahunsi and Oboh, 1999). The objectives of this study, therefore, were to: (a) determine the nutritional value of *C. olitorius* and compare this with those of cabbage (*Brassica oleracea* L.) and spinach (*Spinacia oleracea* L.), (b) investigate the distribution of the nutrients in the plant and (c) provide information on the phytate content of the plant and its potential effect on the bioavailability of selected mineral nutrients.

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MATERIALS AND METHODS

Corchorus olitorius was collected from a garden in May, 2007, while cabbage and spinach were purchased from a supermarket. All the vegetables were obtained in East London, South Africa. All the plant materials were washed carefully but thoroughly with distilled water. *Corchorus olitorius* was separated into leaves, fruits and stems. Each of the samples was oven dried to a constant weight at 60°C. After drying, the plant materials were ground into fine powder using an electric grinder (Fritsch, Idar-Oberstein, Germany) with a mesh size of 0.5 mm and stored in well labeled air tight polythene bags at 4°C until used.

Proximate composition of the various plant samples was determined as described by Antia *et al*. (2006). Ash determination involved the incineration of each sample in a muffle furnace (Naber Industrieofenbau, Bremen, Germany) at 550°C for 12 h. Crude fat determination was achieved by exhaustively extracting the samples with diethyl ether. Crude fiber was estimated from the loss in weight of the crucible and its contents on ignition after ashing, following the sequential extraction of the samples with 1.25% sulphuric acid and 1.25% sodium hydroxide. Protein was determined using the microkjeldal nitrogen method which involved the digestion of 0.5 g of sample with sulphuric acid and a catalyst followed by calorimetric determination of nitrogen. The value of nitrogen was multiplied by 6.25 to obtain percentage crude protein. The carbohydrate content was obtained by subtracting the values of total ash, crude fiber, lipid and protein from the total dry matter (Antia *et al*., 2006).

The calcium, iron, magnesium and zinc contents were measured using an Atomic Absorption Spectrophotometer (Cambridge, UK) after acid-digestion of the samples (Antia *et al*., 2006). Phosphorus content was obtained by converting phosphates into phosphorus molybdate blue pigment and assayed at 800 nm. Phytate was analyzed as described by Onabanjo and Oguntona (2003). All samples were analyzed in triplicates. The proximate composition and mineral data obtained from this study were subjected to one-way analysis of variance (ANOVA) at 5% level of confidence using Genstat 9th edition software.

RESULTS

The leaves of *C. olitorius* contained more crude protein and fiber than those of cabbage. There were no significant differences in the crude protein contents between the leaves of the wild vegetable and spinach (Table 1). There were also, no significant differences in the crude lipid contents of the three vegetables (Table 1).

Table 1: Proximate and nutrient composition of *C. olitorius*, cabbage and spinach

	Composition (g kg^{-1})		
Parameters	*C. olitorius*	Cabbage	Spinach
Proximates			
Ash	105.20±1.0^{a}	140.60±0.8^{b}	174.10±0.8^{c}
Crude lipid	17.20±2.9^{a}	12.00±0.5^{a}	15.80±1.3^{a}
Crude fiber	20.30±1.0^{a}	7.90±1.2^{b}	41.30±3.8^{c}
Crude protein	162.60±3.37^{a}	53.00±2.58^{b}	187.00±3.62^{a}
Total carbohydrate	695.00±32.4^{a}	786.00±26.5^{a}	586.00±34.8^{b}
Mineral elements			
Iron (Fe)	0.228±0.01^{a}	0.056±0.001^{b}	0.411±0.005^{c}
Calcium (Ca)	0.347±0.02^{a}	nd*	0.607±0.040^{b}
Zinc (Zn)	0.051±0.006^{a}	0.0314±0.006^{a}	0.106±0.016^{b}
Magnesium (Mg)	0.560±0.02^{a}	0.279±0.01^{b}	0.426±0.03^{c}
Phosphorus (P)	0.258±0.03^{a}	0.122±0.03^{a}	0.437±0.04^{b}

Table 2: Proximate and nutrient composition of the leaves, fruits and stems of *C. olitorius*

	Compositions (g kg^{-1})		
Parameters	Leaves	Fruits	Stems
Proximates			
Ash	105.20±1.0^{a}	57.40±2.0^{b}	51.90±1.2^{c}
Crude lipid	17.20±2.9^{a}	42.30±6.0^{b}	69.00±1.3^{c}
Crude fiber	20.30±1.0^{a}	35.50±1.5^{a}	88.20±4.8^{b}
Crude protein	162.60±3.37^{a}	76.50±3.20^{b}	51.00±1.80^{b}
Total carbohydrate	695.00±32.4^{a}	788.00±28.70^{b}	802.00±18.2^{b}
Mineral elements			
Iron (Fe)	0.228±0.01^{a}	nd	0.0428±0.005^{b}
Calcium (Ca)	0.347±0.02^{a}	0.197±0.012^{b}	0.0761±0.008^{c}
Zinc (Zn)	0.051±0.006^{a}	0.028±0.005^{b}	0.0340±0.001^{b}
Magnesium (Mg)	0.560±0.02^{a}	0.449±0.020^{b}	0.3340±0.010^{c}
Phosphorus (P)	0.258±0.03^{a}	0.156±0.02^{b}	0.0380±0.003^{c}

Different letter(s) along rows represent significant differences at $p \leq 0.05$. nd = Not detected. Data in mean ± SD; n = 3

Statistically significant difference was observed on ash and crude fiber among all the vegetables, while carbohydrate content was not significantly different for wild okra and cabbage.

Considering the mineral nutrients including iron, calcium and magnesium in *C. olitorius* were significantly higher than those in cabbage while zinc and phosphorus were not significantly different. In contrast, the mineral contents in spinach were accumulated more than those in wild okra, except magnesium. In *C. olitorius* the leaves had the highest ash and protein contents while the stems and fruits were higher in crude fiber and crude lipid, respectively (Table 2). There were no significant differences in the carbohydrate contents between the fruits and the stems of *C. olitorius*. Generally, the leaves showed higher values of minerals analyzed than the fruits and the stems.

The spinach had the highest phytate content followed by *C. olitorius* (Table 3). The phytate-to-zinc ratio was acceptable in all the three vegetables since it was less than the critical ratio of 15 (Abebe *et al*., 2007). The acceptable ratio of phytate-to-iron is ≤ 1 (Chan *et al*.

Table 3: Phytate content and its potential effect on Zn, Ca and Fe bioavailability in the leaves of *C. olitorius*, cabbage and spinach

	Minerals (g kg^{-1})			Phytate ratios			
Vegetable	Fe	Ca	Zn	Phytate	Phy/Zn	Ca/Phy	Phy/Fe
C. olitorius	0.228	0.347	0.051	11.71	2.27	4.88	0.43
Cabbage	0.057	nd	0.034	6.52	1.90	nd*	0.96
Spinach	0.411	0.607	0.106	14.64	1.36	6.82	0.30

nd = Not detected. Data in means of 3 replicates

2007), while that of calcium- to -phytate is ≤ 6 (Ferguson *et al*., 1988). Based on these, the phytate-to-iron ratio was acceptable in all three vegetables. Moreover the calcium-to-phytate ratio was acceptable in wild okra but not in the spinach.

DISCUSSION

The relatively high protein content in the leaves of *C. olitorius* has highlighted the importance of the vegetable. Most rural communities in Southern and other parts of Africa, rely on vegetables as sources of protein; therefore, wild okra could play a significant role in the provision of cheap and affordable protein for rural populations. The mineral composition of the herb has revealed relatively high concentrations of magnesium, iron and calcium. The amount of iron in *C. olitorius* (wild okra) is of particular importance considering the fact that 21% of children in South Africa suffer from anaemia, a condition caused by iron deficiency (van Vuuren, 2006). Lipid content, which was not significantly different in all the three vegetables, is an indication that wild okra competes well with the conventional vegetables. If adequate research attention is developed it can complement these vegetables very well. The mineral composition of the leaves of *C. olitorius* revealed high concentrations of Mg, Fe and Ca.

Wild okra leaves appeared to be nutritionally better than its fruits and stems. This could explain the widespread consumption of the leaves of *C. olitorius* more than all the other parts of this plant. It should be noted that the fruit is rich in total lipid while the stem has good fiber content; this makes the entire aerial parts of this plant important when the issue of good nutrition is being discussed. This explains the use of the plant as a fiber crop (Roy *et al*., 2006).

According to, phytate molar ratios, calcium, zinc and iron bioavailability were high in *C. olitorius*. The mineral contribution of vegetables to human nutrition is limited due to the presence of antinutrients which render some of the micronutrients unavailable to human nutrition (Akwaowo *et al*., 2000). The most common antinutrients in leafy vegetables are phytate, tannins, hydrocyanic acid, oxalic acid and tannins. Phytate is the major phosphorus storage compound in plants (Gupta *et al*., 2006). It has the strong ability to chelate multivalent metal ions especially zinc, calcium and iron. This leads to poor bioavailability of such ions as they are precipitated in the form of insoluble complexes (Gupta *et al*., 2006). This study showed that wild okra can play a role in alleviating micronutrient deficiencies especially zinc and iron which are recognized to be a major nutritional problem worldwide. Diets with low zinc status are correlated to decreased growth, poor pregnancy outcome and impaired immune functions (Lönnerdal, 2002). According to Oyedele *et al*. (2006) zinc plays an important role in actively metabolizing cells and also in HIV positive people. Baum *et al*. (2003) reported that zinc is the most deficient micronutrient in people with HIV infection. According to these authors, low levels of plasma zinc increased HIV mortality by three folds whereas normalization has been associated with significantly lower disease progression and a decrease in the incidence of opportunistic infections.

While, the presence of phytate could decrease mineral absorption in humans, this antinutrient is usually eliminated during cooking (Akwaowo *et al*., 2000). Since phytic acid and other antinutrients are eliminated during processing and cooking of vegetables, therefore, phytic acid consumed by humans in *C. olitorius* might not be as high as suggested in this study. This study has revealed that mineral bioavailability was relatively high in *C. olitorius* when compared to the two conventional vegetables (cabbage and spinach), a situation reflecting that this vegetable can be used to alleviate micronutrient deficiency if cultivated, popularized and improved.

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