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POTENTIOMETERIC STRIPPING ANALYSIS FOR SELECTED HEAVY METALS IN TROPICAL CEREALS AND LEGUMES

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Tropical cereals and legumes available at Peshawar were assayed for heavy metals such as lead, copper, cadmium and zinc using potentiometric stripping analysis technique. Among cereals, maize grains contained maximum amounts of lead (0.72 µg g⁻¹) and cadmium (0.09 µg g⁻¹) and the minimum values of these metals were in barley grains. Maximum amounts of copper (8.10 µg g⁻¹) and zinc (38.5 µg g⁻¹) were in the wheat while the lowest amounts were in rice grains. Among legumes, maximum amounts of lead was in lentil (0.078 µg g⁻¹), copper in soybean (12.9 µg g⁻¹), cadmium in chickpea-white (0.04 µg g⁻¹) and zinc in soybean (40.2 µg g⁻¹). Determination of coefficient of variation among vegetables and legumes revealed generally wide differences for lead and cadmium than copper and zinc.

INTRODUCTION

The determination of heavy metal levels in food materials is becoming increasingly important from nutritional and health hazard considerations. This group of metals includes both the essential and toxic elements. Although it is difficult to classify trace metals into essential and toxic group, yet it is well known that an essential metal becomes toxic at SUfficiently high intakes (Khurshid and Qureshi, 1984). Increasing industrialization and

motorization have greatly polluted the environment with several toxic trace elements. These toxic elements frequently interact with each other and essential trace elements at the absorptive and tissue levels, which makes the work more difficult for laying single minimum and single maximum intake stardards (Buchet et al., 1983). An excellent account of the limiting levels appeared in the WHO technical report (1980). Monitoring of trace element levels of foodstuffs is a routine practice in several countries. High correlations between atomic absorption spectrophotometry (AAS) and potentiometric stripping analysis (PSA) techniques for the analysis of heavy metals in biological materials has already been described (Danielsson et al., 1981). The objective of this study was to determine concentration of cadmium, lead, copp.er and zinc in some commonly used food grains available at Peshawar using the PSA.

MATERIALS AND METHODS

The sample of different cereals and legumes were obtained from the market at Peshawar. They were sorted, cleaned, and dried in an oven. The dried material was ground to pass through 40 mesh in Willey mill. The ground samples were kept in plastic bottles for further analysis. Moisture was determined by drying the samples at 105°C in an oven. For heavy metal assay, wet digestion of the samples was done according to the method of Sattar and Chaudhry (1978) in a mixture of HNO] and HCL0I.(Simaltaneous determination of cadmium, copper, read and zinc was carried out by the potentiometric stripping technique (Jangner and Aren, 1979) using Tecator striptec system comprising glassy carbon electrode, saturated calomel electtrode (SCE) and platinum wire as counter electrode. The stripping curves were measured at potentiall-1.1 volt vs SCE and 180 seconds plating time for cadmium, copper and lead while-1.3 volt VS SCE and 180 seconds plating time for zinc. The concentrator of these metals was determined by means of normal equations employing standard addition method (Danielsson et al., 1981).

RESULTS AND, DISCUSSION

Moisture and heavy metal of some selected cereals cornonly

consumed in .Pakistan are presented in Table-L The data revealed that moisture percentage ranged 8.35 - 14._~3.The concentration of lead varied from 0.009 to 1.72 J.lg g . The highest level of lead was in maize and least in bajra, while the other cereals or their products contained intermediate level of this met~. The copper content was the hight::.~t in- wheat grain (8.1 US g) and least in bajra grain (1.2 J.lg g). *Ir,e* range value of copper in other cereals was 1.35 - 5.5 J.lg g). Tht::.{admium content in different cereals ranged 0.006 - 0.09 J.lg g , the least being in whole-wheat flour and highest in the maize grains. The conct::.~- tration of zinc in the cereals varied from 6.97 to 38.5 J.lg g ; the highest was in wheat grains and lowest in the bajra grains. In order to make an estimate of dispersion of the amount of individual element in relation to the food material, the co- efficient of variation (CV) was measured. This revealed striking differences in the content of heavy metals and moisture especial- ly the toxic elements such as lead and cadmium. Determination of CV is especially appropriate under conditions where there are extreme values or when it is desired to express variation as a percentage of the average around which the deviations are taken.

The moisture and heavy metals content of various legumes are shown in Table-2. It was found tha_t the heavy metals of various legumes varied from 8.66 to 13.67 ~ g . The highest percentage of moisture was in chickpea-white and lowest in the mungbean. The range value for moisture in these legumes was 8.75 - 10.69?p. The concentration of lead varied from 0.015 to 0.078 l4.¥g- . The values of copper were between 3.58 and 17.7 J.lg g ; the highest level was in frenchbean and least in the mungbeanand intermediate in other legum_is. The cadmium content varied between 0.002 and 0.04 J.lg g ; the highest amount was in the chickpea-white and least in the mash. Other legumes contained intermediate levels of ,Sfdmium. In the case of zinc, the values ranged 23.8 - 40.2 u g g in all the legumes tested. The measure- ment of CV revealed highest variation in the cadmium followed by lead, copper, zinc and moisture.

According to the Food and Nutrition Board (1974), the average daily requirement of zinc is 15 mg and that of copper about 1 mg. On the basis of dietary consumption patterns in different sections of society in Pakistan, the mean zinc, copper

Table 1. Moisture and heavy metal contents of [illegible].

Material	Moisture % *	Lead	Copper (μg g^{-1})	Cadmium	Zinc
Maize-grain	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mean	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

1. Values for heavy metals are on moisture free basis.

Coefficient of variability (CV) = $\frac{\text{standard deviation}}{\text{Mean}} \times 100$

Table 2. *Moisture and heavy metal content of legumes*[1].

Materials	Moisture %	Lead	Copper	Cadmium	Zinc
Chick-pea	13.67±.21				
Chickpea-black	9.64±0.85				
Soybean	8.75±0.36				
Mungbean	8.66±.56				
Lentil	10.66±0.42				
Kidneybean	10.58±0.56				
Mash	10.44±0.35				
Small bean	9.49±0.56				
Mungbean	10.69±0.42				
French bean	10.50				
[illegible]	[illegible]	0.034	[illegible]	[illegible]	30.54
CV.	[illegible]		36.76	[illegible]	

1. Values for heavy metals are on moisture free basis.

Coefficient of variability (CV) = $\frac{\text{standard deviation}}{\text{Mean}} \times 100$

contents of these food stuffs would easily meet recommended daily requirements. The joint FA0/WHO Expert Committee (1972) had set tolerable weekly intake limits for lead and cadmium as 3 mg and 315 - 330 g respectively per person. The maximum limits for lead and cadmium in diff~rfnt types of foods were prescribed to be 20.0 and 6.0 mg kg respectively in Pakistan (Govt. Pak,- 1979). However, the maximum t~erance limit set by the PCSIR (1980) for lead was 8.0 mg kg- • Lead in generally known to persist on materials even at large distances from the road as a consequence 01 the transport of aerosol matter, whereas cadmium pollution is an environmental concern only for leafy crops close proxlrnitv to the edge of a road. The overall view of the concentration of these toxic- metals such as lead and cadmium revealed th•it the values were generally below the recommended standards. However, it is, imperative that regular and comprehensive ml)nitoring of heavy metals in a wide variety of food materials .. in relation to different localities be carried out in order h) establish possible health hazards due to pollution.

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