International Journal of Chemistry and Applications.
ISSN 0974-3111 Volume 6, Number 2 (2014), pp. 103-107

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Determination of Trace Amounts of Cadmium in Fruits, Vegetables and Cosmetic Products by Using Atomic Absorption Spectrophotometry

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Abstract

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Cadmium poses a particular risk to the health of humans and animals because it is easily absorbed. In the present communication determination of trace amounts of cadmium in fruits, vegetables and cosmetic products by using Atomic absorption spectrophotometer (AAS) was described. The different fruits, vegetables and cosmetic samples were collected from the agricultural fields and local markets of Visakhapatnam, Andhra Pradesh, India. Solid phase extraction technique was applied for drawing the analyte solution. It was observed in vegetables like cabbage and carrot high levels of cadmium (1.02-3.24 mg/Kg) were present. The cadmium levels in different cosmetics were found in the range of 0.84-1.02 µg/g for talcum powder, 3.48-4.2 µg/g for soap and 01-0.27 µg/g for shampoo. The possibility of skin allergy may increase due to the presence of heavy metals especially cadmium in cosmetics.

Keywords: Cadmium determination, fruits, vegetables, cosmetic products, AAS

Introduction:

Essentially, the heavy metals have only become a focus of public interest since analytical techniques have made it possible to detect them even in very small traces. The relatively reckless handling of heavy metals and their compounds in former times can partly be explained by the fact that their effects were unknown. Today, analytical detection is possible down to a thousandth of a mg/kg for certain matrixes. This has made it possible for toxicologists, in animal experiments, to follow up the effects of

individual substances down to the smallest concentrations. Vegetables and fruits are the important ingredients in human diet and it contains essential nutrients and trace elements. The problem of environmental pollution due to toxic metals has begun to cause concern now in most major metropolitan cities. The most notorious heavy metal contaminants are mercury, lead, and cadmium. They tend to be dangerous because they bioaccumulate in animal tissues over time. Heavy metal contamination usually originates from polluted water supplies. Fish are most susceptible to heavy metal contamination. The most widely used analytical methods for determination of heavy metals in food are graphite furnace atomic absorption spectrometry (GFAAS) and Inductively Coupled Plasma (ICP).

Cadmium is a chemical element with the symbol Cd and atomic number 48. This soft, bluish-white metal is chemically similar to the two other stable metals in group 12, Zinc and mercury.Unlike mercury and lead, human exposure to **Cadmium** is most always through food. It often shows up paired with zinc, and is a by-product of zinc, lead and copper extraction methods. Cadmium exposure is compounded in the body by consuming foods rich with this element, such as mushrooms and shellfish. Additionally, Cadmium is present in cigarette smoke, which acts as a blood transport mechanism for cadmium into the lungs. It can also travel via the blood into the liver and then into the kidneys. The average concentration of cadmium in the Earth's crust is between 0.1 and 0.5 parts per million (ppm).

The determination of metal content in vegetables is important from the view point of crop yield technology, food nutrition and health impacts.In event of their excess presence, these metals enters into the body and may disturb the normal functions of central nervous system, liver, lungs, heart, kidney and brain, produce hypertension, abdominal pain, skin eruptions, intestinal ulcer and different types of cancer [1, 2]

In the determination of cadmium and copper, various methods, including ICP-MS[3] ion chromatography, anodic stripping analysis, [4] and electrothermal atomic absorption spectrometry, [5] have been used. Many of these methods either are time-consuming or require complicated and expensive instruments. Therefore, methods that could determine low concentrations of cadmium and copper rapidly and conveniently in real sample were researched.

Ammonium pyrrolidinedithiocarbamate (APDC) has been used recently in various preconcentration and separation techniques, [6] APDC is most widely used to determine the metal ions, such as Cd^{2+}, Pb^{2+}, Ni^{2+}, Co^{2+}, etc that form slightly soluble complexes in an aqueous solution Usually, metal-APDC complexes are measured by UV-Visible spectrophotometry and flame atomic absorption spectrometry[7] after extraction with nonpolar organic solvent[8]. Solvent extraction techniques are time-consuming, tedious and usually involve harmful solvents.

The main aim of this study was to investigate the level of trace metals in different varieties of vegetables, which are available in local markets and consumed as a part of food.In the lithosphere cadmium appears mainly in the form of sulphides and its presence is connected with the deposits of zinc and copper. Therefore, emissions of zinc and copper works contribute the highest proportion of industrial cadmium pollution, accounting for 60% of all anthropogenic sources of pollution with

cadmium. The amount of cadmium in the environment may also be increased locally by incineration of solid waste. These processes cause pollution of soil and underground and surface water. The content of cadmium in soil increases as a result of the application of the artificial fertilizers.

Materials and method:

Sampling and Sample Preparation:

Several samples of fruits and vegetables collected from agricultural fields in sabbavaram, Visakhapatnam, Andhra Pradesh, India and kept in refrigerator till analysis. Cosmetic samples were procured from local markets in Visakhapatnam.

Vegetables, fruit, crop and plant samples were thoroughly washed to remove all adhered soil particles. Samples were cut into small pieces, air-dried for 2 days and finally dried at 100 ± 1°C in an hot-air oven for 3 h. The samples were ground in warm condition and passed through 1 mm sieve. Digestion of these samples (2 g each) was carried out using 10 ml nitric acid, according to the procedure used for soil samples[2]. Well-mixed milk samples of 250 ml each were taken in 500 ml glass beakers and digested in 24 ml of aqua regia on a sand bath for 3 days. After vaporation to a lesser volume, the samples were filtered and diluted to 50 ml with distilled water.

Analysis:

Heavy metal analyses were carried out using flame atomic absorption spectrophotometer (Hewlett-Packard) calibration curves were prepared separately for all the metals by running different concentrations of standard solutions. The instrument was set to zero by running the respective reagent blanks. Average values of three replicates were taken for each determination.

Collection of cosmetics Samples

Samples of the most popular brands of cosmetics were collected from the various retail shops from local market of Gwalior. Total three different brands (coded A, B and C) of each product and total five samples of one brands of each samples were taken for study. In this way total 15 samples (5 samples for each brand A, B and C respectively) were collected for one cosmetic product. The information about test items and their quantities used in present study is summarized in table I. Five samples of different brands of each cosmetic viz. toilet soap, face cream, shampoo, shaving cream and talcum powder were collected separately in sterilized polythene bags.

Sample preparation

Sample preparation for heavy metal analysis was done under standard procedure. Briefly 1 gm of each sample was digested in approximately 5 ml mixture of concentrated acid (HNO3 and Perchloric acid in 3:1 ratio) for 2-3 hrs on a hot plate. If black or brown color is appeared then again add 3.0 ml of mixture of concentrated acids to find out the white colored sample. The above digested samples were dissolved in 10 ml triple distilled water and filtered with the help of whatman number

1 filter paper. The clear solution was used for metal quantification.

Heavy metals quantification

Two metals i.e. lead and cadmium was analyzed through atomic absorption spectrophotometer (AAS PerkinElmer model AAnalyst 100).

Results and discussion:

The cadmium levels in different fruits and vegetables were analysed and the results are presented in table1

Table 1: Cadmium levels in different fruits and vegetables in mg/kg

Fruit/Vegetable	Cadmium concentration
Onion	0.6
Tomato	0.02
Banana	NF
Grapes	0.3
apple	0.5
carrot	1.03
cabbage	3.24

NF-Not found

From the results it is found that in banana cadmi was not found.Zinc, Copper and Iron are present in all vegetables and fruits.In general The concentrations of Zn and Cd in food crops increased with the degree of contamination of the soil. Several studies have shown that uptake and accumulation of metals by different plant species depend on several factors, and various researchers have identified several reasons. The study reveals that sewage is the main source of pollution of this water body and irrigation with sewage-contaminated water containing variable amounts of heavy metals leads to increase in concentration of metals in the soil and vegetation..

The cadmium content present in various cosmetic products suchas talcum poder, soap, shampoo etc are given in table 2. Three samples of each brand were analysed and their mean value was reported. Cosmetics are one of the most important sources of releasing heavy metals in the environment. The possibility of skin allergy/ contact dermatitis may increase due to the presence of heavy metals in cosmetics. Since the heavy metals toxicity has been exemplified the problem of environment pollution, it is necessary to know about the all possible sources. In this context, we have tested the different cosmetic products for the presence of lead, cadmium.

Table 2: Cadmium levels in cosmetic products collected from local markets in µg/g

Brand	Talcum Powder	soap	shampoo
I	0.91	3.7	0.27
II	0.84	3.48	0.21
III	1.02	4.2	0.24

Conclusion:

This study enable us to conclude that average value of cadmium level in fruits and vegetables were found within the tolerance limits and slightly high in cosmetic samples. The possibility of skin allergy may increase due to the presence of heavy metals in cosmetics.

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