

Assessment of Roadside Soil and Brassica Rapa Contamination by Heavy Metals in District Buner, Pakistan

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ABSTRACT

This study was conducted in Buner district of Pakistan to investigate the presence of Cadmium (Cd) and Lead (Pb) in roadside soil and *Brassica rapa* (Shalgham). For that purpose, soil and *B. rapa* samples were collected from primary, secondary, tertiary roadside fields and control site. The samples were investigated for Cd and Pb presence via atomic absorption spectrometer (PerkinElmer, AAS-PEA-700). The Cd concentrations in soil ranged from 2.55 to 4.35 with mean value 3.31 mg/kg, 3 to 8.85 with mean value 5.41 mg/kg, 3.15 to 5.55 with mean value 4.9 mg/kg and 2.45 to 5.25 with mean value 3.93 mg/kg on primary, secondary, tertiary road and control site respectively. While the Pb concentration in soil was 0.85 to 40.85 with mean value 22.83 mg/kg, 13.25 to 35.3 with mean value 22.05 mg/kg, 29.83 to 43.42 with mean value 34.36 mg/kg and 1 to 36.1 with mean value 21.61 mg/kg on primary, secondary, tertiary road and control sites, respectively. In *B. rapa* the Cd concentrations ranged from 2.13 to 3.5 with mean value 2.87 mg/kg, 2 to 6 with mean value 3.6 mg/kg, 2 to 3.7 with mean value 2.8 mg/kg, 1.5 to 2.6 with mean value 2.21 mg/kg for primary, secondary, tertiary roads and control site respectively. While the Pb concentration in *B. rapa* ranged from 2.9 to 7.3 with mean value 5.12 mg/kg, 0.83 to 11 with mean value 4.25 mg/kg, 0.33 to 5.3 with mean value 4.27 mg/kg, 0.2 to 11 with mean value 6.08 mg/kg for primary, secondary, tertiary roads and control site respectively. By applying Two-way ANOVA significant variation at $P \leq 0.05$ was found among the concentration of Cd and Pb in *B. rapa* and soil samples collected from various sample points. It was concluded that the *B. rapa* along different roads sides were found contaminated with Pb and Cd which may pose health risk.

Key words: Cadmium and lead toxicity, roadside soil, *Brassica rapa*, Buner

INTRODUCTION

Metal concentration beyond safe limit have potential toxicity and bring physiological changes in living beings. The main sources of heavy metals existed in the urban atmosphere due to pollutants from the traffic and transport, effluents from the industries and other man-made activities (Wiseman *et al.*, 2013; Naszradi *et al.*, 2004). Air pollution is due to traffic flux, specially Cd and Pb together with particulate matter, oxides of nitrogen and sulfur etc. (Irvine *et al.*, 2009; Morton-Bermea, 2009).

It is a matter of fact traffic flux and concentrations of Pb have a strong association (Atiku *et al.*, 2011). The main cause of Pb pollution on pavement soils and vegetation is traffic discharges (Sharma *et al.*, 2008; Irvine *et al.*, 2009; Abechi *et al.*, 2010). Cadmium is commercially used in carburetors as alloy during combustion which tends to release into

surroundings (Xu *et al.*, 2015; Liu *et al.*, 2007). The emitted heavy metals contaminate the soil, and from there they make their way to the vegetables.

Heavy metals like Cd and Pb are inoperable and harmful for vegetable' development; however, vegetation absorbs them swiftly when they exist in soil (Sanchez-Martin, 2000). The phytotoxic nature of Cd not only restrains the development of vegetables but perishes them too. Likewise, processes of respiration and photosynthesis are badly affected by Cd which also reduces the vegetables nutrient and water uptake. In addition, continuous load of heavy metal accumulation leads to soil degradation because due to Cd and Pb the plant root growth might be retarded (Irvine *et al.*, 2009; Cannata *et al.*, 2013). Due to decreased production of new cell pace, Cd reduces root growth, restrain anti-oxidative enzyme behavior of vegetables which

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brings oxidative pressure in units (Liu *et al.*, 2003).

The excessive intake of vegetables contaminated with heavy metals pose a risk to human health (Khan *et al.*, 2009; Huang *et al.*, 2014; Cai *et al.*, 2015). In Toyoma Japan, a large number of people were affected by intake of Cd contaminated rice due to nearby mining activities which contaminated the source of irrigation water (Jamil, 2010). In addition, a number of studies have also been conducted in Pakistan to highlight contamination of soil and some food crops of potentially toxic heavy metals (Ullah *et al.*, 2017; Khan *et al.*, 2013; Khan *et al.*, 2011). However quite limited data is available on the contamination of roadside soil and vegetables. Keeping in view the toxicological impacts of the selected metals the current study has been designed to investigate Cd and Pb contamination of roadsides soil and *Brassica rapa* of District Buner, KP.

MATERIAL AND METHODS

Study Area

District Buner lies at 34°26'34.83" latitude and 72°29'57.58" longitude in the Khyber Pakhtunkhwa province of Pakistan. It is a land locked area surrounded by mountain ranges. Due to increasing population and business growth the number of vehicles in district is also increasing day by day (DHP, 2005). The existing road networks bifurcates into three categories i.e. primary roads that mainly carry mass traffic of the area, secondary roads extended from main road and tertiary roads extended from secondary roads also known as link roads. Agricultural fields exist on the banks of these roads were selected for the study.

Soil Sampling and Analysis

Randomly 10 soil samples were collected from each primary, secondary, tertiary road side fields with uniform distance of 4 meters from road sides and control site (field far away from road, having almost no traffic). A sample of 1 kg soil was drawn from 20 centimeters depth and put into an air tight

polythene bags. The bags were transported to laboratory for analysis. Soil samples of 0.5 g were digested with concentrated HNO₃ and HClO₄ (5:1) ratio at 160°C till the appearance of crystal clear solution (Khan *et al.*, 2011). After digestion, the suspensions were filtered and were adjusted to 50 ml by adding deionized water. The concentrations of heavy metals i.e. Pb and Cd were determined by using atomic absorption spectrometer (Analyst 700 Perkin-Elmer) (Khan *et al.*, 2013; Khan *et al.*, 2011).

Vegetable Sample Digestion and Analysis

The *B. rapa* samples were randomly collected from those points where soil samples were collected. An oven dried edible portion of sample of 0.5 g was put into acid washed digestion tube. A mixture of concentrated HNO₃, HClO₄ and H₂SO₄ (5:1:10) was added and left for 24 hrs. Next, the tubes were fixed in the digestion block at temperature of 80°C for one hour and the temperature was increased from 120-130 °C till complete digestion was done. After digestion, the suspensions were filtered and were adjusted to 50 ml by adding deionized water. The concentrations of heavy metals i.e. Pb and Cd were determined by using atomic absorption spectrometer (Analyst 700 Perkin-Elmer) (Khan *et al.*, 2013).

Data Analysis

The collected data was analyzed for descriptive statistics i.e. mean, standard deviation etc. and Two-way ANOVA by using SPSS software.

RESULTS

Cd Concentration in Soil

The Cd concentration in soil ranged from 2.55 to 4.35 mg/ kg with <3.31> mean concentration on primary road site. On secondary road site, the concentration ranged from 3.0 to 8.85 mg/kg with <5.41> mean concentration. On tertiary road site, it ranged from 3.15 to 5.55 mg/kg with mean concentration <4.9>. On control site, the Cd concentration in soil ranged from 2.45 to 5.25 mg/kg with <3.93> mean concentration (Fig: 1).

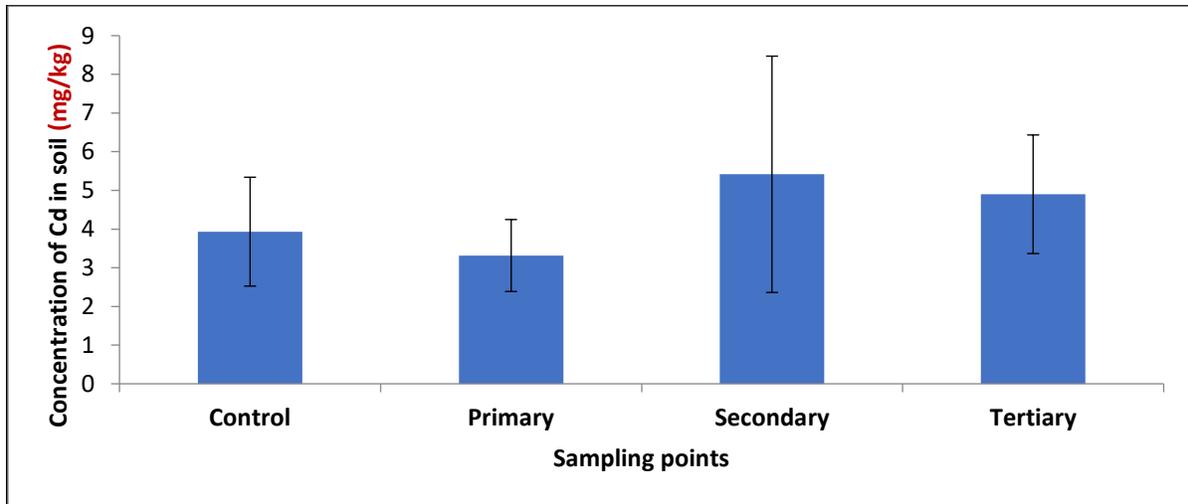


Fig: 1. Mean concentrations of Cd in soil of primary, secondary and tertiary roadside site: error bars indicate standard deviation.

Cd Concentration in *Brassica rapa*

The actual concentration of cadmium in *B. rapa* along with different sampling points namely primary, secondary, tertiary roadside fields and control site were determined. On primary road site, the Cd concentration in *B. rapa* ranged from 2.13 to 3.5 mg/kg with <2.87> mean concentration. On secondary road site,

the Cd concentration in *B. rapa* ranged from 2.0 to 6.0 mg/kg with <3.6> mean concentration, on tertiary road site the Cd concentration in *B. rapa* ranged from 2.0 to 3.70 mg/kg with <2.80> mean concentration. On control site, the Cd concentration *B. rapa* ranged from 1.50 to 2.60 mg/kg with <2.21> mean concentration (Fig: 2).

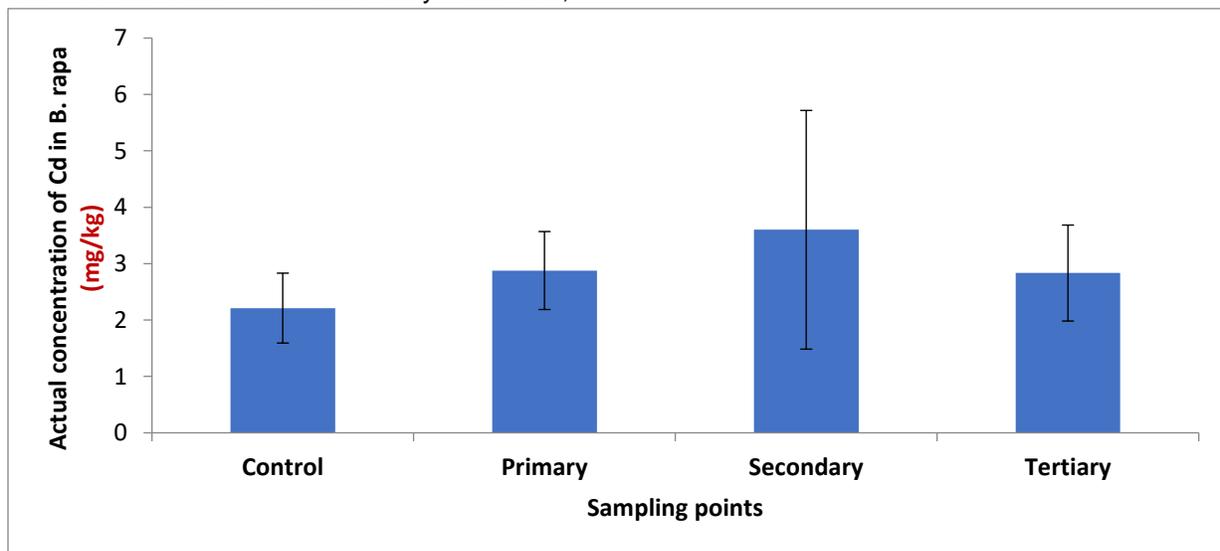


Fig: 2. Mean Cd concentrations in *B. rapa* grown along primary, secondary and tertiary roadside: error bars indicate standard deviation.

Pb Concentration in Soil

The concentration of Pb in soil along with different sampling points namely primary, secondary, tertiary roads and control site were determined. On primary road site, the Pb concentration in soil ranged from 0.85 to 40.85 mg/kg with <22.83> mean concentration. On secondary road site, the Pb concentration in soil ranged from 13.25 to 35.3 mg/kg with <22.05> mean concentration. On tertiary road site, the Pb concentration in soil ranged from 29.83 to 43.42 mg/kg with <34.36> mean concentration. On control site, the Pb concentration in soil ranged from 1.0 to 36.1 mg/kg with <21.61> mean concentration (Fig: 3).

Pb Concentration in *B. rapa*

The actual concentration of Pb Lead in *B. rapa* along with different sampling points namely primary, secondary, tertiary roads and control site were determined. On primary road site the Pb concentration *B. rapa* ranged from 2.90 to 7.3mg/kg with <5.12> mean concentration. On secondary road site, the Pb concentration *B. rapa* ranged from 0.83 to 11 mg/kg with <4.25> mean concentration. On tertiary road site, the Pb concentration *B. rapa* ranged from 0.33 to 5.3 mg/kg with <4.27> mean concentration. On control site, the Pb concentration *B. rapa* ranged from 0.2 to 11 mg/kg with <6.08> mean concentration (Fig: 4).

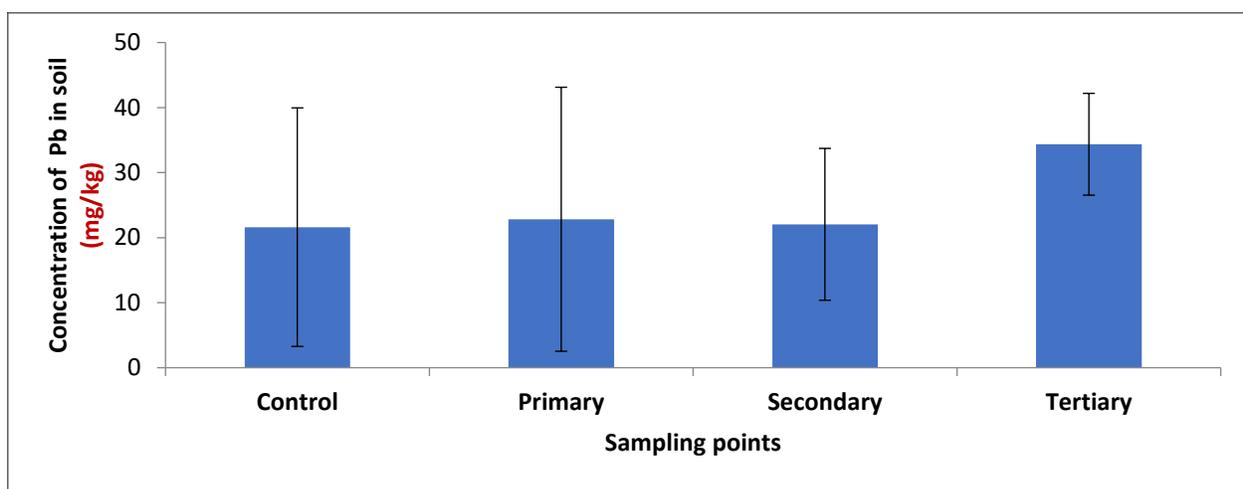


Fig: 3. Mean concentrations of Pb in soil of primary, secondary and tertiary roadside site: error bars indicate standard deviation.

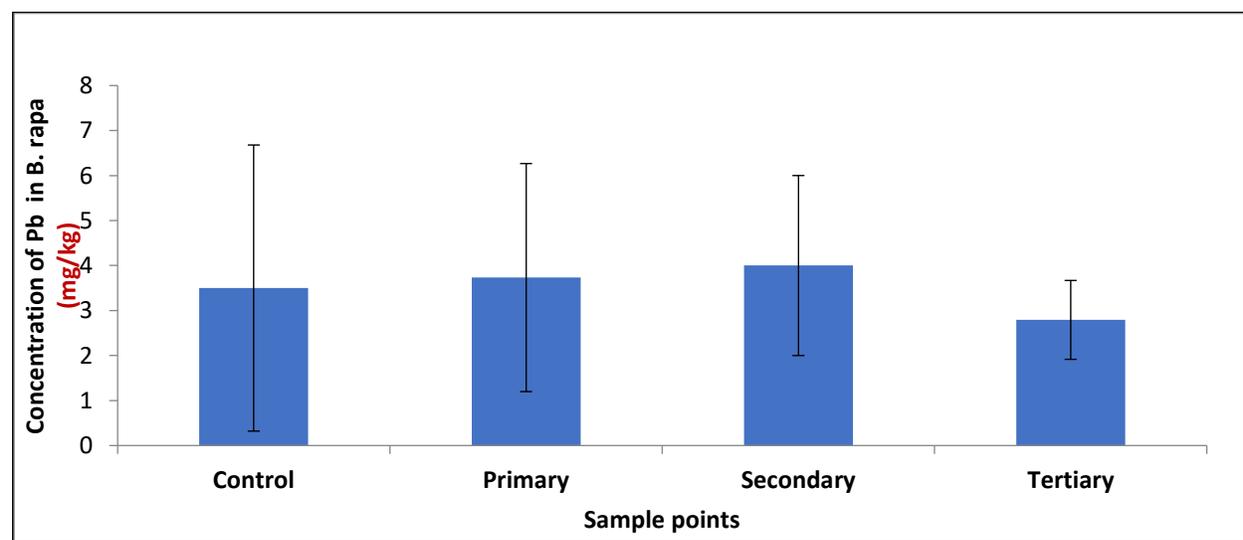


Fig: 4. Mean Pb concentrations in *B. rapa* grown along primary, secondary and tertiary roadside site: error bars indicate standard deviation.

DISCUSSION

Industrialization and motorization have greatly polluted the environment with several potential toxic heavy metals (Waisberg *et al.*, 2003). PM released in environment as a result of gasoline i.e. high-speed engine oil and high speed diesel burning have been analyzed for Cd and Pb contents. The concentration of Pb was found in the range of 0.0275-0.614 g/L while Cd was not detected. In high speed diesel mean value of Cd 0.003g/L and Pb 0.0038gm/L has been reported (Zhou *et al.*, 2016).

Beside these a number of studies reported the contamination of roadside plants and soils with Pb and Cd (Rahim *et al.*, 2016; Bakirdere *et al.*, 2008; Fusconi *et al.*, 2015; Botsou *et al.*, 2016). Important pathways for uptake of these toxic heavy metals are particulate matters and food (Sandalio *et al.*, 2001). Vegetables uptake and accumulate high amount of heavy metals than other food crops (Cenkci *et al.*, 2010). Daily intake of heavy metals like Cd and Pb pose health risk to the general population (Zhou *et al.*, 2016). The presence of Pb and Cd in the vegetable and soil samples is a health risk (Shaheen *et al.*, 2016; Khan *et al.*, 2009; Huang *et al.*, 2014; Cai *et al.*, 2015; Sharma, *et al.*, 2016) for the residents of the study area. Because both Pb and Cd are known for their toxicities. Exposure to which can cause a number of fatal diseases. They include renal malfunction and neurological issues. Studied so far highlighted the harmful impacts of these metals up to some extent while the rest are still awaited to be explored (Meeker *et al.*, 2008).

CONCLUSION

The study estimated the concentration of potentially toxic heavy metals absorbed by roadside soil and vegetables. Comparison of the data of Cd and Pb in soils and *B. rapa* of primary, secondary, tertiary and control sites showed significant variations. So, the higher concentration of these heavy metals may be due to high rate of vehicular emissions, whereas the concentration of Cd and Pb in control site might be due to geographical factors rather than traffic.

It was concluded that the *B. rapa* along different roads sides were found contaminated with Pb and Cd which may pose health risk.

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