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ESTIMATION OF HEAVY METALS IN FRUITS AND VEGETABLES GROWN NEARBY AREAS OF INTEGRAL UNIVERSITY, LUCKNOW INDIA

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ABSTRACT

The purpose of this research was to use the Atomic Absorption Spectroscopy (AAS) technique to identify heavy metals in various vegetables. Six different fruits and vegetable samples, including lady finger, Cauliflower, cabbage, Guava, papaya, and Palak, are frequently seen in the nearby villages of Integral University. Heavy metals which were determined are Chromium (Cr), Iron (Fe) cadmium (Cd), and lead (Pb). Results indicated that the variety of vegetables and fruits tested had limits of heavy metals in a limited range compared to standards, the permissible levels established by the FAO and WHO, and heavy metal levels were found to be within safe limits, which is an indication that the vegetables around the local market of the university are safe for consumption without any risk of environmental toxicants. However, some samples of guava have a quantity of heavy metals more than the permissible limit, which is unfit for consumption. Because heavy metals, are unbreakable and most of them are hazardous to living things when acceptable concentration limits are exceeded. Due to poor immune systems, the most vulnerable populations to heavy metal pollution are young children and elderly people.

KEY WORDS: Heavy Metals, Atomic Absorption spectroscopy, Fruits, Vegetables.

INTRODUCTION

Environmental security is currently the most serious challenge, with human activity, fast population growth, scientific and technological advancements, broad industrialization, and the use of several chemicals in agriculture among the factors harming life (Parvin, *et al*., 2014). A "heavy metal" is a metallic element with a relatively high density that is toxic or hazardous even in small amounts (Duruibe *et al*., 2007). Major elements (vital elements), Trace elements (heavy metals), and ultra-heavy elements are the three categories of heavy metals Calcium, potassium, sodium, magnesium, chlorine, sulfur, and phosphorus. Iron, copper, Iodine, Zinc, Manganese, Selenium, Chromium, Nickel, and Cobalt are among the trace elements that need less than 50g of food per day, whereas Lead, Aluminum, Bromine, Arsenic, Barium, Mercury, Bismuth, Cadmium, and Selenium are among the ultra-trace elements, there is no absolute necessity for Germanium, Silicon, Lithium, Rubidium, Sb, Sr, Ti, and Tungsten (Un nisa *et al*., 2020). If weight and toxicity are related, then metalloids like arsenic, which are classified as heavy metals, and may also be hazardous even at low exposure levels, environmental pollution by these metals has recently been linked to rising ecological and worldwide public health concerns (Tchounwou *et al*., 2012). Heavy metal contamination is presently a significant problem in many regions of the world Chemically, heavy metal elements have atomic masses larger than 20 and gravities greater than 5 g/cm^3 (Adnan *et al*., 2022). The deposition of heavy metals is attributed to a variety of factors, including small-scale enterprises (such as the battery, metal-smelting, and cable-coating sectors), automobile emissions, and diesel generator sets (Sarkiyayi and Samaila, 2017). Metal circulation and migration in the natural world are mostly correlated with events like rock deterioration, volcanic eruptions, ocean evaporation, and forest fires (Szyczewski *et al.*, 2009). Perishable vegetables are frequently planted close to urban areas since these locations are more likely to be contaminated by heavy metals because of various urban and industrial activities. The presence of heavy metals in vegetables is caused by the continuous use of wastewater for irrigation (Shirkhanloo *et al.*, 2015). Cadmium (Cd), lead (Pb), copper (Cu), and zinc (Zn), metals found in gasoline are released into the air by the dense traffic on these roadways, and the soil where these veggies are grown has been contaminated because of these metals. Consuming such vegetables might have the worst health effects since heavy metal pollution affects both the aquatic and terrestrial ecology (Azad, 2020).

Due to the excessive use of agrochemicals and changing climatic conditions, heavy metals are building up in soils and posing a serious threat to human life (Jamal *et al.,* 2013). Healthy fruits and vegetables with high vitamin and mineral content may be harmful to health due to heavy metal contamination (Sarkiyayi and Samaila, 2017). Heavy metal contamination is a significant environmental risk because of some of its characteristics, such as its great ability for bioaccumulation, persistence, and toxicity (Yaqub *et al*., 2021). Determining the presence of heavy metals in fruits and vegetables is an important issue for nutritionists, environmentalists, and scientists. Fruits and vegetables should be examined for heavy metal contamination since they are crucial components of the human diet. Since they are rich providers of vitamins, minerals, fiber, and antioxidants, fruits and vegetables are essential for healthy body formation, growth, and maintenance (Nisa *et al*., 2020). Fruits and vegetables are frequently utilized in cooking, Vegetables and fruits have a major role in vitamin and mineral salts that are present in the human diet. They are made of water, iron, calcium, sulfate, and potash, additionally they serve as neutralizing agents for compounds that become acidic during digestion. Consequently, fruits and vegetables are essential for maintaining overall health and preventing a variety of illnesses. The presence of heavy metals might be harmful and alters the flavor and fragrance of fruits and vegetables by having an impact on their quality (Salhotra and Verma, 2017). Regarding the effects of consuming food products polluted with heavy metals, food quality has been a major concern on a global scale, the main source of hazardous substances consumed in tiny amounts by people is food. Phytochemicals, minerals, and dietary fiber are all found in an abundance of fruits (Pant *et al*., 2020). The quality and safety of vegetables are dangerous because of soil and air pollution with heavy metals, the health of both humans and animals is in danger when heavy metals are consumed in food, there are various heavy metals with known cancer-causing properties including Cd and Pb (Ali and Al-Qahtani, 2012). This study is carried out for the estimation of heavy metals in fruits and vegetables growing nearby areas of Integral University Lucknow, to ensure a major increase in food safety, the primary goals of the current effort are to concentrate on biomonitoring contamination of heavy metals in various vegetables and fruits.

MATERIALS AND METHODS

Instruments

(Atomic Absorption spectroscopy)

AAS is a useful technique for figuring out very low metal concentrations. The determination of the presence of metals in the samples is quick and simple. It uses the flame AAS (FAAS) and electrothermal AAS procedure. FAAS will provide the absorption signal continuously, but ETAAS will send the signal in a discontinuous trend and require two to four minutes for each sample. Usually, a diluted acid solution or xylene solution must be used to dilute the material; sample preparation requires more time since AAS cannot directly evaluate solid materials. Instead, the samples must be in liquid form. This sample will be heated to evaporate its atoms, turning it from a liquid to a gas (Duruibe *et al*., 2007). As early as 1860, Kirchhoff described the basic principle of AAS. It was not until 1955, that the analytical background for its analytical applications was demonstrated by Walsh, Alkemade, and Milatz. The simplicity of this technique marks it an attractive tool for the analysis of many elements (Mukhopadhyay and Mukhopadhyay, 2018).

Study Area

The current study was conducted from January 2022 to March 2022 in the vicinity of Integral University in Lucknow, India. Six essential Indian fruits and vegetables including lady's finger, cauliflower, papaya, cabbage, palak, and guava were simultaneously sampled at the fieldand market locations. To determine the location of locally grown fruits and vegetables and the city's market, a reconnaissance assessment was carried out. According to the report, considerable quantities of palak, cauliflower, cabbage, lady's finger, papaya, and guava are cultivated at several production sites around Integral University. Due to their perishability, these veggies are sold at the city's outdoor markets. All market locations were determined based on the supply of these fruits and vegetables from their production sites, traffic volumes, industrial activities, and residential and commercial districts. These market locations are in an area with a high concentration of heavy metal traffic on a small road (200 cars per hour from 10:00 am to 7:00 pm).

Sampling

The samples of fruits and vegetables were collected from sides of the integral university and brought to the laboratory of the chemistry department integral university, Lucknow, India for the sample preparations. The common names and scientific names of vegetables and fruits are given in Table 1.

Table 1.

Name of fruits and vegetables	Scientific Name
Palak	*Spinacia oleracea*
Lady's finger	*Abelmoschus esculentus*
Cauliflower	*Brassica oleracea* var. botrytis
Papaya	Carica papaya
Guava	*Psidium guajava*
Cabbage	*Brassica oleracea* var. capitata.

Washing and drying

To get rid of the contaminated particles, the fruits and vegetables that were collected were carefully washed with distilled water, the uneatable portions of the vegetables were removed, and the edible portion was chopped into small pieces. These were then sliced into small, practically uniform pieces. These little pieces of the fruits and vegetables were then added to the crucibles, which had been thoroughly cleaned with acid and labeled. The little bits of fruits and vegetables were afterward dried for several hours in an oven at 80°C until they were tight and crunchy.

Sample size reduction

To get homogenized samples, the dried fruit and vegetable pieces were crushed and ground into a fine powder using a mortar and piston. Once they dried, for the next step powdered samples were kept in plastic bags.

Sample preparations

Before the analysis, samples of fruits and vegetables (1gm each) were put in a 100 ml beaker together with 15 ml of the tri-acid combination (70 % high-quality HNO_3, 65% $HClO_4$, and 70 % H_2SO_4 in a 5:1:1 ratio), this mixture was then stored at room temperature. The combination was then broken down at 80 °C till the solution turned clear. An atomic absorption spectrophotometer was used to measure the amounts of Cr, Fe, Cd, and Pb in the resultant solution after it had been filtered and diluted to 50 ml with deionized water. Using a hollow cathode lamp with Cr, Fe, Cd, and Pb at wavelengths of 324.8 nm, 213.9 nm, 288.8 nm, and 213.3 nm respectively, all the heavy metals had their slit width adjusted to 0.7 nm. For Cr, Fe, Cd, and Pb, the detection limits were 0.001, 0.0008, 0.0005, and 0.01 mg/ml, respectively. Standard solutions were periodically run to test the instrument's sensitivity.

Since heavy metals have such a negative impact on human health, it is commonly acknowledged that they hurt the nutritional content of agricultural products. Therefore, the maximum permitted quantities of hazardous metals in human food have been established by national and international rules on food quality. Controlling the levels of heavy metals in fruits and vegetables has become a more crucial component of ensuring their quality. Chromium (Cr) an extremely dangerous heavy metal was not notably found in these widely eaten fruits and vegetables, which is a positive finding (Table 2-7).

The qualitative and quantitative results of heavy metals in the selected vegetables and fruits, i.e., lady's finger = 5 samples, Cauliflower, Cabbage, Palak, Papaya, and Guava= 4 samples each.

Detection of Heavy metals in Vegetables and Fruits samples

Table 2-7. Presence and absence of heavy metals in

Table 2. Lady's finger

Heavy Metals	S1	S2	S3	S4	S5
Cr	ND	ND	ND	ND	ND
Fe	+	+	-	_	+
Cd	+	+	+	+	+
Pb	+	+	+	+	+

Table 3. Cauliflower

Heavy Metals	S1	S2	S3	S4
Cr	ND	ND	ND	ND
Fe	+	-	+	+
Cd	+	+	-	+
Pb	-	+	+	+

Table 4. Cabbage

Heavy Metals	S1	S2	S3	S4
Cr	ND	ND	ND	ND
Fe	+	-	+	+
Cd	+	+	+	+
Pb	+	+	+	+

Table 5. Palak

Heavy Metals	S1	S2	S3	S4
Cr	ND	ND	ND	ND
Fe	+	+	+	+
Cd	+	+	+	+
Pb	+	+	+	+

Table 6. Papaya

Heavy Metals	S1	S2	S3	S4
Cr	ND	ND	ND	ND
Fe	+	+	+	+
Cd	+	+	+	+
Pb	+	+	+	+

Table 7. Guava

Heavy Metals	S1	S2	S3	S4
Cr	ND	ND	ND	ND
Fe	+	+	+	+
Cd	+	+	+	+
Pb	+	+	+	+

ND= Not detected, - and + sign indicates the absence and presence of heavy metalsS1-S5 indicates respective samples.

Mean of heavy metals concentrations (mg/Kg)

Table 8. Lady's finger

Heavy Metal	S1	S2	S3	S4	S5
Cr	ND	ND	ND	ND	ND
Fe	0.2	0.02	0	0	0.07
Cd	0.007	0.04	0.01	0.005	0.011
Pb	1.02	0.02	1.0	0.04	0.051

different samples of fruits and vegetables

CONCLUSION

From the results obtained in this it can be concluded

Table 9. Cauliflower

Heavy Metals	S1	S2	S3	S4
Cr	ND	ND	ND	ND
Fe	0.11	0	0.021	0.002
Cd	0.01	0.04	ND	0.02
Pb	ND	0.03	0.03	0.11

Table 10. Cabbage

Heavy Metal	S1	S2	S3	S4
Cr	ND	ND	ND	ND
Fe	0.1	1.2	0.11	0.01
Cd	0.008	0.02	0.01	0.04
Pb	0.01	0.08	0.007	0.03

Table 11. Palak

Heavy Metals	S1	S2	S3	S4
Cr	ND	ND	ND	ND
Fe	0.089	0.041	0.11	0.071
Cd	0.002	0.002	0.09	0.007
Pb	0.11	1.0	0.07	0.01

Table 12. Papaya

Heavy Metals	S1	S2	S3	S4
Cr	ND	ND	ND	ND
Fe	0.1	1.2	0.11	0.01
Cd	0.008	0.02	0.01	0.04
Pb	0.01	0.08	0.007	0.03

Table 13. Guava

Heavy Metals	S1	S2	S3	S4
Cr	ND	1.23	ND	ND
Fe	1.3	1.2	0.09	1.4
Cd	0.02	0.08	0.004	0.3
Pb	0.1	0.09	0.55	0.6

as: samples of fruits and vegetables have amounts of heavy metals lower than the maximum permissible values prescribedby WHO/FAO. These results imply that the food (Fruits and Vegetables) items purchased are safe for human consumption concerning the fear of contamination by the heavy metals enumerated. A cursory look at the results of this study points to the general trend that some samples of guava have a greater amount of heavy metals.

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