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Determination of chromium in some selected foods and vegetables in Zaria, Nigeria

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Abstract: The levels of Chromium (Cr^{+3}) in some selected foods and Vegetables in Zaria, Nigeria were analysed. Recent studies have shown a potential role of Chromium in maintaining proper carbohydrate and lipid metabolism at the molecular level. Vegetables such as *amaranthus* (gree) *hybridus,* cabbage, carrot, cucumber, okro, and lettuce and stuff such as rice, yam, sweet potato, Irish potato, black eye beans, '*acha'*(*Fonio/Digitalis exilis),* '*alubo'(*yam flour*), 'gari'* (cassava), maize, white bread, and '*semovita*'(wheat grit/flour) were purchased locally in Zaria market. Zaria is known for her rich soil nutrient.The Neutron Activation Analysis (NAA) of both the selected food and vegetable samples were carried out using the Nigeria Research Reactor-1 (NIRR-1), a low-power reactor. Chromium has a half-life of 27.7 days and belongs to long irradiation class. Samples were subjected to NAA irradiation for 6 hours and Delayed Gamma ray counting were carried out. Results obtained parts per milloin (in ppm) indicated the presence of Cr^{3+} and 13 other elements (Sc, Fe, Co, Zn, Rb, Sb, Cs, Ba, Eu, Yb, Lu, Hf, and Ta) in both food and green vegetable samples. Any p values less than 0.005 was considered significant. From the vegetables analysed, highest Cr^{3+} concentration was detected in Lettuce at 7.66±0.00, while carrot has the lowest concentration of 2.23±1.28 ppm. In food samples, Irish potato has the highest level of Cr^{3+} of 4.12±0.00, while rice has the lowest concentration of 0.71±0.64 ppm, which were found to be within acceptable limit of the WHO 200 µg/day, as dietary intake for adults. The study recommends that diabetic patients eat lots of lettuce, cucumber and cabbage with Irish potato due to their high Chromium content.

Keywords: Chromium, Carbohydrate and lipid metabolism, foods vegetables.

INTRODUCTION

Chromium (Cr^0), one of the most common elements in the earth's crust and seawater, exists in our environment in several oxidation states, principally as metallic (Cr^0), trivalent (Cr^{3+}) and Hexavalent chromium (Cr^{6+}). Hexavalent chromium (Cr^{6+}) is largely synthesized by the oxidation of the more common and naturally occurring trivalent (+3) chromium and is highly toxic. Trivalent (Cr^{3+}) chromium, found in most foods and nutrient supplements, is an essential nutrient with very low toxicity [1].

The interest in chromium as a nutritional enhancement to glucose and lipid metabolism can be traced to the 1950s, when it was suggested that brewer's yeast contained a glucose tolerance factor (GTF) that prevents diabetes in experimental animals [2].

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It was eventually found that biological active form which is trivalent chromium could substantially lower plasma glucose levels in diabetic mice [3]. Based on previous animal studies and preliminary human studies, supplemental chromium given for 2 weeks, ameliorated signs and symptoms of diabetics with markedly improved glycemic status and greatly reduced insulin requirements. The results of this study strongly indicated chromium (Cr^{3+}) as a critical co-factor in the action of insulin[3]. Trivalent chromium (Cr^{3+}) is found in a wide range of foods, including egg yolks, whole-grain products, coffee, nuts, green beans, meat, brewer's yeast and some branch of wines and beer [4]. Chromium is also present in many multivitamins, mineral supplements and there are also specific chromium Picolinate (CrP) supplements that contain 200-600µg/day for adult men and women, which is also the Estimated Safe and Adequate Daily Dietary Intake (ESADDI) of chromium for children aged 7 years of adulthood [5]. Americans normally ingest about ≈ 50-60% of the minimum suggested daily intake of 50μg/day, chromium absorption is about ≈0.4%, but the trivalent formulation also significantly influences bio-availability [6]. At a dose of 1,000μg/day, absorption of chromium from chromium chloride ($CrCl_3$) is about ≈0.4%, whereas that from Chromium Picolinate (CrP) may be as high as 2.8%. Once absorbed, chromium is distributed widely in the body with the highest levels being found in the kidney, muscle, liver, spleen and bone

MATERIALS AND METHODS

Sampling

The selected food and vegetable samples for this work were obtained after the harvest from August to September of the same year from Danmagaji, Tudun Wada and Sabon Gari markets in Zaria, Nigeria for the study. 500g of each grain, potato, yam tubers and vegetables were obtained from each market for the research. The grains from the food samples were freed from dust, properly dried and powdered into a suitable form for encapsulation.

Sample Preparation

The samples were then homogenized and sieved with sieve no. 6. The leafy vegetable samples were separated from the stem washed with distilled water to remove dust particles and air-dried. The tuber samples were pilled, cut into pieces and air-dried. The crushed leaves, powered grains and other dried samples were placed in a high density polyethylene 2/5 dram 1.5 ml vial, encapsulated and weighted using a Mettler balance and the vial heat sealed for irradiation.

Calibration Factors

The calibration factors for NAA were obtained using the Classic Relative method with standard reference material from NIST and IAEA – standard samples irradiated simultaneously with the samples for analysis[7].

Method of Standardization

The method employed to set standards for the analysis was Classic Relative Method [8] .Classic Relative method is based on simultaneous irradiation of the sample with standards of known quantities of the element of interest in identical positions, followed by measuring the induced intensities of both the standard and the sample in a well known geometric position.

Quantitative Determination of Chromium

Neutron Activation Analysis (NAA) method was used to determine the level of chromium (in ppm) present in the selected food and vegetable samples using the Nigerian Research Reactor-1 (NIRR-1), a low powered reactor [7].Apart from careful sampling handling, the sample was not subjected to any chemical treatment. The NIRR-1 reactor has been equipped with highly enriched Uranium (^{235}U) as fuel, while light water and Beryllium served as moderator and reflector respectively. Samples (200mg each) were weighed and wrapped in polyethylene films and into the $7cm^3$ rabbit capsules which were earlier cleaned by soaking in 1:1 HNO_3 for 3 days and washed with de-ionized water. Samples were irradiated for 6 hours in the small inner irradiation channels to take maximum neutron flux. As biological reference material, the neutron flux setting for long irradiation was adjusted below 5×10^{11} n/cm^2 s in order to increase detection sensitivity.

The stability of neutron flux throughout the period of irradiation, especially for long irradiation was checked by monitoring the neutron flux reading of a fission chamber connected to the micro-computer, controlled system.

RESULTS

Concentration of chromium in the samples

The mean concentration for food is between 0.7- 4.1 ppm. Irish potato has the highest concentration of (4.12 ± 0.00 ppm), while the lowest concentration of chromium was found in rice (0.71 ± 0.64 ppm) as shown in Fig.1. On the other hand, the mean concentration of chromium in the vegetable samples ranged from 2.23 – 7.06 ppm. The highest concentration of Cr was recorded in lettuce

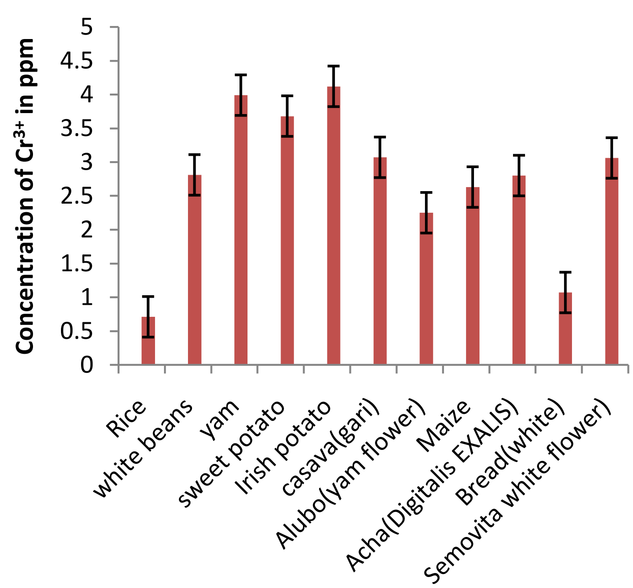

Fig.1:Levels of Cr^{3+} in different food samples

(7.66±0.00 ppm) while the lowest in carrot (2.23±1.28 ppm) as shown in Fig. 2.

Statistical Analysis

The result obtained are expressed as mean ± SEM and were analyzed using one way Analysis of variance(ANOVA) on SP SS11.5 statistical software.

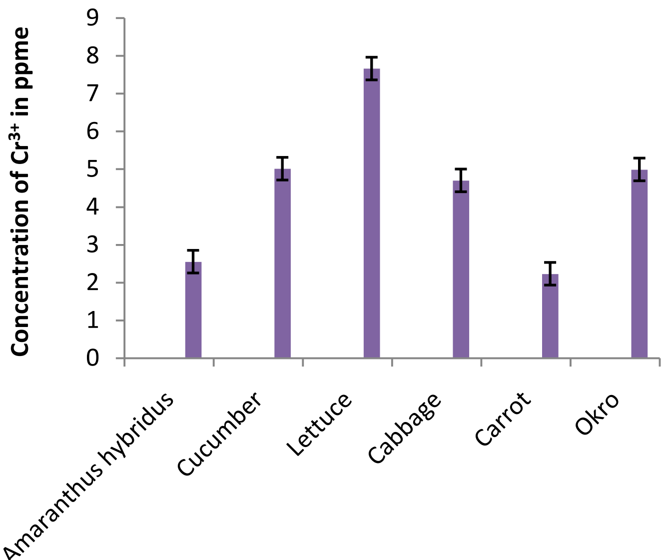

Fig. 2: Levels of Cr^{3+} in diferent vegetables

DISCUSSION

The results of NAA have indicated the presence of chromium in varying concentrations as shown in figures 1 and 2.

The Cr^3 level obtained in selected food samples were lower than those obtained from selected vegetables. Figure 1 result indicated that Cr level in the samples was highest in Irish potato (4.12±0.00) and the lowest is Rice (0.71±0.00 ppm). Next to Irish potato was Sweet potato (3.68±0.00 ppm), then 'gari' (Cassava) (3.07±0.00 ppm), *'Semovita'*(Wheat grit/flour) (3.06±0.00 ppm), Yam (3.70±1.45 ppm), Beans-white (2.81±0.00 ppm), '*acha'*(*Digitalis exilis)* (2.80±0.00 ppm), maize (2.636±0.0000 ppm), '*alubo'*(Yam flour) (2.25±1.72 ppm) and Bread-white (1.07±0.89 ppm). Rice has been observed to be one of the foods not encouraged as meal on dietary control for diabetic patients, perhaps due to its low level of Cr^{3+} and high starch content. The level of Cr^{3+} in food samples was generally lower when compared to those of vegetables, but both are within the acceptable limits of WHO for Cr daily intake of 250μg/day and 0.5 mg/day of European Food Safety Association (EFSA).Since most of the selected food samples studies for this analysis are common stable food in our society, the Estimated Safety Dietary Daily Intake (ESDDI) should seriously be the parameter under consideration. Most of our stable foods do not go beyond secondary preparations, and devoid of excessive treatment was the main driving force for selecting this analytical method of Neutron Activation Analysis (NAA).

The results of vegetables indicated a higher concentration of chromium in most of the samples. Lettuce has the highest concentration of Cr (7.66±0.00 ppm), followed by Cucumber (5.01±0.00 ppm), Okro (4.99±0.00 ppm), Cabbage (4.70±0.00 ppm) and Spinach (2.55±1.21 ppm), while the lowest was detected in Carrot (2.23±1.28 ppm). These values were still within acceptable limits of the Scientific Committee on Food (SCF), EFSA and the Joint FAO/WHO Expert Committee on Food Additives (JECFA) estimated dietary exposure to Nitrate of chromium (159 mg/day).In dietary control for management of diabetes, it was often suggested that the staple food daily intake be taken with a lot of vegetable as indicated by the result of this work. In view of the Cr contents present in vegetables, the Cr level in Lettuce, Cucumber, Okro and Cabbage (7.66±0.00, 5.01±0.00, 4.99±0.00 and 4.70±0.00 ppm) respectively should be noted by the dieticians. Certain long irradiation samples have standard detection limit for the low-power reactor, which was easily achieved in most geochemical samples[7,9].The Neutron Activation Analysis (NAA) Report gave details of the concentrations of Cr in the selected food and vegetable samples, though the levels of Cr^{3+} in all the samples were < 10 ppm.

In conclusion, dietary control and counselling on foods, particularly vegetables with significant level of Cr^{3+} would go a long way in the management of diabetes mellitus in our society.

REFERENCES

1.Cefalu, W.T., Hu, Frank.B (2004). Role of Chromium in Human Health and in Diabetes. *Diabetes Care, American Diabetes Association* 27 (11) 2741-2751.

2.Schwartz, K. Mertz, W. (1959) A glucose tolerance factor and its differentiation from factor 3. *Arch Biochem Biophys* 72: 515–518

3.Tuman, R. W., Bilbo, J. T., Doisy, R. J. (1978): Comparison and effects of natural and synthetic glucose tolerance factor in normal and genetically diabetic mice. *Diabetes* 27: 49–56.

4..Garba, M.A, Moji,T.B,Garba,M and Abel,S.A. (2008).Levels of chromium in fruits, meat products and drinks.Nig.j.pharm.Sc.7:22- 28.

5.Anderson, R. A., Cheng, N., Bryden, N. A. (1997). Elevated intakes of supplemental chromium improve glucose and insulin variables in individuals with type 2 diabetes. *Diabetes*, 46(1) 786–791.

6.Anderson,R.A, 1986. Chromium metabolism and its role in disease processing in man Clin pyhsiol Biochem4:31-41.

7.Jonah S. A., Umar, I. M., Oladipo, M. O. A., Balogun, G. I., Adeyemo. D. J., (2005). Standardization of NIRR-1 irradiation and counting facilities for instrumental neutron activation analysis.. Centre for Energy and Training. Ahmadu Bello University, Zaria Nigeria. *Applied Radiation and Isotopes* 64:818-822.

8.Malner, T. J .(1998) Chromium and Other Minerals in Diabetes Mellitus. U.S. Pharmacist. A Jobson Publication. www.minerals and diabetes.

9.Glascock, M. D. (2003). *An overview of Neutron Activation Analysis*. University of Missouri Colombia. MO 65211.