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A review on heavy metal contamination by non-exhaust vehicular emission on leafy vegetables growing near road side areas

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Abstract

Vehicular non-exhaust emission are the major sources for release of heavy metals in the atmosphere. The sources through which non-exhaust vehicular emissions contribute to road dust are tire, brake and clutch wear as well as road surface abrasion. The released heavy metals through traffic will easily find their way in leafy vegetables through anthropogenic sources by absorbing through their thin leafy tissues. Vehicle brakes release a significant amount of heavy metals in the form of wear particles. One of the most dangerous elements contained in brake pads is copper. Due to traffic load the vegetables grown road side may contaminate with these copper emissions in the form of wear particles from brake pads through anthropogenic source. Vegetables grown on road side fields are exposed to atmospheric pollution in the form of metal containing aerosols through vehicular emissions. These metal containing aerosols may lead high accumulation of heavy metals such as Pd, Cd, Ni, Cu and Zn in leafy vegetables due to atmospheric depositions. The number of vehicles in operation increasing year by year and lengthening of trips have resulted in the emissions of larger amount of metals originating from brake, tyre, and road wear. Zn is the most abundant heavy metal from tire wear. Its high concentration resulted from the addition of ZnO to the tire during vulcanisation. This review is an attempt to determine the effect of heavy metals coming out from non-exhaust vehicular emissions on the leafy vegetables grown near road side areas.

Keywords: copper, zinc, heavy metals

Introduction

Leafy vegetables are important part of daily diets in many households, forming an important source of vitamins and minerals required for human health. The vegetables have beneficial role in growth and development of the body. These not only strengthen the immune system of the body but also help in disease prevention. They also act as neutralising agents for acidic substance formed during digestion. Green leafy vegetables are valuable source of vitamin A and C, iron, calcium, folic acid, and dietary fibre. Heavy metal contamination of vegetables is a great public health concern. One of the factors that influence the uptake and bioaccumulation of trace metals in vegetables is atmospheric deposition. Leafy Vegetables take up metals by absorbing them from contaminated soils, as well as from deposits on different parts of the vegetables exposed to the air from polluted environments. Leafy Vegetables plants that are exposed to atmospheric deposits from anthropogenic activities like vehicular emission, industrial emission and burning of all forms of wastes dumped along road sides should be contaminated with trace metals to a toxic level for consumer. The intake of heavy metals for longer period of time not only results in the disruption of many biological activities but also adversely affect our vital body organs such as kidney, liver etc. Consumption of vegetables loaded with heavy metals such as Pd, Cd, Ni, Cu and Zn are reported to cause cancer and cancer of pancreas, urinary bladder and prostrate. Trace metals such as Cd and Pd are among the most abundant trace metals and are particularly toxic. Cadmium and lead are most prevalent metals that can pose threat to humans at low concentration. Lead is well known for its toxicity and adverse effects on human health. Cadmium is not required by the human body and due to its high specific gravity, it has potential to accumulate in the vital body organs such as liver and kidney. High level of Cd in food is responsible for the abnormal function of kidney, liver and cardiovascular system.

Vehicular non exhaust emission is one of the main sources of emission of heavy metals into the environment. Road traffic involves numerous potential sources of metals through, wear products from tyres, brake linings, bearings and clutches, corrosion products of vehicle components and road construction material. The released heavy metals through traffic will easily find their way in leafy vegetables through anthropogenic activities by absorbing through their leafy tissues. Vehicle brakes release a significant amount of heavy metals in the form of wear particles. One of the most dangerous elements contained in brake pads is copper [1]. Heavy metals produced by vehicular exhaust and road, tire and brake abrasion can be deposited in road dust by dry or wet atmospheric deposition [2]. Concentration of Ni and Zn in road bitumen were higher than in raw bitumen therefore the heavy metal concentrations in road dust are significantly affected by vehicle operation and road abrasion. Various studies have been completed on the characteristics of heavy metal concentrations in road dust caused by traffic activities [3].

Heavy metals rank highest amongst the contamination in leafy vegetables. Cultivated areas near highways are also exposed to atmospheric pollution in the form of metal containing aerosols. These metal containing aerosols deposited on the leaves of vegetables and then absorbed [4]. Regular monitoring of these road side growing leafy vegetables is essential for preventing excessive build-up of heavy metals in food chain.

Material and Methods

Sample preparation and treatment

The collected leafy vegetables from the road side fields samples were first oven dried at 105℃ for 24 hours. The dried samples were then powdered manually in a grinder and then these powdered sample undergoes digestion process [5].

Digestion of samples

The heavy metal analysis of dry leafy vegetable, 1 g sample was taken into a 100 ml acid washed beaker and 15 ml of tri-acid mixture was added. The mixture was then digested at 80℃ till the transparent solution was achieved. After cooling, the digested samples were filtered using Whatman no. 42 filter paper and the filtrate was diluted to 50 ml with deionised water [6].

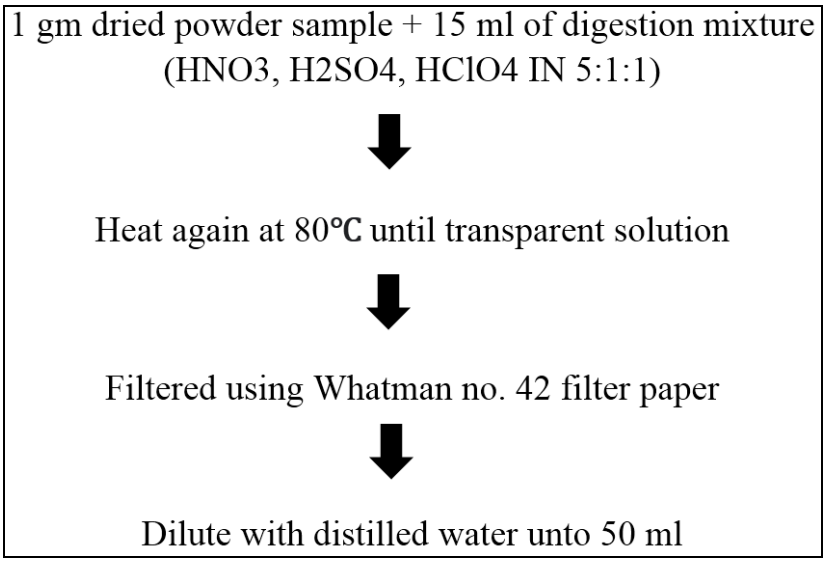

Fig 1

Heavy metal detection

Concentration of the heavy metals such as Cu, Zn, Cd, Pb and Ni in the filtrate of leafy vegetables and atmospheric deposits was achieved by Atomic absorption spectrophotometer [7].

Statistical analyses

Mean, median and range were calculated using statistical package, SPSS (SPSS USA). Linear regression analysis was used to compute the relationships between the deposition rate and the concentrations of heavy metals in edible portions of different vegetables.

FAO/WHO permissible limit in leafy vegetables (mg/kg).

Table 1

Heavy metals	FAO/WHO Permissible limit in leafy vegetable (mg/Kg)
Pd	0.3 mg/Kg
Cd	0.2 mg/Kg
Ni	67 mg/Kg
Cu	100 mg/kg
Zn	73 mg/Kg

Discussion

Heavy metal contamination in leafy vegetables is a great public health concern as they are the major food sources of our daily diet. Lead and cadmium are highly toxic and carcinogenic elements without any known beneficial biological function. The study revealed that washed and unwashed vegetables contaminated with Cr, Fe and Pb are above the WHO permissible limit whereas level of Mn, Cu, Zn and Ni in washed and unwashed vegetables was within the permissible limit of WHO. Vegetables take up metals by absorbing them from metal contaminated soils, as well as from deposits on different parts of the vegetables exposed to the air from anthropogenic activities [4]. The green leafy Vegetables selected are Basella alba (spinach), Trigonella foenumgraecum (fenugreek) and Coriandrum sativum (dhania). These vegetables were tested with the help of Absorption Spectroscopy for Pb, Cd, Cr, Ni and Zn. The levels of lead in all samples were found above the maximum permissible limit recommended by PFA for metals in vegetables. The result obtained from the analysis shows higher concentration of toxic metal in unwashed sample [7]. The results investigated that levels of all the trace metals in the unwashed leaves were high compared to the washed leaves which suggest anthropogenic heavy metal contamination in leafy vegetables. The trace metal levels in the road sides leaves were in the order: Cu > Zn >Pb>Mn>

Cd. The results were high when compared with those of the control samples obtained in IkotEkang village about 10 km away from the study area [8]. During their study they had compared heavy metal concentration in vegetables in urban and rural area of Bologna Italy. Results show that in the city, crops near the road were polluted by heavy metals, with up to 160 mg per kilogram of dry weight for lettuce and 210 mg/kg for basil. The highest Cd accumulation of up to 1.2 mg/kg was found in rural tomato [9]. Study concluded that Ni, Cd, Cr and Pb concentrations in some green leafy vegetables obtained from the selected markets were above the permissible limits set by FAO/WHO for human dietary source. The investigation showed significant differences in elemental concentrations among the green leafy vegetable's determination. But the levels of Cu collected found below the maximum permissible limit. Long term consumption of heavy metal contaminated GLV may possibly cause numerous health hazards in human. Therefore, regular examination of heavy metals in GLV is crucial to avoid excessive contamination of these metals [10]. A study examines concentrations of heavy metals with respect to some macro elements including Ca, Cd, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, and Zn in selected leafy vegetables from Kyrgyzstan. Leafy vegetables are important dietary source providing mineral nutrients. Due to heavy metal deposition in vegetables, metal contents of leafy vegetables need not only to be determined but also estimated health risk for revealing possible health effects on humans. Chinese cabbage was determined to be safe for the consumption of both genders. Based on the carcinogenic risk assessment, most of the vegetables examined in this study were categorized as moderately toxic. It was concluded from the given results that air borne pollution has increased the mineral contents of vegetables for both genders [11].

Conclusion

Leafy vegetables are the major dietary source for providing mineral nutrients. Due to heavy metal deposition in leafy vegetables, metal contents of leafy vegetables need not only to be determined but also estimated health risk for possible health effects on humans. Due to heavy metal deposition in vegetables, metal contents of leafy vegetables need not only to be determined but also estimated health risk for revealing possible health effects on humans. Vegetables grown on road side fields are exposed to atmospheric pollution in the form of metal containing aerosols through vehicular emissions. These heavy metal containing aerosols may lead high accumulation of heavy metals such as Pd, Cd, Ni, Cu and Zn in leafy vegetables due to atmospheric depositions. The number of vehicles in operation increasing year by year and lengthening of trips have resulted in the emissions of larger amount of metals originating from brake, tyre, and road wear. Zn is the most abundant heavy metal from tire wear. Its high concentration resulted from the addition of ZnS to the tire during vulcanisation. The greatest Zn emission from tire occurs through abrasion in the form of tire dust during acceleration, braking, and concerning. Asphalt and sand paper like effects are significant sources of Ni in road dust Chinese cabbage was determined to be safe for the consumption of both genders. Based on the carcinogenic risk assessment, most of the vegetables examined in this study were categorized as moderately toxic. This review strongly demonstrates that regular monitoring of heavy metal concentration in leafy vegetables grown near road side areas is very necessary to control heavy metal toxicity in human dietary system through vegetables.

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