ISSN 2583– 0260 (online) *ISSN 2394 -7837 (print)*

QUALITATIVE ANALYSIS AND CHARACTERISATION OF HEAVY METALS IN SELECTED VEGETABLES

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Received: 23/5/2022 **Revised: 23/6/2022** **Accepted:25/6/2022**

Abstract

A study was undertaken to understand the presence of heavy metal cations in daily use vegetables like Carrot, Cabbage, Cucumber and Beetroot. Heavy metals are closely connected with deterioration of the environment and life quality and chronic exposure to low level of heavy metals can lead to severe health effects that in excess will result in acute poisoning. Humans can be exposed to these metals through different paths such as air, water and food and exposure to the food chain has been widely reported throughout the world. The vegetables for the present investigation were collected from local market and washed with distilled water. From the sample 50-100g were weighed out using digital balance and blended using high speed grinder without adding water and filtered. Solubility test and Cation group analysis were carried out using standard procedure. On analysis it was found that Group I and Group III cations were present in the vegetables abundantly. Among this, Group III cations were prominent. The presence of iron (Fe2+) in Cabbage and Beetroot were detected. In cucumber Aluminum was detected. Aluminum and Iron are group III members. While in Carrot Group I element Lead was detected.

Key words: Heavy metals, cations, vegetables, food chain, solubility

Introduction

In the current scenario, trace metals contamination in vegetables and cereals is a serious growing concern due to their accumulation, persistence and toxicity in nature. Heavy metal contamination of vegetables cannot be underestimated as these foodstuffs are important components of human diet. However, intake of heavy metal-contaminated vegetables may pose a risk to the human health. Heavy metal contamination of the food items is one of the most important aspects of food quality assurance (Marshall, 2004; Radwan and Salama, 2006; Khan , *et al*., 2008).

Sudden industrialization is related to increasing of heavy metals in developing countries. Heavy metals may be absorbed into the plants tissues from deposits on the surfaces exposed to the air from polluted environments as well as from contaminated soils. A number of studies reveal that trace metals are an important fast growing contaminants in the vegetables and cereals (Radwan and Salama, 2006, Maleki and Zarasvand, 2008, Wong*, et al*., 2003, Marshall, 2004; Sharma*, et al*., 2008). It may be die to contaminated water irrigation, pesticides exposures as well as industries and vehicles emissions during their production, transport and marketing. Dietary intake of trace metals also possesses risk to both animals and human health. Long-term consumption of unhealthy foods, which are polluted with heavy metals, may threat human health and eventually leads to cardiovascular, nervous, kidney and bone and diseases and development of abnormalities in children (Trichopoulos, 1997). High concentrations of trace metals like Cu, Cd and Pb were related to high prevalence of upper gastrointestinal cancer (Turkdogan, *et al*., 2002).

Emissions of heavy metals from the industries and vehicles may be deposited on the vegetable surfaces during their production, transport and marketing. Sharma *et al.,* (2008) reported that atmospheric deposition can significantly elevate

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the levels of heavy metals contamination in vegetables commonly sold in the markets of Varanasi, India. The prolonged consumption of unsafe concentrations of heavy metals through foodstuffs may lead to the chronic accumulation of heavy metals in the kidney and liver of humans causing disruption of numerous biochemical processes, leading to cardiovascular, nervous, kidney and bone diseases (WHO 1992, Jarup, 2003). Some heavy metals such as Cu, Zn, Mn, Co and Mo act as micronutrients for the growth of animals and human beings when present in trace quantities, whereas others such as Cd, As, and Cr act as carcinogens (Feig, *et al*., 1994, Trichopoulos, 1997). The contamination of vegetables with heavy metals due to soil and atmospheric contamination poses a threat to its quality and safety. Dietary intake of heavy metals also poses risk to animals and human health. Heavy metals such as Cd and Pb have been shown to have carcinogenic effects (Trichopoulos, 1997). High concentrations of heavy metals (Cu, Cd and Pb) in fruits and vegetables were related to high prevalence of upper gastrointestinal cancer (Turkdogan *, et al*., 2002).

Regulations have been set up in many countries and for different industrial set up to control the emission of heavy metals. The uptake of heavy metals in vegetables are influenced by some factors such as climate, atmospheric depositions, the concentrations of heavy metals in soil, the nature of soil on which the vegetables are grown and the degree of maturity of the plants at the time of harvest (Lake*, et al*., 1984, Scott *, et al*., 1996). Air pollution may pose a threat to post-harvest vegetables during transportation and marketing, causing elevated levels of heavy metals in vegetables (Agrawal, 2003). The main objectives of the present work are to focus on the the distribution and characterization of heavy metals and cations in common vegetables.

Materials and Methods

For the present study, commonly used four vegetables like Carrot, Cabbage, Beetroot and Cucumber were selected and collected from local Market. Care should be taken while selecting to avoid damaged, rotten or infected one. Sufficient quantity of fresh materials were selected and brought to the Laboratory. The collected samples were washed with distilled water to remove the dust particles. Then samples were cut to small pieces using clean knife. The moisture and water droplets were removed with the help of blotting papers.From the vegetable samples, 50-100g were weighed out using digital balance and blended using high speed grinder without adding water. Then it was filtered using dried and clean two layer cotton cloth and the supernatant was stored in analytical bottles.

Solubility Test: From the supernatant 2-3 ml were transferred into a test tube and Check solubility in cold water, hot water, Dilute HCl and concentrated HCl. Label this solution as original solution (Vogel, 1989).

Cation Group analysis: Standard procedures were carried for the cation group analysis. For that, add dilute HCl., if white precipitate formed assumed the presence of Group I present Pb^{2+} and Hg^{2+}. If no precipitate was as formed pass H_2S through the given solution. If a colored precipitate formed, Group 2 cations (Cu^{2+}, Pb^{2+}) were present. If no precipitate obtained from the above, boil off H_2S gas and add a few drops of conc. HNO_3. Cool, add 2-3g of solid NH_4Cl. Boil again and add NH_4OH solution till it becomes alkaline. If a precipitate formed, Group III cations were present. Reddish brown precipitate. Fe^{3+}, Gelatinous white precipitate Al^{3+} . If no precipitate then pass H_2S to the given solution. If precipitate formed, Group IV cations were present. Black ppt. (Co^{2+}, Ni^{2+}) flesh coloured precipitate Mn^{2+} white precipitate Zn^{2+}. If no precipitate formed, boil off H_2S gas add $(NH_4)_2CO_3$ solution. If a white precipitate was formed Group V cations present (Ba^{2+}, Sr^{2+}, Ca^{2+}). If no ppt. Group VI cation (Mg^{2+}) will present. Appropriate -

confirmatory tests were carried out for the confirmation of cations.

Results and Discussion

The qualitative analysis of heavy metals in selected vegetables were analysed using standard techniques are follows.

Carrot (*Daucus carota* L)**:** The solubility of the extracted from carrot was checked by adding few drops of dilute HCl. A colored precipitation was formed and it may be due to the presence of Group I elements like mercury (Hg^{2+}) or lead (Pb^{2+}). The coloured precipitate transferred in to an analytical tube and dissolved by heating and added dilute HNO_3. To one portion of the above solution dilute H_2SO_4 was added and a white precipitate of $PbSO_4$ was obtained (Table 1). To the another portion Potassium iodide solution was added and an yellow precipitate was formed. Precipitate dissolves and reappears in the form of golden spangles. The presence of Pb^{2+} was confirmed.

Carrot *(Daucus carota* L) is one of the popular root vegetables grown throughout the world and is the most important source of dietary carotenoids. In recent years, the consumption of carrot and its products have increased steadily due to their recognition as an important source of natural antioxidants besides, anticancer activity of β-carotene being a precursor of vitamin A (Dreosti 1993; Speizer , *et al*. 1999). Carrots are a good source of carbohydrates and minerals like Ca, p, Fe and Mg. Gopalan *, et al.* in 1991 have reported the chemical constituents of carrot as moisture (86%), protein (0.9%), fat (0.2%), carbohydrate (10.6%), crude fiber (1.2%), total ash (1.1%), Ca (80 mg/100 g), Fe (2.2 mg/100 g) and p (53 mg/100 g). In the present investigation, the extract of Carrot contain the presence of Lead (Pb). Blood containing high level of lead causes inadequate functioning of the central nervous system (CNS) and consequently leads to encephalopathy and edema that mainly affects the cerebellum. (Amadi, , *et al*. 2017, Vigeh, , *et al.* 2011).

Cabbage: Cruciferous vegetables like cabbage and broccoli are notorious for being chock-full of beneficial nutrients. The cabbage may help protect against radiation, prevent cancer, and reduce heart disease risk. Cabbage can vary in color from green to red and purple, and the leaves can be smooth or crinkled. While analyzing the solubility of the extract, dilute HCl was added to the extract. It was found that no precipitate or color was formed. It may be due to the absence of group I and group II cations. Then group III cations were analysed and a reddish brown precipitate was formed. It may be due to the presence of Iron. To confirm this, add a few drops of dilute HCl and then add of potassium ferricyanide solution. Formation of a deep blue color or ppt. and the presence of Fe^{3+} was confirmed. The presence of Ca, K, Mg, P, Co, Ni, Zn, Mn, Cu, and Fe in cabbage (*Brassica oleracea* L. var. *capitata*) grown on acid sulfate (AS) soils in Western Finland. It was observed that various bioactive components were obtained from Cabbage include protein, fats, carbohydrates, vitamins, Phosphorus, Calcium, Potassium and Sodium.

Cucumber: Cucumbers have a mild, refreshing taste and a high water content. They can help relieve dehydration and are pleasant to eat in hot weather. They provide various nutrients but are low in calories, fat, cholesterol, and sodium. On analyzing the solubility of the extract, dilute HCl was added and it was found that no precipitate or color was formed. It may be due to the absence of group I and group II cations. Then group III cations were analysed and found that a gelatinous white precipitate was formed. It may be due to the presence of Aluminum (Al^{3+}). For the confirmation of the above, the white gelatinous precipitate dissolves in minimum quantity of dilute HCl. To this, add a few drops of blue litmus solution, formation of a blue floating precipitate the in colourless solution (known as Lake test), Aluminum was confirmed. White Precipitate -

soluble in excess of NaOH solution, again Aluminum was confirmed. Cucumber (*Cucumis sativus*) fruit is a source of the secondary metabolites, that is, alkaloids, flavonoids, terpenoids, tannins, saponins, steroids, phenols, glycosides, reducing sugars, etc. Cucumber fruit may play vital role in preventing various diseases such as inflammation, bacterial infection, lipid peroxidation, fever, constipation, etc. The anti-inflammatory, anti-bacterial, antioxidant, analgesic and anti-constipation may be due to the presence of the above mentioned phytochemicals especially flavonoid (Uzuazokaro , 2018). Aluminum has long been established in medical applications as, e.g., an adjuvant in vaccines and an agent against pathological hyperhidrosis with a low side-effect profile (Willhite, 2014). In recent years, however, there has been more focus on the at times highly uncritical public debate about the neurotoxic effect of aluminum and its potential carcinogenic effect

Beet Root: Beetroot has been gaining in popularity as a super food. Recent studies claim that beets and beetroot juice can improve athletic performance, reduce blood pressure, and increase blood flow. While analyzing the solubility of the extract, group I and group II cations were absent and while testing to group III cations a reddish brown precipitate was formed. It may be due to the presence of Iron (Fe^{2+}). To confirm this, add a few drops of dilute HCl and then add of potassium ferricyanide solution. Formation of a deep blue color or ppt. and the presence of Fe^{2+} was confirmed.

Beetroot is consist of multiple biologically active phytochemicals including betalains (e.g., betacyanins and betaxanthins), flavonoids, polyphenols, Saponins and inorganic Nitrate (NO_3); it is also a rich source of diverse minerals such as potassium, sodium, phosphorous, calcium, magnesium, copper, iron, zinc and manganese (Baião, , *et al* 2017). In the present investigation the presence of iron was confirmed.

Table 1. Procedure for Separation of Basic Radicals into Groups

To the original solution, add Dil. HCl.					
White ppt. Group I present (Pb2+ and Hg^{2+}					
	If no ppt. pass H2S through the given solution. If a coloured ppt. is formed, group 2 cations are present (Cu2+), Pb2+.				
		If no ppt is obtained from the above, boil off H2s gas and add a few drops of conc. HNO3 to the remaining solution. Cool, add 2-3g of solid NH4Cl. Boil again and add NH4OH solution till it becomes alkaline.			
		If a ppt is formed, Group III cations are present. Reddish brown ppt. Fe3+ Gelatinous white ppt. Al3+			
			If no ppt., pass H2S to the given solution.		
			If a ppt is formed Group IV cations are present. Black ppt. (Co2+, Ni2+) Flesh coloured ppt. Mn2+ white ppt. Zn2+.		
				If no ppt is formed, boil off H2S gas add (NH4)2CO3 solution.	
				If a white ppt is formed Group V cations are present (Ba2+, Sr2+, Ca2+)	
					If no ppt. Group VI cation is present (Mg2+

Conclusions

The most noticeable evil associated with urbanization and industrialization in a haphazard and unplanned manner has resulted in the release of heavy and toxic metals in the local environment It is proposed that tracing of heavy metals in vegetables and other foods should be considered in human food chain. Appropriate precautions should be taken at the time of transportation and marketing of vegetables and cereals as well as during food processing in kitchen

Acknowledgements

The present research work is an output of under graduate research programme supported by DBT Star College Scheme, in the Department of Botany, Sree Narayana College, Kollam in association with Department of Chemistry, Sree Narayana College, Kollam.

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