

A Comparative Study of Nutrients and Mineral Molar Ratios of Some Plant Foods with Recommended Dietary Allowances

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Abstract: The proximate composition and mineral constituents of *Asparagus officinalis* stem and *Momordica dioica* R. fruit were evaluated in order to standard methods. The stem contained an ashes: 10.70%, crude protein: 32.69%, crude lipid: 3.44%, crude fiber: 18.50%, and carbohydrates: 34.67%. Stem also has high-energy value (384.27kcal/100 g) dry weight. The fruits contained an ashes: 9.1%, crude protein: 5.44%, crude lipid: 3.25%, crude fiber: 22.9%, and carbohydrates: 59.31%. Comparing proximate and minerals contents of the stem and the fruit, the results indicated that *Asparagus officinalis* stem could be a good supplement for some nutrients such as protein, potassium, and carbohydrates. The stem could be promoted as a carbohydrate supplement for cereal-based diets in poor rural communities, while *Momordica dioica* R. fruits could be a good supplement for some nutrients such as Fibre, Potassium, Zinc, lipid, Protein and Carbohydrates. *A. officinalis* is suitable for high-temperature food processes.

Key words: *Asparagus officinalis* DC., *Momordica dioica* R., micronutrients, proximate, mineral composition

INTRODUCTION

In developing nations, numerous types of edible wild plants are exploited as sources of food hence provide an adequate level of nutrition to the inhabitants. Recent studies on agro pastoral societies in Africa indicate that these, plant resources play a significant role in nutrition; food security and income generation (Asibey-Berko and Tayie, 1999).

Furthermore, FAO report, at least one billion people are thought to use wild foods in their diet (Burlingame, 2000). In Ghana along, the leaves of over 300 species of wild plants and fruits are consumed. In Swaziland, wild plants provide a greater share of the diet than domesticated cultivars. In India, Malaysia and Thailand, about 150 wild plants species have been identified as sources of emergency food (Faruq *et al.*, (2002). Similarly, in South Africa about 1400 edible plant species are used, In Sahel region of Africa, over 200 wild foods were identified to be used by the rural communities (Sena *et al.*, 1998). In most of these reports, it was emphasized that nutritionally, these unconventional plants foods could be comparable to or even sometimes superior to the introduced cultivars (Edmonds and Chweya, 1995). It is, therefore, worthwhile to note that the incorporation of edible wild and semi-cultivated plant resources could be beneficial to nutritionally marginal populations or to certain vulnerable groups within populations, especially in developing countries where poverty and climatic changes are causing havoc to the rural populace. In this

context, analyses were carried out to evaluate the nutritional content of *Asparagus officinalis* stem and *Momordica dioica* fruit with hope that it would be incorporated into the food basket of the country (Funtua, 2004; Funtua and Trace; 1999; Faruq *et al.*, 2002; Ifon and Bassir, 1980). Aim of analysis of nutrients in the plant foods is preliminary assessment of nutritional value of the plant-based diets.

MATERIALS AND METHODS

Plant material: *A. officinalis* stem and *M. dioica*, fruits used as experimental material were collected from farm and Agricultural lands (garden) in around Behbahan, South Iran, in October 2007. The collected plant material was placed in a polyethylene bag to prevent loss of moisture during transportation to the laboratory.

Preparation of the plant materials for chemical analyses: *A. officinalis* stem and *M. dioica*, fruits were washed with distilled water and dried at room temperature to remove residual moisture, then placed in paper envelope and oven-dried at 55°C for 24 h (Abuye *et al.*, 2003; Aletor and Adeogun, 1995). The dried stem were ground into powder using pestle and mortar, and sieved through 20-mesh sieve. The stem powder was used for the nutrients analyzes.

Plant foods chemical analysis: The methods recommended by the Association of Official Analytical

Chemists were used to determine ash (#942.05), crude lipid (#920.39), crude fibre (#962.09) and nitrogen content (#984.13) (AOAC, 1990).

Determination of crude lipid and crude fibre content:

Two grams of dried stem or fruits were weighed in a porous thimble of a Soxhlet apparatus, with its mouthed cotton wool plugged. The thimble was placed in an extraction chamber, which was suspended above a pre-weighed receiving flask containing petroleum ether (b.p. 40-60°C). The flask was heated on a heating mantle for eight hours to extract the crude lipid. After the extraction, the thimble was removed from the Soxhlet apparatus and the solvent distilled off. The flask containing the crude lipid was heated in the oven at 100°C for 30 min to evaporate the solvent, then cooled in a dessicator, and reweighed. The difference in weight was expressed as percentage crude lipid content.

Crude fibre was estimated by acid-base digestion with 1.25% H₂SO₄ (prepared by diluting 7.2 ml of 94% conc. acid of specific gravity 1.835g/ml per 1000 ml distilled water) and 1.25% NaOH (12.5 g per 1000 ml distilled water) solutions. The residue after crude lipid extraction was put into a 600 ml beaker and 200 ml of boiling 1.25% H₂SO₄ added. The contents were boiled for 30 minutes, cooled, filtered through a filter paper and the residue washed three times with 50 ml aliquots of boiling water. The washed residue was returned to the original beaker and further digested by boiling in 200 ml of 1.25% NaOH for 30 minutes. The digest was filtered to obtain the residue. This was washed three times with 50 ml aliquots of boiling water and finally with 25 ml ethanol.

The washed residue was dried in an oven at 130°C to constant weight and cooled in a dessicator. The residue was scraped into a pre-weighed porcelain crucible, weighed, ashed at 550°C for two hours, cooled in a dessicator and reweighed. Crude fibre content was expressed as percentage loss in weight on ignition, (AOAC, 1990; Nesamvuni *et al.*, 2001).

Determination of nitrogen content and estimation of crude protein:

Macro-Kjeldahl method was used to determine the nitrogen content of the 2 g of dried stem or fruits stem were digested in a 100 ml Kjeldahl digestion flask by boiling with 10 ml of concentrated tetraoxosulphate (VI) acid and a Kjeldahl digestion tablet (a catalyst) until the mixture was clear. The digest was filtered into a 100 ml volumetric flask and the solution made up to 100 ml with distilled water. Ammonia in the digest was steam distilled from 10 ml of the digest to which had been added 20 ml of 45% sodium hydroxide solution. The ammonia liberated was collected in 50 ml of 20% boric acid solution containing a mixed indicator. Ammonia was estimated by titrating with standard 0.01 mol L⁻¹ HCl solution. Blank determination was carried

Table 1: Proximate composition of *Asparagus officinalis* stem

Parameters	Concentration (% DW) *
Ash	10.70± 0.80
Crude protein	32.69± 0.27
Crude lipid	3.44± 0.50
Crude fibre	18.50± 0.35
Carbohydrates	34.67±0.68
Calorific value(kcal/100g)	384.27±5.31

* The data are mean values± deviation(SD) of three replicates.

* Values expressed as % wet weight.

Table 2: Proximate composition of *Momordica dioica* fruit

Parameters	Contents
Ash	6.7±5.17
Crude protein	19.38± 0.27
Crude lipid	4.7± 0.50
Crude fibre	21.3± 0.35
Carbohydrates	47.92±0.68
Calorific value(kcal/100g)	311.5±5.31

* The data are mean values± deviation(SD) of three replicates.

* Values expressed as % wet weight.

out in a similar manner. Crude protein was estimated by multiplying the value obtained for percentage nitrogen content by a factor of 6.25 (AOAC, 1990).

Estimation of carbohydrates and energy values:

Available carbohydrate was estimated by difference, by subtracting the total sum of percent crude protein, crude lipid, crude fibre and ash from 100% DW of the plant the plant calorific value (kJ) was estimated by multiplying the percentages of crude protein, crude lipid and carbohydrate by the factors 16.7, 37.7 and 16.7 respectively (AOAC, 1990).

Mineral analysis: The mineral elements Na, K, Ca, Fe, and Zn were determined on 0.3g plant powder by the methods of Funtua. Using Energy Dispersive X-ray Fluorescence (EDXRF) transmission emission spectrometer carrying an annular 25 mCi 109Cd isotopic excitation source that emits Ag-K X-ray (22.1 keV) and a Mo X-ray tube (50KV, 5mA) with thick foil of pure Mo used as target material for absorption correction. The system had a Canberra Si (Li) detector with a resolution of 170 eV at 5.9 keV line and was coupled to a computer controlled ADC Card (Trump 8K).

Measurements were carried out in duplicate. Na was analyzed after wet digestion of one gramme of the stem powder with nitric/perchloric/sulphuric acid (9:2:1 v/v/v) mixture. Sodium was analyzed with a Corning 400 flame photometer (AOAC, 1990).

RESULTS AND DISCUSSION

Proximate analysis: The results of proximate composition of *A. officinalis* stem and *M. dioica* fruits are shown in Table 1 and 2. The ash content, which is an index of mineral contents, for *Portulaca oleracia* stem the value of 10.70% DW was more than to the values

Table 3: Mineral composition of *Asparagus officinalis* stem

Mineral	Recommended dietary allowances (mg/day) †				
	Available Quantity in mg/100 g DW*	Children 7-10 y	Adult male	Pregnant and Adult female	Lactating mother
Potassium	10.94±0.02	800	800	800	1200
Calcium	0.67±0.15	1600	2000	2000	2000
Sodium	1.840±0.08	400	500	400	500
Iron	0.19±0.01	10	10	15	13
Zinc	2.60±0.07	10	15	12	19

* The data are mean values± deviation(SD) of three replicates. † Sources: Thangadari *et al.* (2001)

Table 4: Mineral composition of *Momordica dioica* fruit

Minerals	Recommended dietary allowances (mg/day)**				
	Available quantity in mg/100 g DW*	Children 7-10years	Adult Male	Adult female	Pregnant and lactating Mothers
Calcium	0.46±0.02	800	800	800	1200
Potassium	8.25±0.15	1600	2000	2000	2000
Sodium	1.51±0.08	400	500	400	500
Iron	0.14±0.01	10	10	15	13
Zinc	1.34±0.07	10	15	12	19

*: The data are mean values± deviation (SD) of three replicates. **: Sources: Thangadari *et al.* (2001)

Table 5: Comparison of ratio of potassium/sodium, phytate/trace elements in eight edible plants with the recommended ratios

Edible plants	Recommended Ratio of potassium to sodium : 10:1	Recommended phytate/calcium molar ratio >0.24	Recommended phytate/iron molar ratio>1, 31	Recommended phytate/zinc molar ratio >15	Recommended phytate× calcium/ zinc >200
<i>Alocacia indica</i> Sch	3.4:4.4	3.55	6.5	2.58	2.27
<i>Asparagus officinalis</i> DC	10.94:1.84	5.07	17.95	1.31	0.88
<i>Portulaca oleracia</i> Linn	14.71:7.17	0.44	17.16	2.73	51.05
<i>Momordica dioica</i> Roxb	8.25:1.51	6.17	20.29	2.12	0.97
<i>Eulophia ochreatea</i> Lindl	4.63:1.62	0.35	0.51	0.69	4.92
<i>Solanum indicum</i> Linn	8.32:1.51	1.55	0.66	7.33	32.82
<i>Cordia myxa</i> Roxb	7.83:1.62	5.39	4.86	7.09	3.26
<i>Chlorophytum comosum</i> Linn	4.29:3.95	0.36	2.48	6.17	81.09

reported for other edible leaves such as *Momordica balsamina* leaves (18.00 ± 1.27% DW) where as for *M. dioica* fruits the value of 9.1% DW was less than the reported values (Aletor and Adeogun, 1995; Asibey-Berko and Tayie, 1999; Faruq *et al.*, 2002). It is apparent that *A. officinalis* stem is a good source of Potassium while *M. dioica* fruits are a good source of Potassium, and Zinc. The crude protein content of both edible plants was more than what is reported for some lesser known wild leafy vegetables such as *Momordica balsamina* (11.29 ± 0.07%), *Moringa oleifera* (20.72%), *Lesianthera africana* leaves (13.10 – 14.90%) and *Leptadenia hastate* (19.10%) (Pearson, 1999; Plessi *et al.*, 1999). Plant foods that provide more than 12% of their calorific value from protein are a good source of protein. In that context, *A. officinalis* stem (32.69%) and *M. dioica* fruits (19.38%) are good sources of protein. The crude lipid contents of both plant foods were less than the range (8.3 – 27.0% DW) reported for some vegetables consumed in Nigeria and Republic of Nigerian, (Isong and Idiong, 1997).

The estimated carbohydrate contents (34.67%) in *A. officinalis* stem and in *M. dioica* fruits were stand to be higher than that for *Senna obtusifolia* leaves (20%) and

Amaranthus incurvatus leaves (23.7%). On the other hand, *A. officinalis* stem and *M. dioica* fruits contain comparable amount of carbohydrate for *Momordica balsamina* (39.05 ± 2.01%). The crude fibre content in both plant foods was more than the reported values (8.50 – 20.90%) for some Nigeria vegetables, (Isong and Idiong, 1997). One discussed drawback to the use of vegetables in human nutrition is their high fibre content, which may cause intestinal irritation and a decrease of nutrient bioavailability. The fibre RDA values for children, adults, pregnant and breast-feeding mothers are 19-25%, 21-38%, 28% and 29% respectively. The calorific value of *A. officinalis* stem was estimated to be 384.27 kcal/100g (DW) and for *M. dioica* fruits was estimated to be 311.5 kcal/100 g (DW), which is an indication that it could be an important source of dietary calorie. High calorific content of the stem could be attributed to high carbohydrates and protein contents.

Mineral content: Table 3 and 4 show the results of the mineral concentrations of *A. officinalis* stem and *M. dioica* fruits. Nutritional significant of elements is compared with the standard recommended dietary

allowance. When compared with standard values as showed in Table 3 and 4, *A. officinalis* stem and *M. dioica* fruits less than adequate level of K, Fe, Zn, Ca, and Na, but the plant stem could be good source of K. Table 5 showed potassium to sodium Ratio, phytate/calcium molar ratio, phytate/iron molar ratio, phytate/zinc molar ratio and phytate \times calcium/zinc Ratio were relatively suitable in *Asparagus officinalis*, *Portulaca oleracia*, *Chlorophytum comosum*, *Solanum indicum*, and *Chlorophytum comosum* respectively. It is observed that these edible plants have good conditions and quality from bionutritional point of view.

CONCLUSION

The results of the nutritional analysis shown that *A. officinalis* stem is good sources of plant potassium, protein and carbohydrates where as *M. dioica* fruit is good sources of plant fibre, potassium, zinc, lipid, protein and carbohydrates. The results suggests that the plant fruits if consumed in sufficient amount could contribute greatly towards meeting human nutritional requirement for normal growth and adequate protection against diseases arising from malnutrition. From the result, *A. officinalis* stem and *M. dioica* fruits are recommend for continues used for nutritional purposes, considering to the amount and diversity of nutrients it contains. Chemical analysis alone however, should not be the exclusive criteria for judging the nutritional significance of a plant parts. Thus, it becomes necessary to consider order aspects such as presence antinutritional/ toxicological factors and biological evaluation of nutrient content, (Aberoumand and Deokule, 2008).

In conclusion, the edible plant suitable for different technological processes:

1- *A. officinalis* plant is suitable for high-temperature food processes, because it has very low carbohydrate concentrations—thereby reducing the possibility of Maillard reaction and then acryl amide formation (Mottram *et al.*, 2002).

2-*A. officinalis* should not be used in high-temperature processes and should be cooked without the peel. We suggest it's use for domestic purposes and home cooking.

Abbreviations

AOAC Association of Official Analytical Chemists
FAO Food and Agricultural Organization
RDA Recommended dietary allowances
DW Dried weight

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REFERENCES

- Aberoumand, A. and S.S. Deokule, 2008. Comparison of compounds of some edible plants of Iran and India, Pak. J. Nutr., 7(4): 582-585.
- Abuye, C., K. Urga, H. Knapp, D. Selmar, A. Omwega, J. Imungi and P.A. Winterhalter, 2003. Survey of wild, green, leafy vegetables and their potential in combating micronutrient deficiencies in rural populations. East Afr. Med. J., 80: 247-252.
- Aletor, V. and O. Adeogun, 1995. Chemical analysis of the fruit of *Vitex doniana* (Verbenaceae). Food Chem., 53: 375-379.
- AOAC, 1990. Official Methods of Analysis, 14th Edn., Association of Official Analytical Chemists, Washington DC. Arlington, Virginia, USA.
- Asibey-Berko, E. and F. Tayie, 1999. The antibacterial properties of some plants found in Hawaii. Ghana J. Sci., 39: 91-92.
- Burlingame, B., 2000. Comparison of total lipids, fatty acids, sugars and nonvolatile organic acids in nuts from *Castanea* species. J. Food Comp. Anal., 13: 99-100.
- Edmonds, J. and J. Chweya, 1995. Black nightshades, *Solanum nigrum* L. and related species. Promoting the conservation and use of underutilized and neglected crops. Taylor and Francis, London, pp: 221-234.
- Faruq, U., A. Sani and L. Hassan, 2002. Composition and distribution of deadly nightshade. Niger J. Basic Appl. Sci., 11: 157-164.
- Funtua, I., 2004. Minerals in foods: Dietary sources, chemical forms, interactions, bioavailability. Instrum. Sci. Technol., 32: 529-536.
- Funtua, I. and J. Trace, 1999. Quantitative variability in *Pisum* seed globulins: its assessment and significance. Plant Food. Hum. Nutr., 17: 293-297.
- Ifon, E. and O. Bassir, 1980. Determination of carbohydrates in foods. II-unavailable carbohydrates. Food Chem., 5: 231-235.
- Isong, E. and U. Idiong, 1997. Nutrient content of the edible leaves of seven wild plants from Nigerian. Plant Food. Hum. Nutr., 51: 79-84.
- Mottram, D.S., B.L. Wedzicha and A.T. Dodson, 2002. Acrylamide is formed in the Maillard reaction. Nature, 419: 449-450.
- Nesamvuni, C., N. Steyn and M. Potgieter, 2001. Nutrients analysis of selected western African foods, South Afr. J. Sci., 97: 51-54.
- Pearson, D., 1999. Nutrient and chemical composition of 13 wild plant foods of Niger. Ghana J. Sci., 39: 91-92.

- Plessi, M., D. Bertelli, A. Phonzani, M. Simonetti, A. Neri and P. Damiani, 1999. Role of indigenous leafy vegetables in combating hunger and malnutrition. *J. Food Comp. Anal.*, 12: 91-96.
- Sena, L., D. VanderJagt, C. Rivera, A. Tsin, I. Muhammadu, O. Mahamadou, M. Milson, A. Pastosyn and R. Glew, 1998. Nutritional profile of some edible plants from Mexico. *Plant Food. Hum. Nutr.*, 52: 17-30.
- Thangadurai, V., P.S. Beurmann and W.J. Weppner, 2001, Synthesis, Structure, and Electrical Conductivity of $A'[A_2B_3O_{10}]$ (A' =Rb, Cs; A =Sr, Ba; B =Nb, Ta): New Members of Dion–Jacobson-Type Layered Perovskites *J. Solid State Chem.*, 158(2): 279-289.