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Short Communication

MINERAL ELEMENTS AND HEAVY METALS IN SELECTED FOOD SEASONINGS CONSUMED IN MINNA METROPOLIS

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ABSTRACT

Eight samples of food seasonings: Ajinomoto, Maggi, Royco, Vedan, Knorr, Dinor, Onga stew, and Onga classic were obtained from Minna Central Market and were digested using standard laboratory techniques. Investigations on the concentrations of some mineral elements, Sodium, Potassium and Calcium and two heavy metals, Cadmium and Lead, were carried out using atomic absorption spectrophotometer. Royco had the highest calcium concentration (0.022+0.001µg/g), with Onga classic having lowest (0.002+0.00 µg/g). Potassium is highest (0.020+0.016 µg/g) in Vedan, and lowest (0.003+0.001 µg/g) in Ajinomoto. Sodium is highest (0.021+0.011 µg/g) in Dinor, and lowest (0.003+0.002 µg/g) in Knorr. Cadmium and Lead were both present in high concentrations in all the samples analysed. The presence of Cadmium and Lead in the food seasonings even at low concentrations could prove fatal through bioaccumulation.

Keywords: bioaccumulation, heavy metals, mineral elements, food seasoning, toxification

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INTRODUCTION

Food seasoning is a substance that adds flavour to food, for example salt, peppers, and other spices. Spices are vegetable substances of indigenous or exotic origin which are aromatic and have hot piquant tastes, used to enhance the flavour of foods or to add to them the stimulant

ingredient contained in them (Cobley, 2002). Seasonings can also be used to replace common salt in a great variety of other industrially prepared food items as well as in the preparation of foods both in restaurants, catering, home kitchen etc. Such seasonings are particularly suitable for soups, beefs, and other foods in which salty, and/or spiced seasonings are used. The ingredient mixture and seasonings when added to various food items change the food composition (Susan and Anne, 1998). The unique seasoning being vegetable product contains not only most of the substances in vegetable but also contains fractions which are not present in some vegetable products. It is this fraction that gives it the characteristic as a spice (Borget, 1993). Some mineral elements such as magnesium, calcium and potassium are necessary for enzyme activities and are included in food seasonings. Ingestion of foods with these combinations leads to a significant decrease in both cholesterol level and blood pressure. Mineral elements are inorganic elements that serve a variety of functions such as co-factors in enzyme catalysed reactions, in the regulation of acid-base balance, in nerve conduction and muscle irritability and as structural elements in the body e.g calcium (Merril and Morton, 2001). Accumulation of these mineral elements by excessive consumption can lead to long-term health risk. The heavy metals on the other hand have different effects on organisms, depending on the stage of development of the organism. Some of these effects of heavy metals are: carcinogenicity, neurotoxicity and reproductive failure. Metal such as cadmium derives its toxicological properties from its chemical similarity to Zinc (an essential micronutrient for plants, animals and man). Cadmium therefore replaces Zn in many of the reactions where Zn plays a role as a co-factor, thereby disrupting cellular activities. Lead on the other hand, manifests its toxicity in neurological, haematological, renal, endocrine and reproductive systems. Lead inhibits several of the enzymes involved in haem biosynthesis especially the synthesis of δ-aminolevulinic acid by aminolevulinic acid synthase to porphobilinogen (Vallee and Ulmer, 2006). Spices as seasonings constitute a huge component of trans-boundary trade in areas such as India, China, Indonesia, East and West Africa. In all parts of Nigeria, seasoning is used to prepare foods and some of these seasonings are believed to aid uterus contraction in pregnant women (Achinewy *et al.*, 1995). Although the risk of the food seasonings can only be identified after a long period, there is need for periodic assessment of their concentrations. The world Health Organisation (WHO, 1983) has therefore set an acceptable limit of 0.0 µg/g for cadmium and lead in food seasonings and 0.4 µg/g for calcium, potassium, and sodium. The National Agency for Food and Drug Administration Control (NAFDAC), has adopted these limits.

MATERIALS AND METHODS

Sample Collection

Eight samples of food seasonings were obtained from Minna Central Market. They include samples coded as: Ajinomoto, Royco, Maggi, Knorr, Dinor, Vedan, Onga stew and Onga classic.

Sample Digestion

2 g of food seasoning sample was weighed and transferred to the digestion tube. 10

ml of H_2O_2, 5 ml of H_2SO_4 and 5 ml of HCl were added to the sample. The digestion bottle was placed on the block digestor while the temperature rose to 160 ^oC. The sample was boiled for two hours. The digestate was allowed to cool, and filtered through Whattman No. 1 filter paper. The filtrate was transferred to the volumetric flask and made up to 100 ml using distilled deionised water (Smith and Schenk, 1998). The samples were kept in plastic bottles till ready for analyses.

Sample Analyses

Atomic absorption spectrophotometer (Schimadzu AA650) was used for the estimation of cadmium, lead, sodium, potassium and calcium as described in the Pye Unican Atomic Absorption data book (Whiteside, 1984), and in the introduction to atomic absorption spectrophotometer scientific equipment book.

Principle

Atomic absorption is a physical process involving the absorption by free atoms of an element of light, at a wavelength specific to that element. The sample to be analysed is digested and dissolved in an aqueous medium. The solution is placed in the instrument where it is heated to vaporize and atomize the elements. A beam of radiation is passed through the atomized sample, and the absorption of radiation is measured at specific wavelengths corresponding to the element of interest. Information about the type and the concentration of element is obtained by measuring the location of the peaks in the absorption spectra (Peter, 1979).

RESULTS

Ajinomoto had a concentration of 0.04µg/g of Calcium and Sodium, 0.03µg/g of Potassium and Lead and 0.02µg/g of Cadmium respectively. Royco had 0.03µg/g of Lead and Cadmium, 0.02µg/g of Calcium and 0.01µg/g of Potassium and Sodium respectively. Maggi had 0.02µg/g of Cadmium and Lead and 0.01µg/g of Calcium, Potassium and Sodium. Knorr, Dinor and Ongar Stew had 0.03µg/g of Lead, 0.02µg/g of Cadmium and 0.01µg/g of Calcium, Potassium and Sodium. Vedan had 0.02µg/g of Potassium, Sodium, Cadmium and Lead and 0.01µg/g of Calcium. While Onga classic had the highest concentration of Lead 0.05µg/g, Calcium and Cadmium 0.02µg/g, and Potassium and Sodium 0.01 µg/g respectively (Table 1).

Table: Concentration of Mineral Elements and Heavy Metals (μg/g) in Food Seasonings in Minna Central Market.

Food Seasoning	Calcium	Potassium	Sodium	Cadmium	Lead
Ajinomoto	0.04 ± 0.01	0.03 ± 0.01	0.04 ± 0.01	0.02 ± 0.01	0.03 ± 0.01
Royco	0.02 ± 0.01	0.01 ± 0.00	0.01 ± 0.00	0.03 ± 0.01	0.03 ± 0.01
Maggi	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.01	0.02+ 0.01
Knorr	0.01 ± 0.01	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.01	0.03 ± 0.00
Dinor	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.01	0.02 ± 0.00	0.03 ± 0.01
Vedan	0.01 ± 0.00	0.02 ± 0.02	0.02 ± 0.02	0.02 ± 0.02	0.02 ± 0.00
Onga stew	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.01	0.03 ± 0.02
Onga classic	0.02 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.00	0.05 ± 0.00

DISCUSSION

All the food seasonings sampled and analysed for heavy metals had values above the limit of 0.0 μg/g by NAFDAC. Bioaccumulation of this little but very significant concentration of lead in tissues of man can affect the activities of some enzymes like δ-aminolerulinic acid (involved in haem biosynthesis), superoxide dismutase (SOD), catalyse, glutathione S-transferase (GST) and glutathione. This accumulation may lead to reactions which generate reactive oxygen species (ROS), thereby leading to oxidative stress. Lead toxicity is known to inhibit the action of these enzymes because they have free sulphydyl groups. This is particularly noted with the precursors of haem, and leads to a decrease in haem synthesis, and hence to anaemia. Irrespective of the way a lead compound enters the body, it first penetrates the initial cellular barrier before reaching the intracellular fluid. The compound then penetrates the capillary blood vessels and thus enters the circulatory system which distributes it throughout the body (Petersdorf *et al.*, 1999). Majority of the lead compounds do not cause damage at the site where they enter the body. The absorption process is the beginning of the path consisting of distribution, biotransformation, accumulation, and elimination of the lead compounds. In order to provoke symptoms of poisoning, lead and its metabolite must first penetrate a target organ which is susceptible to its action, and at the same time the concentration of the toxin must be sufficiently high and appears at the site at a definite time. The target organ is the point of anatomical preference for the appearance of the symptoms of poisoning by lead or its compounds (De Silva, 2007). The health implication of cadmium in man is that it shares the same oxidation state and structural similarity with Zn (which is a beneficial heavy metal). And because of this, Cd readily replaces Zn in many reactions where Zn acts as a cofactor, thereby disrupting the cellular and enzyme activities. Following oral exposure of cadmium, the metal is transported in the blood by the erythrocytes or bound to low molecular weight proteins (e.g metallothionein). Cadmium is taken up by liver cells, and is slowly released back into the plasma.

Because of the small size of cadmium-metallothionein complex, it passes freely through the glomerulus, and into the renal tubule (Nordberg *et al.,* 2001). Cadmium bound to metallothionein is efficiently taken up in the tubule by the pioncytosis. Within the renal tubular cells, the pioncytosis vacuoles fuse with lysosomes which degrade the metallothionein, thereby freeing the cadmium. The cadmium then combines with the newly synthesized metallothionein produced by the tubular cells, and accumulates in the kidney for a long time. Metallothionein is inducible in the liver and kidney by the cadmium, and other metals (Yousuf and El-Shahawi, 2000). Cadmium is stored in the kidney, and liver and very little is eliminated from the body until renal toxicity occurs. Thereupon the renal excretion increases, and levels of cadmium diminish in the liver, particularly in the kidney (El-Hraiki *et al.,* 1992). Calcium, potassium, and sodium in food seasonings were below the NAFDAC limit of 0.4 µg/g and can be supplemented from other food sources especially fruits.

CONCLUSION

The presence of Pb and Cd in the sampled food seasonings even at the lower concentrations may lead to bioaccumulation in tissues with time, thereby altering various biochemical parameters in the liver and kidneys. Since the food seasonings are of vegetable origin, it is most likely that Pb and Cd were taken up by plants from the soil.

REFERENCES

Achinewy, J. and Denny, R. C. and Mendham, I. (1995). *Vogel's Quantitative Inorganic Analysis: Including Elementary Instrumentation Analysis*. 4th Edition. pp 123-134.

Borget, K. R. (1993). Dietary and Environmental Lead: Human Health Effect. Elsevier Science Publishers. Amsterdam.

Cobley, L. (2002). Stimulants in food seasoning. *Encyclopaedia Americana.* 17: 15-30. Grolier Inc: USA

De Silv, P. E. (2007). Determination of lead in plasma and studies on its relationship to erythrocytes. *British Journal of Industrial Medicine*. 38: 309-17

El-Hraiki, M., Kessabi, Y. S. and Bernard, P. (1992). Contamination of Sea Food Products by Cadmium, Chromium, Mercury, and Lead in morocco. *Review medical vetinary*, 143:49- 52.

Merril, J. C. and Morton, J. P. (2001). *Methods of Toxicology.* 41st Edition. Taylor and Francis Philadelphia.

Nordberg, K. Peterson, B. and Owen, V. (2001). Fish Mercury Distribution in Massachusetts, USA Lakes. *Environmental Toxicology and Chemistry,* 18 (17):1370-1379.

Peter, J. W. (1979). *An Introduction to Atomic Absorption Spectrophotometer*: Published by Pye Unicam Ltd. 1st Edition. pp 20.

Petersdorf, R. G., Martin, J. B. and Fauci, A. S. (1999). *Harrison Princilpe of Internal Medicine.* 2: 12th ed. McGraw-Hill, New

York pp 2182-7

Smith, D. L. and Schenk, W. G. (1998). *Association of Analytical Chemists*. Pp 55-59.

Susan, M. and Anne, P. (1998). *Tropical and Sub-tropical Foods*. 2nd Ed. MacMillan Publications New York 154 – 170.

Vallee, B. L. and Ulmer, D. D. (2006). Biochemical Effects of Mercury, Cadmium and Lead. *Journal of Biochemical Medicine,* 42: 54-60

WHO (World Health Organisation), (1983). Evaluation of certain food additives and contaminants (Forty-first Report of Committee on Food Additives). WHO Technical Report Series No. 837 Geneva.

Yousuf, M. H. A. and El-Shahawi, M. S. (2000). Trace Metals in Lithrinus Lengan Fish from Arabian Gulf: Metal Accumulation in Kidney and Heart Tissues. *Bulletin of Environmental Contamination and Toxicology,* 62: 293-300.