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Proximate and Mineral Composition of Kale (*Brassica oleracea*) Grown in Delta State, Nigeria

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Abstract: The study examined the proximate and mineral composition of Kale (*Brassica oleracea*) grown in Delta State, Nigeria. Fresh kale leaves were obtained from Ogbogonogo market in Asaba, Delta State, Nigeria. Random selection of leaves was done by purchasing from randomly selected sellers in the market. The purchased leaves were cleaned by washing with clean water to remove dirt and other contaminants and sent to the laboratory for analysis. From the results, kale was found to be a good source of vegetable protein (11.67%) and fiber (3.0%). Other proximate parameters include; moisture (81.38%), ash (1.33%), fat (0.26%), carbohydrate (2.36%) and energy (58.46 kcal/100 g). Observed mineral content were: sodium (4.69 mg/100 g), potassium (7.03 mg/100 g), calcium (4.05 mg/100 g), iron (8.94 mg/100 g), zinc (2.16 mg/100 g) and magnesium (6.69 mg/100 g). Kale (*Brassica oleracea*) has a high potential as a vegetable in the preparation of different Nigerian dishes and treatment of various diseases due to its nutritional potentials. No wonder the local nick-name "hospital too far".

Key words: Kale, vegetables, proximate, minerals

INTRODUCTION

Vegetables are generally succulent parts of plants grown in gardens and consumed as a side dish with starchy staples (Guarino, 1995). Several vegetable species abound in the world. Green leafy vegetables constitute an indispensable constituent of human diet in Africa generally and West Africa in particular (Chima and Igyor, 2007). In addition, green leafy vegetables are used in the diets of postpartum women during which time it is claimed that they aid the contraction of the uterus.

Kale is a green leafy vegetable that belongs to the brassica family, a group of vegetables including cabbage, collards and brussels sprouts that have recent widespread attention due to their health promoting, sulphur-containing phytonutrients. It is easy to grow and can grow in colder temperatures. The leaves can be curly and quite ornamental, but become too tough to eat fresh, as they mature. Kale is a member of the cabbage family and is susceptible to many of the pests that attack the cabbage family. Its Latin name is *Brassica oleracea*. The common name(s) is: Kale, Borecole. In Asaba, Delta State of Nigeria, kale is nick-named "hospital too far". This is because of the health benefits of kale. It is an annual crop, with sizes which varies with variety. Most are about 12-36 inches in width, 12-24 inches in height. The duration for its harvest is approximately 2 months depending on temperature (Damrosch, 2004). This work was undertaken to determine the proximate and mineral composition of kale grown in Delta State, Nigeria.

MATERIALS AND METHODS

Sample preparation: The kale (*Brassica oleracea*) leaves were purchased at Ogbogonogo market in Asaba, Delta State, Nigeria. Random selection of leaves was done by purchasing from randomly selected sellers in the market. The green leafy vegetables were sorted to remove spoilt, low quality vegetables from the bulk. They were picked and removed from the stalk, trimmed, washed and shredded. Washing was done with clean water to remove dirt and other contaminants. The vegetables were rinsed thoroughly and packaged in polythene bags and sent to the laboratory for analysis. Fresh samples of the leaves were analyzed.

Laboratory analysis: Protein, fat, moisture, crude fibre and total ash content of the leaves were determined using AOAC (1995) method. Carbohydrate (CHO) was calculated by difference. Energy value of kale was calculated using the Atwater formula:

Energy value (kcal/100g) = (4 x % carbohydrate) + (9 x % crude fat) + (4 x % crude protein)

The minerals (calcium, magnesium, zinc and iron) were determined by Atomic Absorption Spectrophotometry (AAS) using the method of Essien *et al.* (1992). The antinutrient tannin was determined using Pearson (1976) method. Oxalate was determined using the

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method described by Ukpabi and Ejidoh (1989) and phytate was determined by James (1995) method.

Statistical analysis: The results generated from the analysis were subjected to statistical analysis using the Statistical Package for Social Science (SPSS) Version 15. Means were used for the analysis of the result.

RESULTS AND DISCUSSION

The proximate composition of kale (*Beassica oleracea*) is shown in Table 1. The carbohydrate content of kale (2.36%) was low. This is not surprising because most vegetables are generally not necessarily good sources of carbohydrate. According to USDA (1984), carbohydrates are pivotal nutrients required for adequate diet. Their prime role is to produce energy required for the smooth functioning of the body. As far as vegetables are concerned, some of them are rich sources while others contain traces of the nutrient. Kale like most vegetables contains low carbohydrate. However the carbohydrate content of kale as observed in this study was lower than that of other vegetables such as *Amaranthus hybridus* (52.18%) (Akubugwo *et al*., 2007). The fat content of kale was low (0.26%). This made kale not be a high fat content vegetable. It could therefore be used by individuals on weight reduction.

Table 1: Proximate composition of Kale (*Brassica oleraceae*)

Nutrient	Composition
Carbohydrate (%)	2.36
Fat (%)	0.26
Crude protein (%)	11.67
Energy (kcal/100 g)	58.46
Moisture (%)	81.38
Crude fiber (%)	3.00
Ash (%)	1.33

Kale is also a good source of vegetable protein having a protein content of 11.67%. This value was higher than that (3.3%) recorded by the USDA Nutrient Database for Standard Reference (Hall, 1998). Its protein content makes it suitable for consumption, as a necessity for body development. The protein value of kale as observed in this study confers on it the advantage as a rich source of vegetable protein over some vegetables such as raw cocoyam leaf (3.4%), cooked cocoyam leaf (2.1%), Amaranthus (6.1%) and *Moringa oleifera* (4.2%) as reported by Adepoju *et al*. (2006). Chima and Igyor (2007) also recorded lower protein values for "Oha" (2.0%) and 'Okazi' (1.5%). Incorporating kale in the diet can furnish it with sizeable amounts of protein which provides enormous benefits such as provision of vital body constituents, maintenance of fluid balance, formation of hormones and enzymes, contribution to immune function, to mention but a few.

The energy value of kale was 58.46 kcal/100 g. This value was high as compared to the energy value of other vegetables such as asparagus (26 kcal/100 g), brocolli (32 kcal/100 g), spinach (23 kcal/100 g), brussel sprouts (40 kcal/100 g) and cauliflower (32 kcal/100 g) (USDA, 1984). Energy value of kale was however lower than that of 'Oha' (*Pterocarpies soyauxii*) (73.00%), but was within the range (21.0-97.0 kcal/100 g) reported for green leafy vegetables grown in southeastern parts of Nigeria (Chima and Igyor, 2007).

The result also revealed that kale has a high moisture content of 81.38%. It is known that products that have low fat values normally have high moisture contents. Moisture content is a widely used parameter in the processing and testing of food. It is an index of water activity of many foods. The observed value implies that kale may have a short shelf life since microorganisms that cause spoilage thrive in foods having high moisture content and also is indicative of low total solids (Adepoju *et al*., 2006). The high moisture content of kale is consistent with the report of Ekumankama (2008) who also observed a high moisture value for vegetables like Oha (83.75%), Nturukpa (80.75%) and Okazi (83.75%).

The fiber content of kale (3.0%) was found to be lower that of some other Nigerian vegetables such as "Oha" (*Pterocarpus soyauxii*) 13.1%, "Nturukpa" (*Pterocarpus santalinoides*) 10.55%, "Okazi" (*Gnetum africanum*) 24.6% (Ekumankama, 2008) and pigweed (*Amaranthus hybridus*) 8.61% (Akubugwo *et al*., 2007) but higher than that of *Telferia occidentalis* (2.3%) and *Piper guineense* (2.9%) (Mensah *et al*., 2008).

Fibre cleanses the digestive tract, by removing potential carcinogens from the body and prevents the absorption of excess cholesterol. Fibre also adds bulk to the food and prevents the intake of excess starchy food and may therefore guard against metabolic conditions such as hypercholesterolemia and diabetes mellitus. The presence of mucilage in some vegetables makes their soups more tasty and palatable (Smith, 1985). Fiber can also help to keep blood sugar levels under control. Fiber binds to cancer-causing chemicals, keeping them away from the cells lining the colon, providing yet another line of protection from colon cancer (Ensminger and Ensminger, 1996). Kale has also been recognized as an excellent source of fiber, which is an important consideration for people who suffer from elevated cholesterol levels and in helping to cleanse the colon (Zhao *et al*., 2007). According to Gates (1984), a number of studies have indicated that components of plants such as dietary fiber have beneficial effects in lowering blood cholesterol levels aside from the decreased intake of saturated fat and cholesterol that occurs with high intakes of plant foods (Ekumankama, 2008).

Ash content which is an index of mineral contents in biota was relatively low (1.33%) in kale leaf as compared to the values reported in leaves of *Talinum triangulare*

Table 2: Mineral composition of Kale (*Brassica oleraceae*)

Minerals	Composition (mg/100 g)
Sodium	4.69
Potassium	7.03
Calcium	4.05
Iron	8.94
Zinc	2.16
Magnesium	6.69

(20.05% DW) (Ifon and Bassir, 1979; Ladan *et al*., 1996), *Ipomea batatas* (11.10%), *Vernonia colorate* (15.86%) and *Moringa oleifera* (15.09% DW) (Lockeett *et al*., 2000; Antia *et al*., 2006), *Ocimum gratissium* (18.00% DW) and *Hibiscus esculentus* (8.00% DW) (Akindahunsi and Salawu, 2005). Ukam (2008) stated that the lower the ash content, the higher the nutrient quality. Kale therefore could be recommended for the preparation of different Nigerian dishes due to its nutritional potentials. Table 2 shows the mineral composition of raw kale. Kale was high in potassium (7.03 mg/100 g), Iron (8.94 mg/100 g), Mg (6.69 mg/100 g), Na (4.69 mg/100 g) and Ca (4.05 mg/100 g) and fairly high in Zn (2.16 mg/100 g). Ekumankama (2008) and Mensah *et al*. (2008) reported lower calcium levels for other vegetables such as Oha (0.20 mg/100 g), Nturukpa (0.03 mg/100 g), Okazi (0.30 mg/100 g), *A. cruentus* (2.05 mg/100 g), *Celosia* sp. (2.66 mg/100 g) and *V. amygdalina* (2.25 mg/100 g). Furthermore the calcium content of kale was lower than that of *Gryllotalpa africana* (4.13 mg/100 g), *T. triangulare* (7.44 mg/100 g), (Mensah *et al*., 2008), "Nchanwu"/"Scent" leaf (*Occinum gratissmum*) (246.80 mg/100 g), Uziza (*Piper guinenses*) (271.32 mg/100 g) and "Inene" (*Amaranthus*) (305.51 mg/100 g) (Chima and Igyor, 2007). Based on this finding, a significant percent of the daily calcium requirement for the average Nigerian can be met through judicious use of kale for meal preparation. Ensminger and Ensminger (1996) also reported kale as a good source of calcium.

Calcium is a major factor sustaining strong bones and plays a part in muscle contraction and relaxation, blood clotting, synaptic transmission and absorption of vitamin B_{12}. The relatively high content of calcium (4.05 mg/100 g) in kale suggests that it may be of therapeutic value in hypocalcaemic state like osteoporosis.

Iron level of kale was also higher (8.94 mg/100 g) than the FAO/WHO (1988) recommended dietary allowance for males (1.37 mg/day) and females (2.94 mg/day). Hall (1998) also reported a lower iron value (1.70 mg/100 g) for kale. Iron has been reported as an essential trace metal and plays numerous biochemical roles in the body, including oxygen binding in haemoglobin and acting as an important catalytic center in many enzymes, for example, the cytochrome (Geissler and Powers, 2005). It is estimated that 2 billion of the world's population (largely in developing countries) have marked iron deficiency anaemia (WHO, 1997). This in turn limits work performance and leads to impaired performance in mental and motor tests in children (Lockeett *et al*., 2000). In infants, children and adolescents, in addition to basal losses, iron is also required for growth of the tissues and organs and for the expanding red blood cell mass. Assuming average endogenous iron losses in adults are 1.0 mg/day in men and 1.7 mg/day in women, the estimated average dietary requirement for iron are 6.7 and 11.4 mg/day in men and women respectively (Geissler and Powers, 2005). Thus, the use of kale in the diet can furnish the diet with iron sufficient enough to meet the daily requirement for the nutrient.

Green leafy vegetables also contain iron needed in haemoglobin formation (Ladan *et al*., 1996) and hence recommended for anaemic convalescence. Kale has relatively high iron (Fe) contents and is recommended for iron deficiency anaemia. Various minerals are also co-enzymes in certain biochemical reactions in the body which underscores the importance of leafy vegetables in metabolic reactions. The iron content of kale was also found to be higher than that of *Gnetum africanum* (Afang, okazi) (6.70 mg/100 g dry weight), *Xanthosoma sagittifolium* (Afia Nkukwo) (5.10 mg/100 g dry weight), *Lasianthera africana* (Editan) (4.69 mg/100 g dry weight) and *Heinsia crinita* (7.60 mg/100 g dry weight) as reported by Ukam (2008).

Zinc content of kale (2.16 mg/100 g) was observed to be higher than the value (0.44 mg/100 g) as reported by Hall (1998). The zinc content of kale was also found to be lower than that of other vegetables like "Afang" (5.20 mg/100 g), "Afia Nkukwo" (3.81 mg/100 g), "Editan" (7.40 mg/100 g) and "Atama" (12.00 mg/100 g). The Required Daily Allowance (RDA) of zinc for infants, children, adolescents and adult males and females ranges between 2.0 mg/100 g to 11 mg/100 g (Shils *et al*., 2006).

FAO/WHO (2001) reported that zinc is an essential component of a large number (>300) of enzymes participating in the synthesis and degradation of carbohydrates, lipids, proteins, and nucleic acids as well as in the metabolism of other micronutrients. Zinc stabilizes the molecular structure of cellular components and membranes and contributes in this way to the maintenance of cell and organ integrity. Furthermore, zinc has an essential role in polynucleotide transcription and thus in the process of genetic expression. Its involvement in such fundamental activities probably accounts for the essentiality of zinc for all life forms. Zinc plays a central role in the immune system, affecting a number of aspects of cellular and humoral immunity (Shankar and Prasad, 1998).

Magnesium content of kale was high (6.69 mg/100 g). Magnesium is widely distributed in plant and animal foods and geochemical and other environmental variables rarely have a major influence on its content in foods. Most green vegetables, legume seeds, peas, beans and nuts are rich in magnesium, as are some

shellfish, spices and soya flour, all of which usually contain more than 500 mg/kg fresh weight (FAO/WHO, 2001). Although most unrefined cereal grains are reasonable sources, many highly refined flours, tubers, fruits and fungi and most oils and fats contribute little to dietary magnesium (<100 mg/kg fresh weight) (Koivistoinen, 1980; Tan *et al*., 1985). Magnesium is widely distributed in plant and animal sources but in differing concentrations (Shils *et al*., 2006). Magnesium content of kale was found to be lower than that of Purslane (101 mg/100 g) but higher than that of Oha (*Pterocarpus mildbreadii*) (0.25 mg/100 g), Nturukpa (*Pterocarpus santalinoides*) (0.28 mg/100 g), Okazi (*Gnetum Africana*) (0.21 mg/100 g), *A. cruentus* (2.53 mg/100 g), *T. triangulare* (2.22 mg/100 g), *Celosia* (1.41 mg/100 g) and *G. latifolium* (1.32 mg/100 g) respectively (Mensah *et al*., 2008; Chima and Igyor, 2007).

Potassium (K) content of kale was 7.03 mg/100 g. The K content of kale was higher than that of *Amaranthus cruentus* (4.82 mg/100 g), *Telferia occidentalis* (2.45 mg/100 g), *Vernonia amygdalina* (3.75 mg/100 g), *Gnetum africana* (0.08 mg/100 g), *Piper guineense* (3.92 mg/100 g), Basella rubra (2.32 mg/100 g) and *Ocimum grattisimum* (2.34 mg/100 g) as reported by Mensah *et al*. (2008). Potassium plays a role in controlling skeletal muscle contraction and nerve impulse transmission. Patient with soft bone problems are usually placed on high calcium and potassium vegetable meals. The high K content of kale could also be beneficial for patients on diuretic drugs to replenish the lost K in the urine.

Sodium content of kale was observed to be 4.69 mg/100 g. The sodium content of kale was however comparatively lower than of *Gnetum africanum* (Afang, okazi) (92.00 mg/100 g dry weight), *Xanthosoma sagittifolium* (Afia Nkukwo) (26.00 mg/100 g dry weight), *Lasianthera africana* (Editan) (63.80 mg/100 g dry weight) and *Heinsia crinita* (179.00 mg/100 g dry weight) (Ukam, 2008); but higher than that of *Telferia occidentalis* (1.17 mg/100 g), *Vernonia amygdalina* (3.75 mg/100 g), *Gnetum africana* (1.50 mg/100 g), *Piper guineense* (0.07 mg/100 g), *Cochorus olitorius* (0.33 mg/100 g) and *Talinum triangulareisimum* (0.28 mg/100 g) (Mensah *et al*., 2008). The lower sodium content of kale could be beneficial in the treatment of hypertension and renal diseases.

Conclusion: From the results of this study, it is clear that kale (*Brassica oleraceae*), though a lesser known vegetables, has enormous nutritional potentials and thus can favourably be used as a substitute for most of the commonly used vegetables. Kale has been recognized as a good source of vegetable fiber which helps to reduce high cholesterol levels thus helping in the prevention of atherosclerosis. It can also help in keeping blood sugar levels under control and is an excellent vegetable for people with diabetes. The high protein content of kale confers on it the advantage as a rich source of vegetable protein over other lesser known vegetables. Though carbohydrate content was low, kale is also a good source of carbohydrate and energy compared to other commonly known vegetables as observed in this study. Kale (*Brassica oleracea*) has a high potential as a vegetable in the preparation of different Nigerian dishes and treatment of various diseases due to its nutritional potentials. No wonder the local nick-name “hospital too far”.

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