

*Full Length Research Paper*

## **Nutritional prospects and mineral compositions of selected vegetables from Dhoda sharif – Kohat**

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Kohat, a semi arid region, has bestowed with ample natural wealth of vegetables and plant species. Local people are depending, one way or the other, on these vegetable species for food and medicine. To fulfill the nutritional needs of the local people, various vegetable species are cultivated. In the present study, *Momordica charantia*, *Cucurbita maxima*, *Solanum melongena var. esculentum*, *Allium sativum*, *Capsicum frutescens* and *Brassica oleraceae var. capitata* were evaluated for the first time for nutritional and mineral analysis. In nutritional analysis, ash, carbohydrates, proteins, fibers, fats, moisture and energy values were assessed using AOAC methods, while Cu, Ni, Zn, Pb, Co, Cd, Fe and Cr, were evaluated for mineral analysis by the use of Atomic Absorption Spectrometer. The species evaluated in the present study showed variations in the results. *B. oleraceae var. capitata* has revealed highest percentage of moisture, fats and proteins (14.708, 2.877 and 22.342%, respectively), while *M. charantia* showed the highest percentage of fibers and energy value (23.418% and 330.441 kcal/100 g respectively), when compared with other vegetable species. In mineral contents, *A. sativum* had the highest concentrations of Zn and Cu (262 and 28 mg/L respectively) compared to the other species.

**Key words:** Nutritional assessment, micronutrients, atomic absorption, Kjeldahl.

### **INTRODUCTION**

Researchers, the governments and the other organizations show a great concern on the nutritional status of the general population, and more especially the pregnant and lactating mothers and the children habituating the developing countries (Andersen et al., 2003). In these countries, natural disasters, bad economic policies, political instability, population explosion, high price of food commodities, poor implementation of agricultural policies and restrictions in food importation are the major factors that contribute to the burden of inadequate food intake among average people (Adebooye and Phillips, 2006). In these regions, starch-based foods are the main staple food which supply

both energy and protein requirement. Thus, protein deficiency prevails among the general population as recognized by the Food and Agricultural Organization (FAO) (Ladeji et al., 1995). To alleviate the situation, efforts should be focused on exploiting the under-exploited and lesser-known wild plants as sources of nutrients supplements. It is reported in literature that the protein, vitamin and mineral supply of the human diet is partly delivered by vegetables. Roughage, which promotes digestion and prevents constipation, is also provided partly by vegetables (Aliyu, 2006).

In traditional societies, nutrition and health care are interconnected and many plants are consumed as food in order to benefit health (Etkin, 1996). With the increasing population of the world, food demands have overwhelmed the available land resources to produce more. Along with other food alternatives, vegetables are

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**Table 1.** The medicinal properties and the common names of the vegetable species.

Vegetables	Common name	Parts used	Medicinal properties
<i>C. maxima</i>	Kado	Fruit	Diuretic, tonic, vermifuge and nerve tonic (Chiej and Donald, 1984)
<i>S. melongena</i> var. <i>esculentum</i>	Bengan	Fruit	Antihemorrhoidal and hypotensive, the leaves are narcotic and regulate high blood pressure (Chiej and Donald, 1984; Chopra et al., 1986)
<i>A. sativum</i>	Garlic	Rhizome	Anthelmintic, antiasthmatic, anticholesterol, antiseptic, antispasmodic, cholagogue, diaphoretic, diuretic, stimulant, tonic and vasodilator (Holtom and Hylton, 1979)
<i>M. charantia</i>	Bitter guard	Fruit	Increases insulin sensitivity, help in digestion, dyspepsia, and constipation, tonic, emetic and laxative (Nadkarni, 1982).
<i>C. frutescens</i>	Chilly	Fruit	Stimulate the appetite, encourage bowel movements, aid in digestion, comfort stomachaches, and strengthen immune systems depleted by colds (Padilla, 1999).
<i>B. oleraceae</i> var. <i>capitata</i>	Cabbage	Fruit	Excellent source of Vitamin C, Inflammation, anti-inflammatory, and peptic ulcers (Helen, 2006).

considered as the cheap sources of energy and other essential bio-chemicals and nutrients such as carbohydrates, proteins, vitamins, calcium, iron, ascorbic acid and palpable concentration of trace minerals (Prakash and Pal, 1991; Devadas and Saroja, 1980). These vegetables will continue to remain the basic source of energy for the developing countries like Pakistan (Laporte, 1976). In the present study, these vegetable species were subjected to nutritional and micronutrient analyses. In nutritional analysis, the ash content, carbohydrate, protein, fat, fiber, moisture and energy values were analyzed, while the micronutrients; Cu, Ni, Pb, Co, Cr, Fe, Zn, and Cd were scrutinized in the essential nutrient analysis.

## MATERIAL AND METHODS

### Plants collection

The selected vegetable species were collected from Dhoda Sharif, Kohat, Kpk, Pakistan and were identified by Mr. Shoab Khan, Plant Taxonomist, Department of Botany, Kohat University of Science and Technology, Kohat. All the vegetable species were packed in the Kraft paper and herbarium sheets were prepared.

### Sample preparation

The samples were washed under running water and blotted dry. The dried material obtained was ground to a fine powder and stored at 5°C in air-tight containers prior to further analysis.

### Nutritional composition

Moisture, ash, crude fat and crude fiber contents were determined

by using the standard methods (AOAC, 1999). Nitrogen was determined by the micro Kjeldahl method (Pearson, 1976) and the nitrogen content was converted to protein by multiplying with 6.25. Carbohydrate was determined by difference method. The energy values (kcal/100 g) were determined by multiplying the values of carbohydrates, lipids and proteins by a factor of 4, 9, and 4 respectively, and taking the sum expressed in kilocalories. All the nutritional values were reported in percentage (AOAC, 1999; Hussain et al., 2009, 2010a, b). The lipid contents were extracted using the principle of gravimetric extraction by using the Soxhlet extraction method (Block, 1956; Hussain et al., 2009, 2010a, b).

### Determination of mineral contents

The mineral contents of each sample were carried out using the established method (Hussain et al., 2009). All the mineral contents were reported in mg/L and Atomic Absorption Spectrometer (Perkin Elmer AA Analyst 700) was used for this purpose.

### Statistical analysis

Each experiment was repeated three times. The results are presented with their means, standard error using Microsoft Office Excel 2003.

## RESULTS AND DISCUSSION

Vegetables are a vital component of human diet that is eaten all year round (Aliyu, 2006) and taking into account this importance in the human diet; some selected vegetables from the Kohat region of Pakistan are analyzed for their nutritional values. These properties prompted us to investigate the nutritional and mineral analysis of the selected vegetables investigate their nutritional and mineral analysis. The results of nutritional analysis showed variations in the nutritional values of

**Table 2.** Nutritional analysis of selected vegetables of Dhoda-Kohat with standard error.

Species name	Moisture (%)	Ash (%)	Fats (%)	Fibers (%)	Proteins (%)	Carbohydrates (%)	Energy value (kcal/100 g)
<i>M. charantia</i>	9.43±0.02	10.15±0.01	1.75±0.02	23.41±0.01	11.67±0.03	66.98±0.05	307.315±0.25
<i>C. maxima</i>	10.21 ±0.01	14.72±0.03	1.49± 0.01	17.49±0.02	5.59±0.05	67.87±0.01	307.31±0.25
<i>S. melongena</i>	11.21±0.06	10.86±0.03	0.37± 0.00	15.60±0.01	9.65±0.02	68.14±0.11	314.76±0.47
<i>A. sativum</i>	10.12 ±0.02	19.47±0.03	0.29± 0.01	1.52±0.01	12.52±0.03	57.58±0.02	282.69±0.19
<i>C. frutescens</i>	9.03±0.00	58.08±0.04	1.83± 0.02	22.60±0.01	7.57±0.02	23.46±0.03	140.65±0.16
<i>B. oleraceae</i>	14.70±0.01	12.34±0.01	2.87± 0.02	7.35±0.11	22.34±0.01	47.72±0.02	306.15±0.06

these selected vegetables. The moisture content for each species was different, and it was found to be highest in *Brassica oleraceae var. capitata* (14.708%), followed by *Solanum melongena var. esculentum* (11.211%) and then *Cucurbita maxima* (10.211%). The remaining species had comparatively lesser composition of moisture (Table 2). The ash content, which is an index of mineral contents in biota, was found high in *C. frutescens* (58.08) and in *A. sativum* (19.47), compared to the values reported in leaves of *Ipomea batatas* (1.8%), *Corchorus tridens* (8.7%) and *Amaranthus incarvatus* (14.4%) grown in Ghana (Asibey-Berko and Tayie, 1999). Lockeett et al. (2000) had also reported the high ash content in some greens, being used by the lactating mother. They include the bitter leaves, *Veronia colorate* (15.86%) and *Moringa oleifera* (15.09%). This indicates that *C. frutescens* and *A. sativum* could be a good source of mineral elements (Table 2).

The results of fat analysis showed that *B. oleraceae var. capitata* has the highest concentration (2.877%) of fat as compared to the other species (Table 2). Although, the crude lipid content of *B. oleraceae var. capitata* was low compared with the reported values (8.3 to 27.0%) of some vegetables in Nigeria and the Republic of Niger (Ifon and Bassir, 1980), however, this value is higher than some *Sonchus* species (0.52 to 0.75%), and sweet potato leaves (0.33 to 1.03%) (Guil-Guerrero et al., 1998; Ishida et al., 2000). These results indicated that the leaves of *B. oleraceae var. capitata* are poor sources of lipid, which is in agreement with the general observation that the leafy vegetables are low lipid containing food, and thus are advantageous, health wise, to avoid obesity (Lintas, 1992).

The crude fiber content in *Momordica charantia* (23.418%) was high, compared to some Nigerian vegetables (8.5 to 20.9%) (Ifon and Bassir, 1980). The major drawback to the use of vegetables in human nutrition is their high fiber content, which invariably causes intestinal irritation and hence lowers the nutrient bioavailability. Thus, large quantities of plant vegetables have to be consumed to provide adequate level of nutrients (Aletor and Adeogun, 1995). On the other hand, intake of dietary fiber can lower the serum cholesterol level, the risk of coronary heart disease, hypertension,

constipation, diabetes, colon and breast cancer (Ishida et al., 2000). The recommended daily allowance (RDA) of fiber for children, adults, pregnant and lactating mothers are 19 to 25, 21 to 38, 28 and 29%, respectively. Thus, *M. charantia* can be considered as a valuable source of dietary fiber in human nutrition (Table 2).

Vegetables are considered as good source of protein if they provide more than 12% of its calorific value from protein (Pearson, 1976). Furthermore, the pregnant, lactating mothers and adults require respectively 13 to 19, 71 and 34 to 56 g of proteins daily (FND, 2002). It has been reported in literature that protein level of green leafy vegetables range from 20.48 to 41.66% and the protein-calories malnutrition is a major factor responsible in nutritional pathology (Roger et al., 2005). The results obtained from our study of nutritional analysis showed that *B. oleraceae var. capitata* contained 20.342% protein, which is even greater than that of the reference vegetable, *T. occidentalis* (13.33%) (Roger et al., 2005). *A. sativum* has, however, comparatively lower protein value (12.52%), as was found during this analysis (Table 2). Thus, it has been concluded that adequate proteins were present in these vegetables and thus they can be used as a good diet for human beings.

If we look at the overall percentage of the carbohydrate composition, it was found highest in *S. melongena var. esculentum* (68.14%), followed by *C. maxima* (67.87%), *M. charantia* (66.98%), *B. oleraceae var. capitata* (47.72%), *C. frutescens* (23.469%) and *A. sativum* (57.58%) (Table 2). Although, all of these values were found to be greater than that of the reported values for the leaves of *Senna obtusifolia* (20%) (Faruq et al., 2002), and *Amaranthus incurvatus* (23.7%) (Asibey-Berko and Tayie, 1999), however, they are less than the available carbohydrate content compared to *Corchorus tridens* (75.0%) and sweet potatoes leaves (82.8%) (Asibey-Berko and Tayie, 1999).

The calorific value of *M. charantia* was estimated to be 307.31 kcal/100 g (Table 2), which is higher as compared to the reported value (248.8 to 307.1 kcal/100 g) of some Nigerian leafy vegetables (Isong et al., 1999). It was also found to be higher than the reported high energy content, Ghanaian green leafy vegetables, *Corchorus tridens* (283.1 kcal/100 g) and sweet potato leaves

**Table 3.** Mineral composition of selected vegetable species (mg/L).

Vegetables	Cu	Ni	Zn	Pb	Co	Cd	Fe	Cr
<i>M. charantia</i>	2.0	NR	85	NR	NR	NR	612	NR
<i>C. maxima</i>	9.0	NR	92	NR	1.0	NR	66	NR
<i>S. melongena</i>	17	NR	32	NR	13	3.0	70	NR
<i>A. sativum</i>	28	NR	262	NR	4.0	NR	164	NR
<i>C. frutescens</i>	13	NR	41	NR	2.0	1.0	104	NR
<i>B. oleraceae</i>	19	NR	40	NR	NR	NR	102	NR

BD = Below detection.

(288.3 kcal/100 g) (Asibey-Berko and Tayie, 1999). Therefore, all these vegetables are hereby regarded as edible vegetables, particularly during the season when other conventional vegetables are scarce, expensive or not available.

### Mineral contents

The mineral composition of the vegetables, evaluated during our analysis is summarized in Table 3. The level of Cu is very high in *A. sativum* (28 mg/L). This value is even higher than the acceptable range (2 to 5 mg intake per day) set by the World Health Organization (WHO, 1998). It has been reported that Cu consumption in excess of 3.0 mg/L of drinking water result in nausea and other adverse effects on the gastrointestinal tract (GIT) (Pizzaro et al., 1999). The presence of excess of Cu can cause oxidative stress in plants and subsequently increase the antioxidant responses due to increased production of highly toxic oxygen free radicals. Accordingly, it was observed that excess of Cu in plants led to the oxidative stress inducing changes in the activity and content of some components of the antioxidative pathways (that is, ascorbate peroxidase (APX), monodehydroascorbate reductase (MDHAR), and dehydroascorbate reductase (DHAR) etc., (De Vos et al., 1992; Luna et al., 1994).

Fe is an essential trace element for haemoglobin formation, normal functioning of the central nervous system and in the oxidation of carbohydrates, proteins and fats (Adeyeye and Otokiti, 1999). The results obtained in our study showed that *M. charantia* had the highest concentration (612 mg/L), followed by *A. sativum*, *C. frutescens*, *B. oleraceae* var. *capitata*, *S. melongena* var. *esculentum* and *C. maxima* having 164, 104, 102, 70 and 66 mg/L of Fe respectively. In case of Cd concentration, *S. melongena* var. *esculentum* and *C. frutescens* had the concentration of 3.0 and 1.0 mg/L, while negligible amount was found in other species (Table 3).

The level of Zn found in the selected vegetable too, is not in line with the WHO values of 2 to 5 mg intake per day. There is no documented evidence regarding the

adverse health effects from the intake of Zn, which is normally found in various diets consumed worldwide. But chronic zinc ingestion that is, 300 mg/day for six weeks causes suppression of the immune system and decrease in high density lipoproteins (Cantilli et al., 1994). While the remaining nutrients (Ni, Pb and Cr) had negligible concentration levels (Table 3). It has been reported that for many vegetable species Cr is proved to be toxic at 5 mg/L. In this regard, all the studied vegetables have very low concentration of Cr as compared to that of the recommended level for toxicity in plants (Adriano, 1986). In case of Pb, the suggested concentration in vegetable species is 2 to 6 mg/L (Broyer et al., 1972) but the vegetable species under investigation showed the presence of negligible amount of Pb, which further clarify their use as a food supplement.

In comparative assessment of the various species, the results showed that *A. sativum*, *M. charantia* and *B. oleraceae* var. *capitata* are the most significant species having higher concentrations of fats, proteins, and moisture as compared to the other vegetable species evaluated in this study (Table 2). The graphical representation of the nutritional analysis of these vegetable species is given in Figure 1.

Looking at the correlation analysis, it was found that similar parameters have highly significant correlation while among other parameters the correlation is either non-significant or less significant or moderate relation. Proteins showed significant correlation with fats and moisture. However, ash showed non-significant correlation with carbohydrates and energy value. All the correlations were established in a similar manner for all of the other parameters and are summarized in Table 4.

### Conclusion

Among the vegetable species analyzed for evaluation of micronutrients and nutritional parameters, *A. sativum*, *M. charantia* and *B. oleraceae* var. *capitata* proved to have some micronutrients and moderate level of nutritional parameters, which proves their importance in their nutritional values.

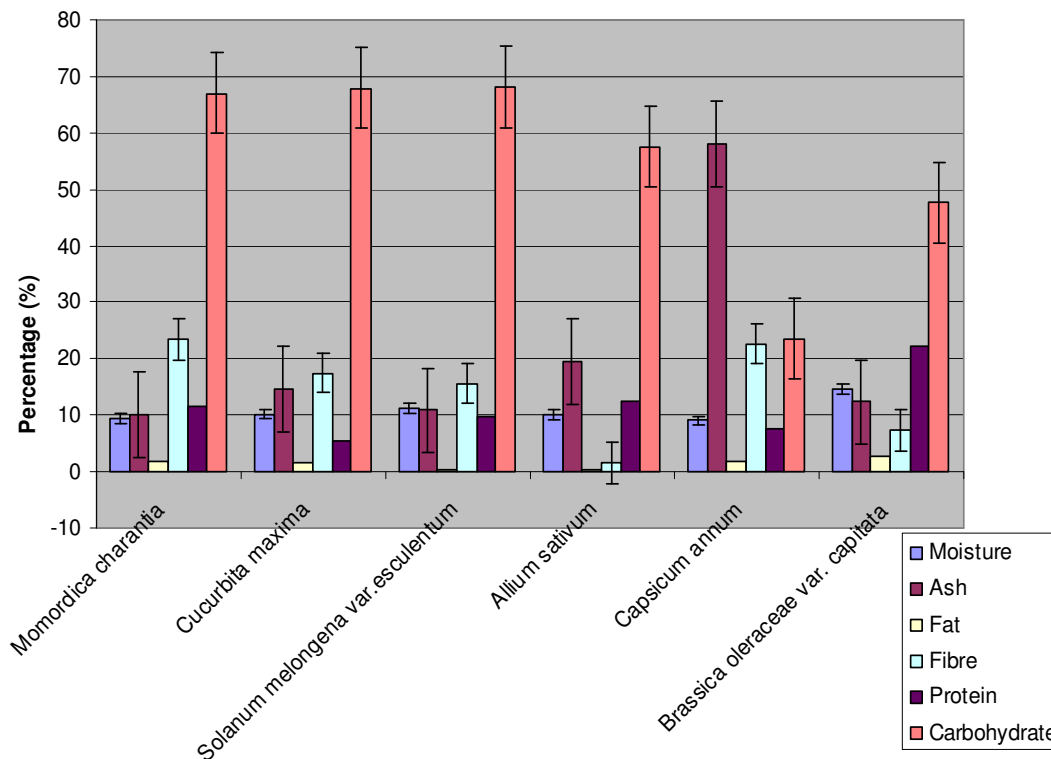


Figure 1. Comparative assessment of the species in nutritional analysis.

Table 4. Correlation matrix of nutritional parameters.

Parameter	Moisture	Ash	Fats	Fibers	Proteins	Carbohydrates	Energy value
Moisture	1						
Ash	-0.439	1					
Fats	0.478	0.119	1				
Fibers	-0.525	0.319	0.227	1			
Proteins	0.844	-0.344	0.509	-0.554	1		
Carbohydrates	0.037	-0.896	-0.412	-0.102	-0.098	1	
Energy value	0.380	-0.996	-0.115	-0.257	0.299	0.914	1

- Shows negative correlation.

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## REFERENCES

- Adebooye OC, Phillips OT (2006). Studies of seed characteristics and chemical composition of three morphotypes of *Mucuna urens* (L.) Medikus-Fabaceae. *Food Chem.*, 95: 658-663.
- Adeyeye EI, Otokiti MKO (1999). Proximate composition and some nutritionally valuable minerals of two varieties of *Capsicum annum*. (Bell and Cherry peppers). *Discov. Innov.*, 11: 75-81.
- Adriano DC (1986). Trace elements in the terrestrial environment. Springer -Verlag, New York, Berlin, Heidelberg, Tokyo.
- Aletor VA, Adeogun OA (1995). Nutrient and antinutrient components of some tropical leafy vegetables. *Food Chem.*, 53: 375-379.
- Aliyu HM (2006). Proximate analysis of some leafy vegetables (Roselle, Jute and Bitterleaf). *Int. J. Food Agric. Res.*, 3: 11-14.
- Andersen LT, Thilsted SH, Nielsen BB, Rangasamy S (2003). Food and nutrient intakes among pregnant women in rural Tamil Nadu, South India. *Public Health Nutr.*, 6: 131-137.
- AOAC (1999). Methods of Analysis of Association of Official Analytical Chemists (16<sup>th</sup> Edn), Washington, DC., 1: 600-792.
- Asibey-Berko E, Tayie FAK (1999). Proximate analysis of some under utilized Ghanaian Vegetables. *Ghana J. Sci.*, 39: 91-92.
- Block TD (1956). Methods of lipid extraction in plants. *Mycology*, 48: 337-343.
- Broyer TC, Johnson CN, Paull RE (1972). Some aspects of lead in plant

- nutrition. For. Sci., 21: 33-35.
- Cantilli R, Abernathy CO, Donohue JM, Mertz W (1994). Assessment of essential trace elements. Washington, DC. ILSI Press, pp. 113-125.
- De Vos CHR, Vonk MJ, Voojjs R, Schat H (1992). Glutathione depletion due to copper-induced phytochelatin synthesis causes oxidative stress in *Silene cucubalus*. Plant Physiol., 98: 853-858.
- Devadas RP, Saroja S (1980). Availability of Fe and  $\beta$ -carotene from *Amaranthus* to children. In, Emmaus P, Proceeding of the 2<sup>nd</sup> *Amaranthus* Conference, Rodala Press Inc., pp. 15-21.
- Etkin NL (1996). Medicinal cuisines: diet and ethno pharmacology. Int. J. Pharmacog., 34: 313-326.
- Faruq UZ, Sani A, Hassan LG (2002). Proximate composition of sickle pod (*Senna obtusifolia*) leaves. Nig. J. Basic Appl. Sci., 11: 157-164.
- FND (2002). Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein and Amino Acid (Micronutrients). Food and Nutrition Board, Institute of Medicine. National Academy of Sciences.
- Guil-Guerrero JL, Gimenez-Gimenez A, Rodriguez-Garcia I, Torija-Isasa ME (1998). Nutritional composition of *Sonchus* species (*S. asper* L, *S. oleraceus* L and *S. tenerrimus* L). J. Sci. Food Agric., 76: 628-632.
- Hussain J, Khan AL, Rehman N, Hamayun M, Shinwari ZK, Malik W, Lee IJ (2009). Assessment of herbal products and their composite medicinal plants through proximate and micronutrients analysis, J. Med. Plants Res., 3(12): 1072-1077.
- Hussain J, Ullah R, Rehman N, Khan AL, Muhammad ZF, Hussain ST (2010a). Endogenous Transitional Metal and Proximate Analysis of Selected Medicinal Plants from Pakistan. J. Med. Plants Res., 4(3): 267-270.
- Hussain J, Muhammad Z, Ullah R, Khan FU, Rehman N, Khan N, Naseem M, (2010b). Proximate composition and metal evaluation of four selected medicinal plant species from Pakistan. J. Med. Plants Res., 3(3): 138-141.
- Ifon ET, Bassir O (1980). The nutritive value of some Nigerian leafy green vegetables - Part 2. The distribution of protein, carbohydrates (including ethanol-soluble simple sugars), crude fat, fiber and ash. Food Chem., 5: 231-235.
- Ishida H, Suzuno H, Sugiyama N, Innami S, Todokoro T, Maekawa A (2000). Nutritional evaluation of chemical component of leaves stalks and stems of sweet potatoes (*Ipomoea batatas* poir). Food Chem., 68: 359-367.
- Isong EU, Adewusi SAR, Nkanga EU, Umoh EE (1999). Nutritional and phytochemical studies of three varieties of *Gnetum africanum* (afang). Food Chem., 64: 489-493.
- Laporte JC (1976). Effects of phytates on proteases. Ann. Bid. Anim. Biochem. Biophys., 16: 719-729.
- Ladeji O, Okoye ZS, Ojobe T (1995). Chemical evaluation of the nutritive value of leaf of fluted pumpkin (*Telferia occidentalis*). Food Chem., 53: 353-355.
- Lintas C (1992). Nutritional aspects of fruits and vegetables consumption. Options Mediterr., 19: 79-87.
- Lockeett CT, Calvert CC, Grivetti LE (2000). Energy and micronutrient composition of dietary and medicinal wild plants consumed during drought: Study of rural Fulani, Northeastern Nigeria. Int. J. Food Sci. Nutr., 51: 195-208.
- Luna CM, González CA, Trippi VS (1994). Oxidative damage caused by excess of copper in oat leaves. Plant Cell Physiol., 35: 11-15.
- Pearson D (1976). The Chemical Analysis of Foods, 7<sup>th</sup> ed. Churchill Living stone, London.
- Pizzaro F, Olivares M, Uauy R, Contreras P, Rebelo A, Gidi V (1999). Acute gastrointestinal effects of graded levels of copper in drinking water. Environ. Health Perspects, 107(2): 117-121.
- Prakash D, Pal M (1991). Nutritional and antinutritional comparison of vegetable and grain *Amaranthus* leaves. J. Sci. Food Agric., 57: 573-585.
- Roger P, Elie F, Rose L, Martin F, Jacop S, Mercy AB, Felicite MT (2005). Methods of preparation and nutritional evaluation of dishes consumed in a malaria endemic zone in Cameroon (Ngali II). Afr. J. Biotechnol., 4(3): 273-278.
- WHO (1998). Quality control methods for medicinal plant materials. World Health Organization, Geneva. ISBN 92 4 154510 0 (QV 766).