Journal of Food Technology 3 (3): 290-293, 2005

Composition of Bulk, Trace and some Rare Earth Elements in the Seeds of *Moringa oleifera* (Lam) *Detarium microcarpum* (Guill and Perr)and *Bauhinia monandra* (Kurz)

[1]B.A. Anhwange, [2]V.O. Ajibola and [3]S.J. Oniye
[1]Department of Chemistry, College of Advanced and Professional Studies, Makurdi, Nigeria
[2]Department of Chemistry,[3]Department of Biological Sciences, Ahmadu Bello University, Zaria, Nigeria

Abstract: The seeds of *Moringa oleifera* (Lam.) *Detarium microcarpum* (Guill and Perr) and *Bauhinia monandra* (Kurz.) were analysed for essential, essential trace and non-essential elements. *Detarium microcarpum* had high amount of potassium (105 mg g^{-1}), sulphur (1.63 mg g^{-1}) and iron (3.12 mg g^{-1}), while *B. monandra* had high amount of calcium (77.9 mg g^{-1}) magnesium (2.87 mg g^{-1}) and phosphorus (1.59 mg g^{-1}) sodium concentration as highest (2.999 mg g^{-1}) in *M. oleifera*. The concentration of essential trace elements in the seeds varied, the iodine (5.42 mg g^{-1}) was found to be highest in *D. microcarpum* and the lowest was molybdenum (0.011 mg g^{-1}) in *M. oleifera*. The concentration of the non-essential and rare earth elements (arsenic, lead, tin, nickel, bromine, vanadium, cobalt, rubidium, strontium, yttrium, zirconium, thallium and niobium) were found to be low (<0.70 mg g^{-1}) in the three seeds. The concentration of thallium was 1.10, 1.96 and 1.69 mg g^{-1} in *M. oleifera*, *D. microcarpum* and *B. monandra*, respectively. The results indicate that the mineral contents of these wild plants are comparable with average values of common fruits and seeds. Therefore, they could serve as supplementary sources of mineral nutrients for man and livestock.

Key words: *Moringa oleifera, Detarium microcarpum, Bauhinia monandra,* elements

INTRODUCTION

Several minerals are essential nutrients to both man and animal. Mineral elements such as calcium, magnesium, phosphorus, fluorine and sulphur constitute the structural components of body organs and tissues. They are also major constituents of body fluids and tissues and serve as electrolytes concerned with the maintenance of osmotic pressure, acid-base balance membrane permeability, muscle irritability and oxygen transport. Furthermore, they are found enzymes and hormone systems, forming the integral and specific components of metalloenzymes or less specific activator of these enzyme[1]. Eromosele[2,3] vegetables constitute the main chemical fraction of *C. obtusifolia* leaves. The values obtained in the present study fell within the 44-59% dw range reported for various Nigerian leafy vegetables and are in agreement , examined the mineral content of some fruits of *Sclerocarya birra* and *Adansonia digitata* and observed that these plants have high concentrations of calcium and phosphorus, while the iron contents were however 2 to 5 times higher than the values in common fruits. Smith *et al.*[4], determined concentrations of Cu, Fe, mg, Mn and Zn in wild and cultivated fruits and seeds of southern Burkina Faso and Niger Republics and compared their results with imported exotic reference goods of the study area and found that the edible wild plants contained higher mineral concentrations. Similarly, Glew *et al.*[5] worked on *Hibscus esculeretus* and *Bombax constatum* seeds and observed that they are excellent sources of zinc and calcium. *Moringa oleifera*, *D. microcapum* and *B. monandra* had earlier been reported to contain a high percentage of essential amino acids, oils and essential elements[6,7]. In this paper the composition mineral and some rare earth elements in the seeds of the wild *Moringa oleifera* Lam (family: Moringaceae), *Detarium microcarpum* Guill and Perr (family: Caesalpiniodeae) and *Bauhinia monandra* Kurz (family: Caesalpiniaceae) in Zaria, Nigeria is reported.

MATERIALS AND METHODS

Sample collection and preparation: The flowers, leaves pods and seeds of *M. oleifera, D. microcarpum* and *B. monandra* were collected from villages around Samaru-Zaria, Kaduna State, Nigeria. The samples were identified at the Herbarium of the Department of Biological Sciences, Ahmadu Bello University, Zaria. The

Corresponding Author: B.A. Anhwange,Department of Chemistry, College of Advanced and Professional Studies, Makurdi, Nigeria

seeds were obtained by breaking the pods and subsequently removing the seed coats. They were oven dried at 60°C in an air circulated oven for 48 h, then ground with porcelain mortal and pestle to fine particles and stored in screw-capped plastic containers.

0.2843 g of *M. oleifera,* 0.3150 g of *D. microcarpum* 0.2983 g of *B. monandra* were ashed and made into pellets of 19mm diameter using three drops of an organic binder (19% solution of styropone in toulene). The pelletisation was done using a pressure of about 10tons (204081.60 NM^{-2}) on a hydraulic press. The EDXRF method used is as described earlier[7]. Sodium and magnesium were determined by Atomic Absorption Spectrometry while sulphur and phosphorus were determined by standard colorimetric method[8].

RESULTS AND DISCUSSION

The result of the essential bulk elements (K, Ca, Na, mg, S, P and Fe) showed that the amount of potassium (105.0 mg g^{-1}), sulphur (1.63 mg g^{-1}) and Iron (3.12 mg g^{-1} were highest in *D. microcarpum.* Calcium (77.90 mg g^{-1}), magnesium (2.87 mg g^{-}) and phosphorus (1.59 mg g^{-1}) were highest in *B. monandra* (Table 1). Sodium concentrations in the seeds ranged between 3.0-2.32 mg g^{-1} with the highest value in *M. oleifera*. The essential element are needed in significant quantities to form part of the rigid body structure, soft tissues and body fluids. Reddy and Love[1], stated that the essential elements are needed for growth, formation of bones, teeth, blood and nerves. The healthy functionality of nervous transmission, blood circulation, fluid regulation, cellular integrity, energy production and muscle contraction are influenced by essential elements[9]. For example, the Food and Nutrition Board, National Research Council[10] noted that phosphorus contributes to many natural chemical body process such as phosphate bonds of ATP and provide the energy necessary for metabolism and recommended a daily intake of phosphorus for children aged (1-3 years) and lactating women to be 800 and 1,200 mg, respectively. Potassium plays a critical role in the transmission of nerve impulse, muscle contractions and maintenance of normal blood pressure; the recommended daily intake for potassium is 1000 mg for an average adult and its deficiency can caused excessive vomiting, chronic diarrhoea and kidney failure[11]. Lack of calcium in diet causes the break bones of bones for calcium necessary for life-preserving metabolic processes. The recommended dietary intake of calcium per day is 1000-1200 mg for pre-menopausal women and 1200-1500 mg for menopausal and

Table 1: Bulk elements concentrations (mg g^{-1})

Elements	*M. oleifera*	*D. microcarpum*	*B. monandra*
Potassium	77.400±2.460	105.000±2.990	74.200±2.460
Calcium	20.500±2.030	023.000±2.690	77.900±2.980
Magnesium	01.190±0.330	000.220±0.020	02.870±0.020
Sodium	02.999±0.007	002.384±0.270	02.319±0.070
Sulphur	03.750±0.004	001.625±0.078	04.170±0.005
Phosphorus	01.365±0.007	001.252±0.136	01.590±0.009
Iron	01.480±0.009	003.120±0.136	01.710±0.110

Table 2: Trace elements concentrations (mg g^{-1})

Elements	*M. oleifera*	*D. microcarpum*	*B. monandra*
Iodine	3.390	5.420	4.150
Copper	0.127±0.027	0.177±0.035	0.374±0.036
Manganese	0.374±0.1	2.78±0.18	3.520
Chromium	0.460	0.496	0.716
Molybdenum	0.011	0.67±0.012	0.011±0.004
Selenium	0.023	0.035	0.026
Zinc	0.570±0.027	0.635±0.033	0.535
Arsenic	0.042	0.051	0.058
Lead	0.061	0.074	0.085
Tin	0.035	0.362	0.364
Nickel	0.083±0.04	0.18±0.05	0.096
Bromine	0.019	0.023	0.020
Vanadium	0.519	0.753	0.769
Cobalt	0.120	0.187	0.186
Strontium	0.070±0.008	0.083±0.009	0.654±0.02

Table 3: Rare earth elements concentration

Elements	*M. oleifera*	*D. microcarpum*	*B. monandra*
Thallium	1.100	1.960	1.690
Rubidium	0.310±0.01	0.914±0.02	0.340±0.012
Yttrium	0.051	0.063	0.067
Zirconium	0.023	0.025	0.025
Niobium	0.011	0.017±0.006	0.010

postmenopausal women[12]. Excess calcium is stored in the body tissue and this adversely affect the body's immune function, cell growth and heart health[13,14]. According to Halliday[15], iron carries oxygen to the cells and it is necessary for the production of energy, synthesis of collage and functioning of the immune system. Its deficiency is common only among children and pre-menopausal women.

Magnesium is necessary for maintaining both the acid-alkaline balance in the body and healthy functioning of nerves and muscles (including the heart), as well as to activate enzymes to metabolize blood sugar, protein and carbohydrates[11]. Appreciable quantity of magnesium could be obtained from *B. monandra* and this quantity according to The National Research Council report is enough to supplement for proper bone growth, which is indirectly related to adequate calcium absorption. Generally, too litter of any of these elements can lead to deficiency diseases and too much of any can be toxic[9,11]. Iodine concentration was highest (5.42 mg g^{-1}) I n *D. microcarpum*, then *B. monandra* (4.15 mg g^{-1}) and in *M. oleifera* (3.93 mg g^{-1}) (Table 2). Iodine is needed in the body for proper functioning of the thyroid

gland and its deficiency could lead to enlargement of the gland and malformation of foetus during pregnancy and infancy leading to abnormalities in brain development and in children's growth[17]. The amount of copper in the seeds are generally low, i.e. *B. monandra* *D. microcarpum* and *M. oleifera* had, 0.374, 0.127 and 0.177 mg g^{-1}, respectively. The results compared well with the values obtained by Barker[17], for *M. oleifera.* Jones *et al.*[18], emphasized that copper is necessary for blood, nerves, joints heart, skin, liver and the immune systems. It is also critical to the absorption and utilization of both zinc and iron. Danks[19], observed that, the inability to produce important antioxidant enzymes and shortage of red blood cell has been implicated by copper deficiency and excess copper in the diet depress retention and utilization of zinc[20].

Manganese concentrations were 0.374, 2.780 and 3.52 mg g^{-1} for *M. oleifera*, *D. microcarpum* and *B. monadra*, respectively. Wansantwisut[16], indicated that, manganese is necessary for normal bone metabolism and important enzyme reactions, maintenance of normal nerve, brain and thyroid functions. Its deficiency is uncommon but can affect brain, glucose tolerance, normal reproduction, skeletal and cartilage formation[21].

The amount of chromium in the seeds was highest in *B. monandra* (0.716 mg g^{-1}), while *D. microcarpum* and *M. oleifera* had 0.496 to 0.46 mg g^{-1}, respectively. Chromium forms part of several enzyme system, including the glucose tolerance factor, w hich works with insulin in the utilization of blood glucose[22]. Its deficiency is linked to improper metabolism and imbalances of blood sugar.

Detarium microcarpum contained the highest amount of molybdenum 0.67 mg g^{-1}, while *M. oleifera* and *B. monandra* contained equal amount of molybdenum (0.011g g^{-1}). This element is involve in the operation of several key enzymes in the body. Its deficiency is uncommon but rare cases had been reported in people who suffer from mal-absorption conditions[23]. Selenium concentrations in the seeds ranged between 0.035-0.023 mg g^{-1}. selenium is a powerful antioxidant, which works closely with vitamin E and supports critical antioxidant enzyme functions. It also reduces the risk of abnormal cell growth and support cardiovascular health[24].

Zinc concentrations was highest in *D. microcarpum* (0.635 mg g^{-1}) than in *B. monandra* (0.535 mg g^{-1}) and *M. oleifera* (0.51 mg g^{-1}). According to Sandstead[20], zinc supports the health of the immune system, normal synthesis of protein and the health of reproductive organs (especially in men). The deficiency of zinc adversely affect normal physical growth, skin, nerve health, natural healing ability and immune function especially in infant[9].

The non-essential (arsenic, lead, tin, nickel, bromine, vanadium, cobalt and strontium) and rare earth elements (Table 3) have various concentrations ranging between 0.011 and 1.96 mg g^{-1}, thallium had the highest concentration in *B. monandra.* The rare earth elements are not yet recognized by health authorities as essential to human or livestock nutrition, but may have some valid health benefits however, vomiting, fatigue and headache could result if tin is consumed in large quantities and above threshold concentrations of cobalt in man could result in cardiac disease[25].

CONCLUSION

This study concludes that the seeds of *M. oleifera, D. microcarpum* and *B. monandra*, of Zaria, Nigeria are valuable sources of essential minerals nutrients which could be beneficial to the health of man and livestock. Further study is desired to elucidate specific nutritional and health implications of the rare earth elements in the concentrations they are found in the three seeds.

REFERENCES

1. Reddy, M.B. and M. Love, 1999. The impacts of food processing on the nutritional quality of vitamins and minerals. Adv. Exp. Med. Biol., 459: 99-106.
2. Eromosele, I.C., C.O. Eromosele and D.M. Kuzhkuzha, 1991. Evaluation of mineral elements and ascorbic-acid content in fruits of some wild plants. Plant Foods for Human Nutrition, 41: 151-154.
3. Eromosele, I.C. and C.O. Eromosele, 1993. Studies of the chemical composition and physio-chemical properties of seeds of some wild plants. Plants Food for Human Nutriton (Netherlands). 43: 251-258.
4. Smith, G.C., M.S. Clegg, C.L. Keen and L.E. Grivetti, 1996. Mineral values of selected plant foods common to burkina faso and to niamey, Niger, West Africa. Intl. J. Food Sci. Nutrition, 47: 41-53.
5. Glew, R.H., D. VanderJagt, C. Lockett, L.E. Grivetti, G.C. Smith, A. Pastuszn and M. Millson, 1997. Amino acid, fatty acid and mineral composition of 24 indigenous plants of burkina faso. J. Food Composition and Analysis, 10: 205-217.
6. Anhwange, B.A., V.O. Ajibola and S.J. Oniye, 2004a. Amino acid composition of the seeds of Moringa oleifera (Lam), *Detarium microcarpum* (Guill and Perr.) and *Bauchinia monandra* (Kurz). ChemClass J., pp: 9-13.

7. Anhwange, B.A., V.O. Ajibola and S.J. Oniye, 2004b. Nutritional potential of the seeds of *Bauchinia monandra* (Kurz). J. Food Technol., (in press), pp:
8. Allen, E.S., H.M. Grimshaw, J.A. Parkinson and C. Quarmby, 1974. Chemical analysis of ecological materials blackwell scientific publications, Ox ford, London, pp: 69-89.
9. Schauss, A., 1995. (White papers) Minerals, Trace Elements and Human Health. Life Science Press: Tacoma.W.A., pp: 2-23.
10. Food and Nutrition Board, National Research Council, 1989. Recommended Dietary Allowances 10th Edn. Wash. DC'. National Academy Press.
11. Shils, M.E, J.A. Olson and M. Shike, 1999. Modern Nutrition in Health and Diseases 9th Edn., Baltimone, M.D. Willians and Wilkins.
12. Nichel, K.P., S.S. Nielsen, C.A. Mitchell and M.A. Belury, 1996. Calcium bioavailability of vegan diets for a controlled ecological life-support system. FAEB. J. 10. A 232.
13. Tzonou, A., 1998. Dietary iron and coronary heart risk: A study from Greece. Am. J. Epidemiol., 147: 161-166.
14. Fleming D.J., 1998. Dietary determinants of iron store in a free-living elderly population: the Framingham Heart Sturdy. Am. J. Clin. Nutr., 67: 722-733.
15. Halliday, J.W., 1998. Hemochroatosis and iron needs. Nutrition Review, 58: S30-S37.
16. Wasantwisut, E., 1997. Nutrition and development. Other micronutrients effect on growth and cognition Southeast Asian J. tropical Med. Public Health, 2: 78-82.
17. Barke, H.M., 1996. Nutrition and Dietetics for Health Care. 9th Edn., Churchill Livingstone New York, N.Y. Danks, S.M. 1988. Copper deficiency in humans. Ann. Rev. Nutr., 8: 235-57.
18. Jones, A.A., R.A. Disilvestro and M. Oleman, 1997. Copper supplementation of adult men: effect on blood copper enzyme activity and indicators of cardiovascular disease risk.Metabolism, 46:1380-3.
19. Reddy, M. B. and M. Love 1999. The impacts of Food Processing on the nutritional quality of vitamins and minerals. Adv. Exp. Med. Biol., 459: 99-106
20. Sandstead, H.H., 1995. Requirement and toxicity of essential trace element, illustrated by zinc and copper. Am. J. Clin. Nutr., 61(supd):62s-64s.
21. Keen, C.L., J.C. Ensunsa and M.H. Watson, 1999. Nutritional aspect of manganese from experimental studies. Neurotoxicology, 20: 213-223.
22. Bahadori, B., 1997. Effect of chromium and chromium picolinate on body composition of obese, non-diabetic patient during and after a formula diet. Acta med. Austriaca, 24:185-187.
23. Sardesai, V.M., 1993. Molybdenum: An essential trace element. Nutr. Clin Pract., 8:277-281.
24. Korpela, A., J. Kumpulanen and E. Jussila, 1993. Effect of selenium supplementation after acute myocardial infarction. Res. Commun. Chem., 26: 226-8.
25. WHO, 1972. Health hazards of the human environment. World health organization. Geneva, Switzerland, pp: 72-89.