

Heavy Metal Contamination in Vegetables Grown Near Highways and Industrial Area: A Review

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Abstract

In India, urban food security is becoming more of a worry. By 2030, it is expected that 65% of India's population would be living in cities. Through the eating of vegetable crops, heavy metals such as cadmium (Cd), lead (Pb), zinc (Zn), and copper (Cu) have been found as a concern to human health. These metals can offer a serious health issue to people, especially in amounts that exceed the body's minimal requirements. As a result, increasing the production and consumption of fresh vegetables is an important priority, and humans have a right to quality food and to know that the vegetables they eat are not contaminated beyond permissible safe limits. Major pollutants identified on the surface and in the tissue of fresh vegetables are discussed in this article. It covers the consequences of extended human ingestion of these hazardous amounts of contaminants in mankind, as well as the rising danger of growing contaminations in food. The article concludes with recommendations to promote the consumption of healthy and nutritious fruit and vegetable products, emphasizing the need of increasing supply and optimising nutrient content to benefit consumers.

Key words: heavy metals, vegetable contamination, health issues, quality of food, limits of metals in fruits & vegetables

I. Introduction

Since vegetables are quite an integral part of the human diet, heavy metal contamination of these foods should not be overlooked. Vegetables are rich in vitamins and minerals, minerals, and fibers, and they also have antioxidant properties. Intake of heavy metal-contaminated products, on the other hand, may pose a health risk to humans.

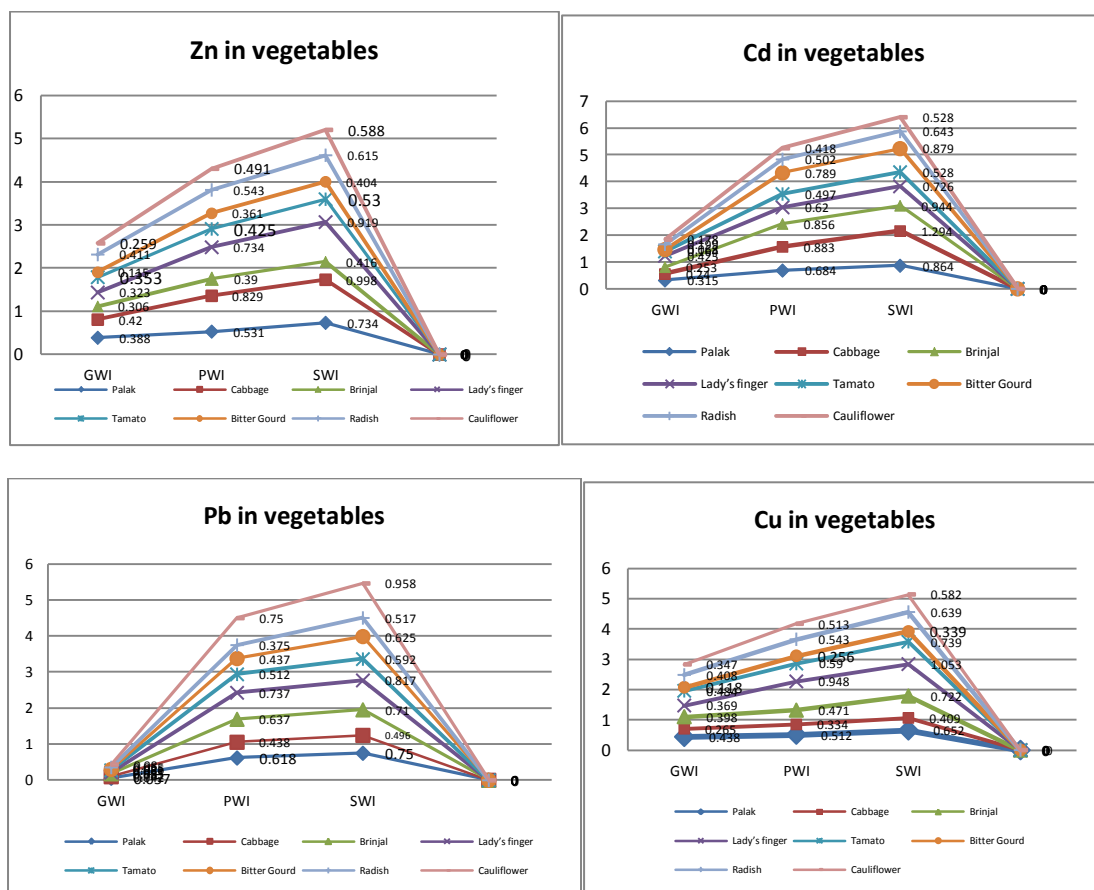
Ecosystems have been and continue to be contaminated with heavy metals as global heavy metal concentrations rise owing to diverse human and natural activities. Contamination of the ecosystem is caused by activities such as controlled and uncontrolled waste disposal, accidental and process spillages, use of fertilisers, herbicides, insecticides, and pesticides, and migration of contaminants into non-contaminated land as vapors and leachate through soil or dust, or spreading of sewage sludge.

Sources of Heavy Metal Contamination in Vegetables

Heavy metal contamination of the food items is one of the most important aspects of food quality assurance [3,5,6 & 7]. International and national regulations on food quality have lowered the maximum permissible levels of toxic metals in food items due to an increased awareness of the these metals pose to food chain contamination Sources of Heavy Metal contamination Heavy metal depositions are associated with a wide range of sources such as small-scale industries (including battery production, metal products, metal smelting & Cable coating industries), brick kilns, vehicular emissions, re-suspended road dust and diesel generator sets. These can all be important contributors to the contamination found in vegetables. In general, coal combustion is an important source, because Indian coal is of relatively poor quality and has high heavy metal contents.

Additional potential sources of heavy metals in field locations in urban and peri-urban areas include irrigation water contaminated by sewage and industrial effluent leading to contaminated soils and vegetables [13,14]. Other sources can include unsafe or excess application of (sometimes banned) pesticides, fungicides and fertilizers such as sewage sludge run off from high ways. Heavy metals may be present as a deposit of the surface of the vegetable, or may be taken up by the crop roots and incorporated into the plant tissue. In either case the original source of the pollution may be from water borne sources (such as industrial effluent) or from industrial or vehicular air pollution. This distinction is very important, because metal deposited on the surface of the vegetables can often be washed off by consumers prior to consumption. Heavy metals are non-biodegradable and persistent environmental contaminants, which may be deposited on the surfaces and then absorbed into the tissues of vegetables. Plants take up heavy metals by absorbing them from deposits on the parts of the plants exposed to the air from polluted environments as well as from contaminated soils [3, 4, 8, 9 & 13].

Heavy metal contamination of vegetables may also occur due to irrigation with contaminated water [8-14]. Emissions of heavy metals from the industries and vehicles may be deposited on the vegetable surfaces during their production; transport and marketing have reported elevated levels of heavy metals in vegetables sold in the markets [3]



GW=Ground Water, PWI= Partial sewage effluent Irrigated, SW=Sewage effluent Irrigated (Metal concentration= $\mu\text{g g}^{-1}$), source:Basal O.P., Int. J. of Adv. Res. In Sci. and Eng.,6(12),2017.

The contributions of heavy metals in selected vegetables through atmospheric deposition were quantified in an urban area of India [11,12]. Deposition rate of Zn was recorded maximum followed by Cu, Cd and Pb. The concentrations of Zn and Cu were highest in Brassica oleracea, Cd in Abelmoschus esculentus and B. oleracea, while Pb was highest in Beta vulgaris. Heavy metal pollution index showed that B. oleracea was maximally contaminated with heavy metals followed by A. esculentus and then B. vulgaris. The results of washing showed that atmospheric deposition has contributed to the increased levels of heavy metals in vegetables. Both Cu and Cd posed health risk to local population via test vegetables consumption, whereas Pb posed the same only through B. oleracea. The study concludes that atmospheric depositions can elevate the levels of heavy metals in vegetables during marketing having potential health hazards to consumers.

Effect on Community

The poor urban consumer could be affected more by the heavy metals present in vegetables purchased for the following reasons:

- Poor consumers wash their vegetables less thoroughly than better off consumers
- The poor may purchase vegetables that have been in the market for a longer time at a lower price, therewith increasing the risk of longer exposure times of the vegetable to aerial deposition of heavy metals
- The poor have less access to higher priced food that is perceived to be of higher Quality
- The poor may be more susceptible to the adverse effects of HMs due to an already unfavorable relative health and nutritional situation, with particular reference to women and children

On the other hand, wealthy consumers may be more exposed to HMs through greater overall consumption of vegetables. The wealthy are able to purchase costly 'off season' vegetables when high doses of agro-chemicals (some containing heavy metals) are applied by farmers to stave off insect pests. WHO has reported in 1992 that

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, and kidney and bone diseases, 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 Percent contribution to daily intake rate of Cu, Ni, Pb and Cr is higher by fruit vegetables, whereas that of Cd and Zn was higher by leafy vegetables. Consumption of these vegetables with elevated levels of heavy metals may lead to high level of body accumulation causing related health disorders.

Thus, regular monitoring of heavy metal contamination in the vegetables grown at waste water irrigated area is necessary and consumption of contaminated vegetables should be avoided in order to reduce the health risk caused by taking the contaminated vegetables. The waste water treatment technology should involve steps to remove heavy metals causing risk to human health.

Recommendations to Decrease Metal Contamination in Vegetables

By Reducing Pollution at Source

Reduced industrial and vehicular pollution of water, soil and air will prevent high concentrations of heavy metal traces such as cadmium and lead from entering the food chain. Aerial deposition of heavy metals can be reduced by measures such as:

- Setting emission standards for HMs which account for contamination of food
- Monitoring of HMs in aerial deposition, stack emissions and industrial effluent.

Improved Vegetable Production and Post-Harvest Handling

Currently there is no regular testing of heavy metals in vegetables by the designated health authorities. Thorough and transparent food testing inspections and dissemination of results by well-qualified government and non-government organizations are needed. Regular monitoring will also help to raise awareness about the food safety issue and will strengthen consumer demand for anti-pollution measures and better-quality food for all.

It is important to recognise that farming in areas close to cities and high ways performs a very important role in providing cities with fresh vegetables, and those small-scale farmers in particular, and agricultural laborers, derive a livelihood from this. It is also essential to encourage the intake of highly nutritious produce. However, farmers need to be made aware of best practices regarding the hazards associated with certain pesticides, fertilizers and irrigation water sources during cultivation. Also, famers often wash produce before bringing them to the market, and they must be encouraged to wash in clean water. Good coverage of vegetables during transport & sale may also help in reducing additional contamination post-harvest.

Increased Public Awareness

Experimental programmes by the research team should be highlighted that a simple, low-cost opportunity for people to reduce HM contamination is by thorough washing of vegetables in clean water. It has been found that at least 50% of the Pb contamination on palak is found on the surface of the vegetables and by twice washing in clean water the Pb contamination can be reduced to within PFA safe limits. Clearly the potential to reduce HM contamination by thorough washing depends on the access that people have to clean water sources, and competing needs for this scarce commodity; this may be a barrier for some of the poorest communities. The capacity to reduce food contamination will be an added advantage of improved water supply and sanitation, which is already recognised as an important poverty alleviation tool.

II. Conclusion

It should be particularly important to encourage the consumption of highly nutritious fruit and vegetable (F&V) crops, but as the income elasticity of demand for these products tends to be high, there is a clear need to increase supply and maximize the nutritional quality of these products to benefit the poor. This is also acknowledged by the Government of India's policy, which recognises the long-term preventative need for sustained increased consumption of fresh vegetables and fruits, rather than distribution of iron and vitamin supplements. The awareness in the public is slowly increasing about the nutritional benefits of consuming vegetables, they know that fresh vegetables are good for health and expecting mothers must consume it for healthy growth of the fetus.

Industrial effluents and urban pollution associated with sewage sludge, municipal waste water might have increased the levels of Pb, Cd, and Ni intake of the vegetables and soils. All these metals have toxic potential, but the detrimental impact becomes apparent only after decades of exposure. Monitoring of heavy metals in plant tissues is essential in order to prevent excessive build-up of these metals in the human food

chain. It is shown that the transportation and marketing of vegetables in contaminated environment may elevate the levels of heavy metals in vegetables through surface deposition. The consumption of vegetables directly from production areas might be less hazardous to human health in comparison to those from polluted open market areas. Heavy metals have a toxic impact, but detrimental impacts become apparent only when long term consumption of contaminated vegetables occurs. It is therefore suggested that regular monitoring of heavy metals in vegetables and other food items should be performed in order to prevent excessive buildup of these heavy metals in the human food chain. Appropriate precautions should also be taken at the time of transportation and marketing of vegetables.

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