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Zinc and chromium in commonly used food items, intake by Sri Lankan adults and their levels in serum

By

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DECLARATION BY CANDIDATE

The work described in this thesis was carried out by me under the supervision of Dr. (Mrs.) M.I.F.P. Jayawardene, (Department of Biochemistry, Faculty of Medical Sciences, University of Sri Jayewardenepura) and Dr. K.A.S. Pathiratne (Department of Chemistry, University of Kelaniya) and a report on this has not been submitted in whole or in part to any university or any other institution for another Degree/Diploma.

10: 07: 2008

Date

Signature of candidate

DECLARATION BY SUPERVISORS

We certify that the above statement made by the candidate is true and that this thesis is suitable for submission to the University for the purpose of evaluation.

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ABBREVIATIONS

24 HR	- 24 hour recall
AAS	- Atomic absorption spectrometry
AOAC	- Association of Official Analytical Chemists
APDC	- Ammonium pyrrolidine dithiocarbamate
ASV	- Anodic stripping voltammetry
BMI	- Body mass index
BMR	- Basal metabolic rate
BW	- Body weight
CAD	- Coronary artery disease
CMP	- Capacitively coupled microwave plasma
CRM	- Certified reference materials
CSV	- Cathodic stripping voltammetry
DCS	- Department of Census and Statistics of Sri Lanka
DH	- Diet history
DP-ASV	- Differential-pulse Anodic stripping voltammetry
EDTA	- Ethylene di-amine tetra acetic acid
EHC	- Environmental health criteria
ESADDI	- Estimated safe and adequate daily dietary intake
ETAAS	- Electrothermal atomic absorption spectrometry
FAAS	- Flame atomic absorption spectrometry
FAO	- Food and Agricultural Organization
FFQ	- Food frequency questionnaires
FI	- Flow injection
GTF	- Glucose tolerance factor
HDL	- High density lipids
IAEA	- International Atomic Energy Agency
ICDA	- International Chromium Development Association
ICP-AES	- Inductively coupled plasma atomic emission spectrometry
ICP-MS	- Inductively coupled plasma mass spectrometry
INCLEN	- International Clinical Epidemiological Network
IOS	- International Organization for Standardization

LOD	- Limit of detection
LOL	- Level of linearity
MRI	- Medical Research Institute
NAA	- Neutron activation analysis
NHANES III	- The third national health and nutrition examination survey
NRC	- National Research Council
RDA	- Recommended dietary allowances
SD	- Standard deviation
SEM	- Standard error of mean
SF-ICP-MS	- Sector-field inductively coupled plasma mass spectrometry
US-EPA	- Environmental Protection Agency, United States
VAD	- Vitamin A deficiency
WHO	- World Health Organization
XRF	- X-ray fluorescence

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ABSTRACT

Zinc and chromium are two essential trace elements required in modest amounts to maintain health and optimal physical function of humans. Trace elements either toxic or essential, reach the human body through foods, drinks, ambient air and other occupational and accidental exposures. There are no reported data on levels of these metals in foods, environmental samples, and dietary intake levels of the population with their serum levels in Sri Lanka. The aim of the present study is to determine Zn and Cr in commonly used food items and to determine the intake and the levels of Zn and Cr in serum of Sri Lankan adults and compare their intake levels with respect to serum levels of Zn and Cr.

Individual food items (categorized into groups) were analysed for Zn and Cr using flame atomic absorption spectrometry (FAAS) and electrothermal atomic absorption spectrometry (ETAAS) respectively. Accuracy and validity of the results were examined by analyzing certified reference materials [IAEA–155, Whey powder and IAEA–140/TM, Sea weeds (*Fucus sp.*)], which gave expected values.

Dietary energy, protein, Zn and Cr intake were measured by using twenty-four-hour recall method (24 HR) in a selected group of Sri Lankan adult men and women age 20 to 59 years. In order to compare the reported dietary intakes of Zn and Cr, market baskets containing more than a hundred food items included in the average Sri Lankan diet were purchased from 4 locations: Colombo, Kandy, Dambulla and Balangoda.

Freeze dried homogenates representative of each basket of food from each location were then dry ashed and analysed for Zn and Cr elements using FAAS and ETAAS respectively.

The 24 HR reported mean dietary Zn intakes of Sri Lankan adult men and women were 8.6 ± 1.7 mg/day and 7.2 ± 1.3 mg/day respectively. Market basket results reported the average Zn level to be 9.4 ± 0.2 mg/day. Based on the 24 HR, the mean dietary Cr intakes of Sri Lankan adult men and women were 65.3 ± 32.3 μg/day and 62.6 ± 34.6 μg/day respectively. Market basket results reported the average Cr level to be 70.0 ± 1.0 μg/day. These reported Zn and Cr intakes were comparable with several research studies conducted worldwide. The results of the dietary intake survey indicate that the dietary intake of Zn is lower than the recommended dietary allowance (RDA) of Sri Lanka and intake level is nearly 60 % for men and 72 % for women. In all the cases, the reported Cr intake levels were above the lower limit of the safe and adequate daily dietary intake levels of 50 – 200 μg/day suggested by the National Research Council, USA (1989).

In estimation of the serum levels of Zn and Cr, serum samples were diluted with a mixture of 1% HNO_3 and 2% Triton X-100 and analysed for Zn and Cr using FAAS and ETAAS respectively. For the whole population mean serum Zn for men and women were 93.8 ± 3.0 μg/dl and 91.4 ± 3.2 μg/dl respectively. Reported mean serum Cr for men and women were 4.4 ± 0.3 $\mu g/dm^3$ and 3.9 ± 0.2 $\mu g/dm^3$ respectively. In this limited number of samples, serum Zn and Cr levels decreased with age. In order to decide the correlation between Zn and Cr intake of individuals with their respective values in serum, further extensive research including bioavailability studies are needed.