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Comparative Study on Essential and Trace Metals in Plant Nuts Consumed in Nigeria

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Abstract: In this study five nuts, groundnut (*Arachis hypogea*), coconut (*Cocos nucifera*), nutmeg (*Myristica fragrans*), walnut (*Juglans nigra*) and Afican nutmeg (*Monodora mynstica*) were investigated for the following metals: potassium, sodium, calcium, iron, zinc, lead, chromium and selenium using Perkin Elmer 3110 Atomic Absorption Spectrophotometer. Maximum amount of sodium was found in coconut (1685.86±80.6 mg/kg) and the lowest in African nutmeg (34.13±2.5 mg/kg). The highest Potassium and magnesium concentrations occurred in walnut at 3110.3±40.5 and 1164.4±55.6 mg/kg, respectively whilst the least potassium and magnesium was in African nutmeg (42.25±3.5 mg/kg) and nutmeg (4.56±0.06 mg/kg), respectively. Calcium was found highest in walnut (910.25±50.3 mg/kg) and lowest in African nutmeg (7.26±0.5 mg/kg). For iron and zinc the highest value occurred in walnut at 30.24±2.1 and 19.36±2.3 mg/kg, respectively and the lowest value for iron (6.25±0.4 mg/kg) and zinc (1.25±0.03 mg/kg) were for African nutmeg and nutmeg respectively. Apart from nutmeg that has Na/K ratio of 1.505 the other nuts had Na/K ratio of less than 1 with walnut having the lowest value. Thus it can be concluded that eating of walnuts may be beneficial for hypertensive individuals as it is rich in potassium which eliminates sodium which is highly implicated in elevation of blood pressure.

Key words: Nuts, metals, sodium/potassium ratio Hypertension

INTRODUCTION

Trace metal composition of food is of interest because of their essential or toxic nature. Accumulation of metals can have short and long term health risk and strict periodic surveillance of these contaminants is therefore advisable (Cabrera *et al*., 1995). Micronutrients constitute a small fraction of the entire diet but plays important role in different metabolic processes (Akhler *et al*., 2002). The metals play a vital role as structural and functional components of metalloproteins in living cells (Ansari *et al*., 2004). Zinc is a metal with great nutritional importance and is particularly necessary in cellular replication and the development of the immune response (Salgueiro *et al*., 2002). Iron is an essential constituent of haemoglobin, myoglobin and a number of enzymes. Iron is stored in body tissues to supply body needs. However, deficiency may occur from inadequate dietary intake or blood loss which results in anaemia and loss of well-being. Deficiency in infants and young children increases susceptibility to infection and impairment of growth (Goyer, 2013).

Nuts are considered by so many people as healthy snacks. They are the one seeded hard shelled fruits of some plants. Plant nuts are considered a major source of income and foreign exchange in many countries and are widely consumed around the world during all seasons (Jaffer and Salerem, 1987). Essential and toxic trace elements are present in low concentrations in these food materials depending upon their production site. Monitoring of trace metals in biological materials has gained importance in recent years either due to their role in controlling some vital biological processes or their potential toxicity for living organism (Khurshid and Qureshi, 1984). Due to the potential toxicities of some metals the joint FAO/WHO expert committee has set tolerable weekly intake limit of 3mg and 315-330 µg for lead and cadmium, respectively for human consumption (FAO/WHO, 1972).

Bioaccumulation of metals in man, animals and plants may result in metal poisoning. The health effects of this poisoning in man have been identified (Kaiser and Tolg, 1980; Magazumi and Smith, 1975; Macfarland, 1979; Forstner, 1980; Erickson *et al*., 1983). A high level of sodium in the diet raises blood pressure and the risk of chronic hypertension by stiffening arteries and blocking nitric oxide, which relaxes arteries. Hypertension contributes to heart disease and stroke which are leading causes of death. Potassium on the other hand, activates nitric oxide and thus reduces pressure in the arteries, lowering the risk of hypertension (Brody, 2011).

The deleterious effect of high sodium intake has been severally reported. Potassium has a beneficial effect on sodium balance. A high intake of potassium has been reported to protect against increasing blood pressure and other cardiovascular risks. Hence the sodium to potassium ratio (Na/K) in the body is of great concern for the prevention of high blood pressure. A Na/K ratio of less than one is recommended (Langford, 1983; Ogbuagu, 2010; Cappucio and Mc Gregor, 1991).

Available evidence indicates that there are significant differences in the mineral profile of nuts grown in different regions which suggest that environment and soil types have an important influence. Several reports are also available in literature on the mineral composition of nuts grown in Asia, Europe and America (Chung *et al*., 2013). However, there is limited information on the mineral composition of nuts commonly consumed in Nigeria which underscores the need for the present study. Due to variations in the composition of minerals in edible nuts, there is also a need for a comparative evaluation of their functional properties. Therefore the present study is aimed at comparing the mineral characteristics of some nuts commonly consumed in Nigeria with a view to identifying those that may be functionally useful in the management of high blood pressure.

MATERIALS AND METHODS

Five plant nuts which are generally grown in different parts of Nigeria were collected from a local market in Abraka, Delta State, Nigeria. They include groundnut (*Arachis hypejaee*), coconut (*cocos nucifera*), nutmeg (Myristica *fragrans*), walnut (*Juglans nigra*) and African nutmeg (*Monodora myristica*). African nutmeg is also called calabash nutmeg. Mineral analysis was done on the samples of each of the above nuts.

Sample preparation and procedure: Each of the samples was washed, cleaned and crushed to fine particles. The crushed samples were dried in an oven at temperature between 100-120°C and kept in plastic container before ashing. Ashing involved the introduction of the sample that has been crushed into a furnace at 200-400°C to burn off organic materials and convert them to inorganic oxides and carbonate for elemental analysis.

Digestion procedure: One gram of each plant nut sample was digested with 20 mL of acid digestion mixture of nitric acid, perchloric acid ($HClO_4$) and sulphuric acid (ratio 2:1:2 v/v). The mixture was heated in hot plate for homogeneity for about 3-5 min. Then the digested samples were allowed to cool for sometimes and the digests were filtered and the residues obtained. Further, the filtrate were diluted into a standard 50 mL volumetric flask and made up to mark with distilled deionized water, the filtrates were subsequently analyzed for their metal content using Perkin Elmer 3110 Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

The result of the metals found in the plant nuts are shown in Table 1.

Maximum amount of sodium was found in coconut (1685.86±80.6 mg/kg) followed by groundnut (621.82±15.4 mg/kg) followed by nutmeg (123.75±5.8 mg/kg), walnut (75.12±2.5 mg/kg) and the lowest amount of sodium was found in African nutmeg (34.13±2.5 mg/kg). The highest Potassium concentration occurred in walnut at (3110.3±40.5 mg/kg) followed by coconut (2431.7±100.5 mg/kg), groundnut (890.13±10.5 mg/kg), nutmeg (82.22±7.0 mg/kg) and lastly African nutmeg (42.25±3.5 mg/kg). Calcium was found highest in walnut (910.25±50.3 mg/kg) followed by coconut (32.48±5.2 mg/kg), groundnut (14.57±1.0 mg/kg), nutmeg (12.10±0.6 mg/kg) and African nutmeg (7.26±0.5 mg/kg).

Magnesium was highest in walnut (1164.4±55.6 mg/kg), followed by African nutmeg (20.33±1.2 mg/kg) followed by coconut (19.82±0.8 mg/kg) followed by groundnut (8.25±0.6 mg/kg) and the lowest was nutmeg (4.56±0.06 mg/kg). Zinc and iron were found in small amount in the nuts and the levels of iron were higher than that of zinc in each nut investigated.

For iron, the highest value was 30.24±2.1 mg/kg for walnut followed by 24.11±0.4 mg/kg for groundnut followed by 17.23±0.6 mg/kg for nutmeg followed by 10.24±0.3 mg/kg for coconut and the lowest value of 6.25±0.4 mg/kg was for African nutmeg. Thus the study showed that these nuts can supplement other sources of dietary iron. Iron is present in heamoglobin. Haemoglobin is the protein that transports oxygen in human blood from the lungs to the tissues of the body (Terwilliger, 1998). Iron is also a component of several enzymes involved oxidation-reduction reactions in cells (Schroder *et al*., 2003).

For zinc the highest value of 19.36±2.3 mg/kg was for walnut followed by 8.25±0.5 mg/kg for groundnut followed by 5.33±0.6 mg/kg for African nutmeg and the lowest value was 1.25±0.03 mg/kg for nutmeg.

Thus the results obtained revealed that potassium, calcium, sodium, magnesium and iron are abundant in walnuts. It follows therefore that an adequate serving of walnut would satisfy the Recommended Daily Allowance (RDA) for these minerals which are known to serve as cofactors for many physiologic and metabolic functions. For instance calcium has been shown to be useful in bone and teeth formation and maintenance (WHO, 2004; Pravina *et al*., 2013). Calcium is also important in blood clotting, muscle contraction and is a requirement for the activity of certain enzymes (WHO, 2004; Pravina *et al*., 2013).

The sodium potassium ratio of less than 1 has been suggested to support the reduction of hypertension (Drewnowski *et al*., 2012). Of the two elements, sodium and potassium, sodium is the element implicated in hypertension. Therefore it is necessary to determine the sodium potassium ratio in the selected nuts because the presence of enough potassium can eliminate sodium consequently removing its hypertensive ability. This is because potassium is higher than sodium in the electrochemical series. The values of the sodium/potassium ratio for the nuts are presented in Table 2.

Table 1: Plant nuts and metal concentrations

	Na	K	Ca	Mg	Zn	Pb	Cr	Se	Mn	Fe
Plant nuts	(mg/kg)									
Groundnut	621.82±15.4	890.13±10.5	14.57±1.0	8.25±0.6	8.25±0.5	ND	ND	ND	ND	24.11±0.4
Coconut	1685.86±80.5	2431.7±100.5	32.48±5.2	19.82±0.8	2.34±0.05	ND	ND	ND	ND	10.24±0.3
Nutmeg	123.75±5.8	82.22±7.0	12.10±0.6	4.56±0.06	1.25±0.03	ND	ND	ND	ND	17.23±0.6
Walnut	75.12±2.5	3110.3±40.5	910.25±50.3	1164.4±55.6	19.36±2.3	ND	ND	ND	ND	30.24±2.1
Afr. nutmeg	34.13±2.5	42.25±3.5	7.26±0.5	20.33±1.2	5.33±0.6	ND	ND	ND	ND	6.25±0.4

ND: Not detected, Afr: African

Table 2: Calculated values for Sodium/potassium ratio in the nuts

Plant Nut	Sodium/potassium ratio
Groundnut	0.699
Nutmeg	1.505
Coconut	0.693
Walnut	0.0242
African nutmeg	0.808

The low Sodium/Potassium ratio (0.0242) for walnut (Table 2) is a likely indication that it will be very good for the control of heart problems. However nutmeg with a sodium/potassium ratio of 1.505 is not advisable as food for people with hypertension or high blood pressure. The lower the sodium/potassium ratio the better the nut can be used in the control of hypertension. Besides walnut other nuts such as round nut, coconut and African nutmeg also had a sodium/potassium ratio of less than 1. This is a likely indication that they could be useful in the control of high blood pressure as potassium eliminates sodium from the body. Eating of nuts, vegetables and fruits and exercise have been reported to have good effect on high blood pressure (Whelton *et al*., 2002; Casas-Agustench *et al*., 2011).

Conclusion: The findings of the study showed that groundnut, coconut, walnut and African nutmeg are rich in potassium and other minerals. However most of the minerals were found to be more abundant in walnuts which also had the lowest sodium-potassium ratio. Thus it can be concluded that eating of walnuts may be beneficial for hypertensive individuals as it is rich in potassium which eliminates sodium which is highly implicated in elevation of blood pressure.

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REFERENCES

Akhler, P., M. Akram, S.D. Orfi and N. Ahmed, 2002. Assessment of dietary zinc ingestion in Pakistan, Nutr., 18: 274-278.

Ansari, T.M., N. Ikram, M. Najam-Ul-Haq, O. Fayyaz, I. Ghafoor and N. Khalid, 2004. Essential trace metals (Zn, Mn, Cu and Fe) Level in plants of medicinal importance. J. Boil. Sci., 4: 95-99.

Brody, J.E., 2011. Sodium saturated diet is threat to all, International New York Times, http://www.nytime.com 2011/12/27 health/L.

Cabrera, C., M.L. Lorenzo and M.C. Lopez, 1995. Lead and cadmium contamination in dairy products and its repercussion on total dietary intake. J. Agric. Food Chem., 43: 1605-1604.

Cappucio, F.P. and G.A. Mc Gregor, 1991. Does potassium supplementation lower blood pressure? A meta-analysis of published trials. J. Hypertens, 9: 465-473.

Casas-Agustench, P., P. Lopez-Uriarte, E. Ros, M. Bullo and J. Sala-Salvalo, 2011. Nuts, Hypertension and endothelial function. Nutr. Metab. Cardiovasc Dis., 21: 21-33.

Chung, K.H., K.O. Shin, H.J. Hwang and K. Choi, 2013. Chemical composition of nuts and seeds sold in Korea. Nutr. Res. Pract., 7: 82-88.

Drewnowski, A., M. Maillot and C. Rehm, 2012. Reducing the sodium-potassium ratio in the US diet: a challenge for public health. Am. J. Clin. Nutr., 96: 439-444.

Erickson, M.M., A. Poklis, A.W. Dickson and L.S. Hillman, 1982. Tissue mineral levels in vitamins of sudden death syndrome I toxic metal-lead and cadmium. Pediat Res., 17: 779-784.

FAO/WHO, 1972. Joint Expert Committee on Food Additives: Evaluation of certain food addictive and the contaminants, mercury, lead and cadmium WHO Tech. Rep. Ses., 505: 32-36.

Forstner, U., 1980. Cadmium, In: Hut ZO. (Ed) Handbook of Educational Chemistry, Heidelberger Platz: Springer Verlag, 3: 59-107.

Goyer, R.A., 2013. Eurometaux European association of metals. Which metals are essential to human health? http://www.eurometaux.org/metalstoday/meta.

Jaffer, M. and M. Salerem, 1987. Concentration of selected toxic metal in some vegetables and fruit of local origin. Pak. J. Agric. Sci., 24: 140-146.

Kaiser, G. and G. Tolg, 1980. Mercury In: Hut ZO (Ed) Handbook of Environmental Chemistry, Heidelberger Platz: Springer Verlag, 3: 1-58.

Khurshid, S.J. and H.I. Qureshi, 1984. The role of inorganic element in the human body. Nucleus, 21: 3-23.

Langford, H.G., 1983. Dietary potassium and hypertension epidemiologic data. Ann. Intern. Med., 98: 770-772.

Macfarland, H.M., 1979. Pulmony effects of cadmium In: Mennear JE (Ed). Cadmium toxicity, New York: Marcel Dekker, 113-132.

Magazumi, H. and U.A. Smith, 1975. Minamata disease a medical report: In: Smith WE, Smith AM. (Eds). Minamata. London: London, Chatto and Windus, 180-192.

Ogbuagu, M.N., 2010. The nutrient composition of the carva of Raffia palm weevil: Rhynchophorus phoenicis. J. Chem. Soc. Nigeria, 35: 97-100.

Pravina, P., D. Sayaji and M. Avinash, 2013. Calcium and its role in human body. Inter. J. Res. Pharm. Biomed. Sci., 4: 659-668.

Salgueiro, M.J., M.B. Zubillaga, A.E. Lysionek, R.A. Caro, R. Weill and J.R. Boceio, 2002. The role of zinc in growth and development of children. Nutr., 18: 510-519.

Schroder, I., E. Johnson and S. de Vries, 2003. Microbial ferric iron reductases. FEMS Microbiol. Rev., 27: 427-447.

Terwilliger, N.B., 1998. Functionaladaptations of oxygen-transport proteins. J. Exp. Biol., 201: 1085-1098.

Whelton, S.P., A. Chin, X. Xin and J. He, 2002. Effect of aerobic exercise on blood pressure: a meta-analysis of randomized, controlled trials. Ann. Intern. Med., 136: 493-503.

WHO, 2004. Vitamin and mineral requirements in human nutrition: cakcium, Geneva: World Health Organisation.