

Determination of Heavy Metals Contamination of the Environment Around Ziway Floriculture Industry

Alemayehu P. Washe Tadelech Tiruneh Ermias Haile

Department of Chemistry, College of Natural and Computational Sciences, Hawassa University, P.O. Box 5, Hawassa, Ethiopia

Abstract

The aim of this study was to determine the level of environmental pollution by selected heavy metals in soil, water and vegetables around floriculture industry. The level of the selected heavy metals in soil, water and vegetables were analysed by Flame Atomic Absorption spectroscopy. The detected range of the heavy metals in soil sample collected at different distances from the targeted floriculture area were Cd($ND-0.10 \pm 0.002$), Pb($1.78 \pm 0.003-7.01 \pm 0.007$), Cr(7.00 ± 0.006 to 14.2 ± 0.003), Ni(7.22 ± 0.006 to 13.76 ± 0.003), Co(3.12 ± 0.025 to 5.71 ± 0.003), Cu($2.22 \pm 0.003-5.89 \pm 0.002$), Zn($56.2 \pm 0.006-70.9 \pm 0.003$) mg/kg in top soil and subsoil were Cd(ND to 0.10 ± 0.004), Pb(1.7 ± 0.005 to 2 ± 0.015), Cr(4.03 ± 0.002 to 13.8 ± 0.01), Ni($8.39 \pm 0.005-10.0 \pm 0.003$), Co($3.0 \pm 0.001-6.95 \pm 0.003$), Cu($2.0 \pm 0.002-4.60 \pm 0.002$), Zn($40.75 \pm 0.02-67.9 \pm 0.01$). The level of metals Cd ($0.258 \pm 0.0-0.61 \pm 0.001$), Pb($0.053 \pm 0.002-1.67 \pm 0.002$), Cr($1.20 \pm 0.005-3.01 \pm 0.002$), Ni($17.15 \pm 0.013-34.46 \pm 0.009$), Cu($1.61 \pm 0.002-3.29 \pm 0.030$), Zn ($33.33 \pm 0.004-40.53 \pm 0.006$), Co ($0.13 \pm 0.003-1.39 \pm 0.003$)mg/kg in vegetable .Onion accumulate metals than tomato and cabbage Onion>tomato>cabbage. Concentration of metals in Lake ziway were 0.01 ± 0.001 , 0.06 ± 0.001 , 0.012 ± 0.12 , 0.117 ± 0.02 , and 0.05 ± 0.01 mg/L for Ni, Cr, Cu, Zn and Co respectively. Pb and Cd were below the limit of detection. The measured physico chemical parameters in soil sample ranged pH (7.49-8.92) Electrical Conductivity ($0.786 \pm 0.010-2.851 \pm 0.01$), the pH of water was 8.78 ± 0.001 and its EC was 0.626 ± 0.003 . The level of heavy metals in soil samples was found to increase as sampling distance from the factory decreases. This study indicates that all of the metals are concentrated on the surface soil, and decreased in the lower part of the soil, this is due to reflect their mobility and physical properties of soil and its alkaline pH values.

Keywords: Environmental sample, Floriculture industry and Heavy metals.

1. Introduction

Floriculture can be defined as a discipline of horticulture concerned with the cultivation of flowering and ornamental plants for gardens and for floristry [1]. The rapidly growing floriculture industry is using chemicals (pesticides and fertilizer). The rapidly growing floriculture industry is intensively poisoning its workers and the environment [2]. production process that requires the extensive use of agrochemicals (fertilizers and pesticides), which have a negative effect on the soil and water supply. Agrochemicals leave residues such as heavy metals and organic compounds which pose health risks to humans and hazardous ecological risks to plants and animals [3].

The main causes of NO_3 and trace element pollution are fertilizers and pesticides used in agricultural activities [4]. The floriculture industry is a short-cycle continued use of chemical fertilizers and pesticides may destroy these nitrogen-fixing bacteria and many other micro- and macro-organism of the soil [1]. The industry is blamed for using too much chemicals which damage the environment through its discharge [5].

Floriculture industry located at Ziway has been putting pressure on the environment through discharging chemicals (fertilizers and pesticides) containing compounds of heavy metals. Effluents from the farm are causing algal blooms around the outlet of the farm which is driven by excessive nitrate and phosphate residues. Besides, toxic chemicals pesticides and fertilizers can migrate via water in to the food chain ultimately being consumed by humans and animals in food.

This study was conducted to assess the potential negative impact of heavy metals on the environment and human health, causing long-term hazardous effects on soil and negatively influence the soil biological processes, soil microbial biomass and function associated with soil N transformation.

2. Methods and Materials

2.1 Study area

The research was conducted in Ziway town around floriculture, the Great Rift Valley zone in Ethiopia. It is situated in east showa zone of oromia region at about 160km from Addis Ababa. Floriculture industries are situated between Lake Ziway and the main highway with altitude range between 1600–1700 meters above sea level the soils in the rift valley have been derived from the parent materials. Alkaline sub soil occurs in area [3].

2.2 Instrument and Apparatus

In this work atomic absorption spectrometry was used to determine selected heavy metals (cadmium, lead, cobalt,

nickel, chromium, zinc and copper) in soil sample, lake water sample and vegetable sample. All chemicals and reagents were analytical grade and all standards were prepared from reagent grade chemicals. Drying oven was used for drying the samples placed on porcelain crucibles. Measuring cylinders, pipettes and micro pipettes were used for measuring different volumes of sample solution, acid reagents and metal standard solutions. Volumetric flasks (10, 25, 50 and 100 ml) were also used during dilution of sample and preparation of metal standard.

2.3 Reagents and materials used

Reagents that used in the analysis were all analytical grade (69-72 %) HNO₃, 37% HCl and 70% HClO₄ were used for digestion of Soil samples. The standard solutions of metals Cr, Cu, Ni, Cd, Co, Zn and Pb (Buck Scientific) were prepared in different concentrations to obtain calibration curve by diluting 1000 mg/L stock solutions of each metal. Distilled water was used throughout the experiment for sample preparation, dilution and rinsing apparatus prior to analysis.

2.4 Sampling

Samples of soil, vegetable and water were collected around share Ethiopia floriculture (Ziway). The samples were collected for detection of level of heavy metals.

2.4.1 Sampling and Sample Pre-treatment of soil

The composite Soil samples were collected from each sampling site in poly ethylene bags from soils around the selected floriculture area in Ziway town. Samples were taken systematically around the floriculture starting from the fence and proceeding away from the farm at 100 m, 250m, and 500m and 1Km intervals in every direction (East, West and North) of the reference point until 1 km radius is covered around the floriculture. Soils from depths of 0-15cm and 15- 30cm were taken at each sampling point. A total of 24 soil samples from floriculture area were brought to Hawassa university chemistry laboratory for analysis. Stones and unwanted objects were removed by hands. Soil samples were then measured and be dried in the oven dry for 24hours at 80 °C then weighed by using analytical balance. The dry soil samples were ground by using ceramic mortar and passed through a (<2mm) sieve.

2.4.2 Sampling and sample pre- treatment of vegetable

The vegetable sample includes cabbage, onion and tomato. Those samples were collected around Lake Ziway from each site taking three different samples. Each sample was collected by grid system and handpicked, wrapped and labelled. In the laboratory, each sample was washed with tap water and distilled water then dried in an oven at 80 °C for 48hrs. Each sample was ground into a fine powder, sieved and finally stored in plastic packed and appropriately labeled.

2.4.3 Sampling and pre-treatment of water

The samples were collected in one liter of polyethylene air-tight plastic bottles. Prior to sampling the well cleaned 1-L polyethylene bottles were cleaned by incubating for 48 hours in a hot water bath and then washed and rinsed with distilled and de-ionized (<1µs/cm) water. They were thoroughly rinsed with the water from the sampling sites before sampling. Lake water samples were taken by immersing the pre cleaned plastic beaker at the depth of the river. Samples were collected in pre-cleaned polyethylene bottles and acidified to pH < 2 with 3 ml concentrated nitric acid (reagent grade, Spectrosol, England). Finally all the samples were stored at 4 °C until analysis in a refrigerator for maintaining the sample in a state that minimizes change in the composition or concentration of the components in the time between collection and analysis.

2.4.4 Sample Preparation for Physico-chemical analysis

The pH of the sample was measured with a portable pH meter (Model HI9024, HANNA Instrument) calibrated with pH 4.0, 7.0 and 10.01 standard buffer solutions. Conductivity was analyzed using portable digital conductivity meter (model 4200, Jenway, England instrument). It has been calibrated with 0.001 M KCl standard conductivity buffer solution to give a value of 14.7µS/m at 25°C.

2.5 Sample digestion

2.5.1 Soil digestion

Soil sample was weighed to 1 gram in a balance and transferred to a 250ml round bottom flask. 10 ml of 6:2:2 ratio of HNO₃, HCl and HClO₄ was carefully added then heated in a hot plate at a temperature of 200 for 2h. The digested solution was cooled and 5ml distilled water was added and gently swirled and filtered through whatman filter paper. The filtrates were collected in a 25ml volumetric flask and filled to the mark with distilled water and sample metals were analyzed by flame atomic absorption.

2.5.2 Vegetable digestion

The vegetables were weighed to 1 gram in a weighing dish and transferred to a 250ml round bottom flask. 8ml of 6:2 ratios of HNO₃ and HClO₄ was carefully added then heated in a hot plate at temperature of 200 for 2h. The digested solutions were left to cool and 5ml distilled water added and gently swirled then filtered through whatman filter paper. The filtrates were collected in a 25ml volumetric flask then filled to the mark with distilled

water and Sample metals were measured by flame atomic absorption.

2.5.3 Digestion of blank samples

Digestion of blank was performed in parallel with the root sample with the same digestion parameters. Digestion for the analysis of the samples six reagent blank samples were prepared for each. All the digested blank samples were stored in refrigerator until analysis. The solutions of the digested blank samples were used to determine the concentration of each element by FAAS.

2.5.4 Digestion of soil sample for nitrogen by using kjeldahal

The Kjeldahl procedure is based on the principle that the organic matter is oxidized by treating soil with concentrated sulfuric acid, nitrogen in the organic nitrogenous compounds being converted in to ammonium sulphate during the oxidation.

The acid traps NH_4^+ ions in the soil, which are librated by distilling with NaOH. The librated NH_4^+ is absorbed in boric acid and back titrated with standard H_2SO_4 . Potassium sulfate is added to raise the boiling point of the mixture is added as a catalyst. The procedure determines all soil nitrogen (including absorbed NH_4^+). One gram of soil sample (<0.5mm sieved) and transferred into digestion tube, mixture of catalyst and boiling stones then 7ml of H_2SO_4 was added. The tube with rack was placed and exhausted manifold on the digestion block. Digested for 3h and the digest was pale yellow. 50ml distilled water was added and allowed to cool. 20ml boric acid solution placed in receiver Erlenmeyer flask then the end of the condenser was immersed in it. 75ml of 40% NaOH poured gently to the digest and distillation was started. The receiver flask solution was titrated from green to a pink end point by H_2SO_4 and reading was recorded

2.5.5 Determination of Nitrate in water sample

For NO_3^- , one level spoonful of Nitratest Powder and one Nitratest tablet was added in to Nitratest Tube containing 20 ml of sample, the tube was shaken for one minute. The tube was allowed to stand two minutes to ensure complete settlement and 10 ml of solution was transferred in to palintest tube (Round Test Tubes, 10 ml glass, PT 515) and for full color development the solution was stand for 10 minutes after one Nitricol tablet was added. Finally, the Photometer reading was taken at 570 nm wavelength and the transmittance of the photometric reading was converted in to concentration (mg/L) by using Nitratest calibration chart.

2.6 Recovery analysis

The validity of the analytical procedures and efficiency of atomic absorption spectrophotometer used for sample analysis was tested by spiking experiments calculating the recovery percent. To evaluate the validity of the optimized digestion procedure and efficiency of optimized digestion spiking experiment was done. All the spiked samples were digested in triplet following the optimal digestion procedure and sample was analysed by atomic absorption photometer.

2.7 Data analysis

As the study is aimed at assessing the degree of contamination of vegetable and soil samples using heavy metals analysis, data obtained were analyzed by a computer program to analyze tabulated data using Microsoft Excel 2007 and origin 8 Software. Analysis of variance commonly abbreviated as ANOVA. One-way ANOVA ($\alpha = 0.05$) was used to assess the significance difference between the sample sites. t- test was used to check whether there was a significant difference or not between the upper and layer soil sample.

3. Results and Discussion

3.1 Physicochemical characterization

Soil quality can be defined by physicochemical characterization and often with biological processes influence soil fertility in a variety of ways, each of which can make better effect on the main soil based constraints to productivity. In this study pH and EC are shown in Table 1. The pH value is measured for all samples and ranging in narrow interval (7.49-8.92), indicating that the soils are originally alkaline. The maximum and the minimum value are recorded for the samples taken at a distance of 100m and 1km, layer soil samples the value ranges from (7.83-8.89) and also showing maximum and minimum value at similar distance with top soil samples, these values were obtained in eastern direction.

The EC value of top soil samples is higher than the layer soil sample. It is found in the range of (0.786-2.851) ms/cm. The highest value was recorded at 100m in north direction and the lowest value was recorded at 1km in eastern direction from the farm. For the sub soil sample the values of EC ranged between (0.932-2.771) ms/cm. The maximum and the minimum value of EC are found in the same distance and direction as top soil samples. High EC value is due to concentration of salt in the soil. Industrial saline wastes and irrigation are the main human activities that add salts to the soil [6]. Table 1 summarizes results for physicochemical parameter.

On the other hand the physicochemical properties of water sample were pH (8.78±0.001) and its EC was 0.626±0.003. The pH of the water is important because it affects the solubility and availability of nutrients and how they can be utilized by aquatic organisms. Lake Ziway is slightly Alkaline in nature due to the geology of

the rocks. P^H of the Lake slightly exceeded FAO and WHO water quality guidelines for irrigation, P^H of >8.4 are beyond the normal range for irrigation (FAO, 2001)[3]. This could show that the lake water is becoming less suitable for irrigation and domestic use, extraction of water and release of products from the floriculture industry. EC estimates the amount of total dissolved salts or the total amount of dissolved ions in the water. High electrical conductivity indicates high dissolved solids concentration; dissolved solids can affect the suitability of water for domestic, industrial and agricultural uses [7].

3.2 Result of total nitrogen in soil

Heavy metals cause hazardous effect on soil microbial biomass and functions, this has negative influence on nitrogen transformation processes, which in turn affects the amount and form of mineral nitrogen present in soil[8].

Total Kjeldahl Nitrogen analysis quantify the amount of nitrogen contained in organic form. Heavy metals increase around the farm the total nitrogen decreases due to decrease in biomass of microbial (Table 2).

3.3 Results of Nitrates in water

The main causes of NO_3 and trace element pollution are fertilizers and pesticides used in agricultural activities [9, 10].

Concentration of nitrate in lake water sample was 24.5 ± 0.003 . The amount of nitrate in this study was less than that obtained by Malefia[3]. Based on FAO guidelines, NO_3-N values between 5-30mg/l have slight moderate problems for irrigation [10].

3.4 Result of heavy metals in soil samples

In Ethiopia there are floricultures present now a day, floriculture though release of chemicals like heavy metals generated from fertilizers and pesticides. Calibration curves for each heavy metal were set to ensure the accuracy of the Atomic absorption Spectrophotometer. The comparisons of metal concentrations in upper soil sample around floriculture with reference soil were listed in Table 3 and Table 4

3.5 Determination of top soil samples collected around Floriculture farm (Ziway)

Table 4 summarize the concentrations of seven heavy metals in 12 top composite soil collected around the floriculture farm. All the seven metals display their presence in the entire soil.

Cadmium (Cd)

The mean levels of Cadmium ranged from ND to 0.1 mg/Kg in the soil samples from the farm. These values are lower than the natural limits of 1 and 3 mg/kg in soil as given by EU (2006) FAO, WHO guideline [11]. In this work Cd level was lower than those reported by Attah, L.E. et al [12].

Lead (Pb)

The concentration of Pb in the upper part of soil varies from 1.7 ± 0.003 - 7.01 ± 0.002 mg/kg which is lower than 100 mg/kg reported by WHO, FAO and EU (2006). The minimum value was recorded at 1km from the farm in eastern direction. The maximum was recorded at 100 m from the farm in northern direction. The low lead contents obtained in this work agreed with those obtained by Kebede et al [13].

Chromium (Cr)

The concentration of Cr in top soil ranged from 7.00 ± 0.001 to 14.2 ± 0.005 mg/kg and significantly lower than 100 mg/kg reported by EU (2006) and WHO/FAO. The minimum was detected at 1km from the farm in eastern direction. The maximum was detected at 100 m from the farm in northern direction. The chromium value in this study was less than those reported by Attah et al [12].

Nickel (Ni)

The mean concentration of Ni in soil around the floriculture varied between 7.23 ± 0.006 mg/kg_ 13.76 ± 0.03 mg/kg it is lower than 50mg/kg reported by EU (2006) and WHO FAO. The minimum was detected at 1km from the farm in eastern direction. The maximum was detected at 100m from the floriculture in eastern direction. The chromium value in this study was less than those reported by Attah et al [12].

Copper (Cu)

The level of Cu detected in the studied soil samples ranged between 2.22 ± 0.003 mg/kg 5.94 ± 0.002 mg/Kg which is below permissible limit 100mg/Kg set by FAO and WHO. The minimum was detected at 1km from the farm in west direction. The maximum was detected at 100m of north direction from the farm.

Cobalt (Co)

The level of Co detected in the studied soil samples ranged between 3.12 ± 0.003 - 5.71 ± 0.003 mg/kg. The minimum was detected at 1km from the floriculture in western direction. The maximum was detected at 100m from the farm in eastern direction. The mean of Co in this work was lower than those reported by Mico et al [14].

Zinc (Zn)

The level of Zn detected in the studied soil samples ranged between 53.6 ± 0.06 to 70.9 ± 0.08 mg/kg. The minimum

was detected at 1km from the floriculture in east direction. The maximum was detected at 100m from the farm in north direction. Based on the results presented in (table 4), the overall degree of contamination by seven metals in distance terms of the order 100m>250m>500m>1km. And also table provides information which indicated that the order of contamination is N>W>E in terms of directions from the floriculture farm. Zn>Cr>Ni>Pb>Co>Cu>Cd. Zinc metal

3.6 Results of sub- soil samples collected from the area around floriculture

The mean concentration of metals in both soil depths (Table 5) is found to be higher than their corresponding mean values in the reference.

Lead (Pb)

The concentration of Pb in the layer part of soil varies from 1.70 ± 0.003 – 5.2 ± 0.015 mg/kg which are lower than 100mg/kg reported by EU (2006) and FAO/WHO. The minimum value was recorded at 1km from the floriculture in east direction. The maximum was detected at 100m in north direction. The low lead contents obtained in this work agreed with those obtained by Kebede et al. [13].

Chromium (Cr)

The mean concentration of Cr in sub soil ranged from 4.03 ± 0.004 – 13.8 ± 0.003 mg/kg and significantly lower than 100mg/kg reported by EU (2006) and FAO/WHO. The minimum was detected at 1km from the floriculture in east direction. The maximum was detected at 100m around floriculture in west direction. The chromium value in this study was less than those reported by Attah et al. [12]

Nickel (Ni)

The mean concentration of Ni around floriculture soil varied between 6.45 ± 0.005 mg/kg and 16.81 ± 0.003 mg/kg and which was lower than the critical permissible level which is 50mg/kg for soil recommended by EU (2006) and FAO/WHO. The minimum was detected at 1km from the floriculture in east direction. The maximum was detected at 100m from the farm in west direction. The nickel value reported in this study was less than those reported by Attah et al. [12] and Kebede M. et al [13].

Copper (Cu)

The mean concentration of Cu around floriculture soil varied between 2.00 ± 0.002 mg/kg 5.5 ± 0.002 mg/kg. The minimum was detected at 1km from the floriculture in east direction. The maximum was detected at 100m from the farm in north direction. In this study, the mean of Cu was lower than the permissible level

Cobalt (Co)

The mean concentration of Co around floriculture soil varied between 3.01 ± 0.0015 mg/kg 6.95 ± 0.005 mg/kg. The minimum was detected at 1km from the farm in east direction. The maximum was detected at 100m from the farm in north direction. The mean of Co in this work was lower than those reported by Mico et al [14] in Mediterranean agricultural soil.

Zinc (Zn)

The mean concentration of zinc around floriculture soil varied between 41.26 ± 0.028 mg/kg and 67.9 ± 0.016 mg/kg. The minimum was detected at 1km from the farm in east direction and maximum was detected at 100m in north direction. The maximum mean value of zinc in this work (67.9mg/kg) the reference value (52.2 mg/kg) of Attah et al [12]. Contained less than the maximum permissible concentration of zinc 300mg/kg by Kabata-Pendias and Pendias as cited by Attah et al [12]. Vegetables are significantly different (0.05 level)

3.7 Result of heavy metals in vegetables (cabbage, tomato, onion).

The sources of heavy metals to vegetable crops are growth media (soil, air, nutrient solutions) from which they are taken up by the roots or foliage [15]. The daily intake of heavy metals depends on both the concentration of heavy metals in edible portions of vegetables and the consumption. Average metal concentrations range mg/Kg found in cabbage, onion, and tomato from study area are shown on (Table 6)

Lead (Pb)

The maximum Pb concentration level was recorded in onion (1.67 ± 0.002 mg/kg) and the lower Pb concentration was recorded in cabbage (0.053 ± 0.002 mg/kg). The mean concentration of lead in onion vegetable was above metal permissible limit in vegetables Lead metal is significantly different in vegetables sampling sites (at 0.05 levels).

Nickel (Ni)

The highest mean concentration of Ni was found in onion (34.46 ± 0.009 mg/kg) and the lowest mean concentration of Ni found in tomato (17.15 ± 0.013 mg/kg). The level of Nickel metal is significantly different in vegetables sampling sites (at 0.05 levels).

Chromium (Cr)

The maximum mean concentration of Cr found in onion (3.01 ± 0.002 mg/kg) and the minimum mean concentration of Cr found in tomato (1.20 ± 0.005 mg/kg). The concentration of Chromium metal is not

significantly different in vegetables sampling sites (at 0.05 levels). It is higher than the permissible standard limit of heavy metals in vegetable FAO/WHO.

Copper (Cu)

The maximum mean concentration of Cu found in tomato (3.29 ± 0.030 mg/kg) and the minimum mean concentration of Cu found in cabbage (1.61 ± 0.002 mg/kg). Copper is significantly different in vegetables samples (at 0.05 level).

Zinc (Zn)

The highest mean concentration of Zn was found in onion (40.53 ± 0.006 mg/kg) and the lowest mean concentration found in tomato (33.33 ± 0.004 mg/kg). Zinc concentration was higher than reported by Reta B.K et al [8]. Zinc is not significantly different in vegetables samples (at 0.05 levels).

Cobalt (Co)

The maximum mean concentration of Co found in tomato (1.39 ± 0.003 mg/kg) and the minimum mean concentration of Co found in onion (0.13 ± 0.003 mg/kg). The level of Cobalt metal is significantly different in vegetables sampling sites (at 0.05 levels).

Cadmium (Cd)

The mean levels of Cadmium ranged from 0.000-0.01 mg/kg in the soil samples from the farm. These values are lower than the natural limits of 1 and 3 mg/kg in soil as given by EU FAO, WHO guideline. In this work Cd level was lower than those reported by Attah, L.E. et al [12]. The concentration of Cadmium metal is significantly different in vegetables sampling sites (at 0.05 levels).

3.8 Results of heavy metals in water sample

Seasonal variations and flooding water subsequently lead to pollutant dilution. Even though heavy metal contents in water and sediments are below the acceptable levels, a hazardous possibility may generate depending on rapid expansion [13, 39]. Concentration of metals in Lake Ziway were 0.01 ± 0.001 , 0.06 ± 0.001 , 0.012 ± 0.012 , 0.117 ± 0.02 , and 0.05 ± 0.01 mg/L for Ni, Cr, Cu, Zn and Co respectively. Pb and Cd were below the limit of detection. Heavy metal in water sample, is below the standards of Permissible limits of heavy metals given by WHO/FAO.

4. Conclusions

The data obtained in this study demonstrate that the metals concentrations of soil around the floriculture industry were below the toxicity limits set by WHO/FAO and EPA. Highest value of physicochemical parameters and heavy metal concentration were found for the top and sub soil in the area close to the floriculture factory. Long term exposure and deposition of this metal can cause an effect on both living things and soil properties. The effects of heavy metals contamination on soil cause huge disturbances in the ecological balances and health of living organisms on earth. Microorganisms and enzymes associated with N transformation in soil are inhibited by heavy metals for the vegetable samples based on results of the study the concentration of all studied heavy metals were above the permissible limit. Toxic metal accumulation in vegetables detected was severe and has potential to cause health risk to the communities consuming these vegetables, since these metals tend to bioaccumulate in consumer bodies.

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Table 1 Results for Physico chemical parameters of soil samples (mean \pm SD, n=3)

Upper soil sample(0.15cm)			Sub soil sample(0.30cm)		
Sight of the study	pH	EC (ms/cm)	Sight of the study	P ^H	EC(ms/cm)
100mETS	8.92 \pm 0.030	1.054 \pm 0.001	100mESS	8.894 \pm 0.024	1.375 \pm 0.004
250mETS	8.85 \pm 0.030	1.563 \pm 0.01	250MESS	8.64 \pm 0.06	1.86 4 \pm 0.007
500mETS	8.64 \pm 0.14	0.834 \pm 0.003	500mESS	8.04 \pm 0.08	1.040 \pm 0.002
1KmETS	7.49 \pm 0.005	0.786 \pm 0.010	1kmEsS	7.83 \pm 0.06	0.932 \pm 0.002
100mNTS	8.67 \pm 0.036	2.851 \pm 0.01	100mNSS	8.625 \pm 0.025	2.771 \pm 0.003
250mNTS	8.21 \pm 0.037	1.974 \pm 0.004	250mNSS	8.56 \pm 0.035	1.991 \pm 0.006
500Mnts	8.31 \pm 0.049	1.862 \pm 0.025	500mNSS	8.41 \pm 0.027	1.891 \pm 0.005
1KmNTS	7.88 \pm 0.095	0.877 \pm 0.010	1KmNSS	8.04 \pm 0.0021	0.980 \pm 0.0047
100mWTS	8.67 \pm 0.036	2.010 \pm 0.003	100mWSS	8.843 \pm 0.105	1.922 \pm 0.002
250Mwts	8.73 \pm 0.049	1.941 \pm 0.005	250mWSS	8.604 \pm 0.010	1.821 \pm 0.002
500Mwts	8.72 \pm 0.020	1.660 \pm 0.003	500mWSS	8.510 \pm 0.046	1.154 \pm 0.010
1KmWTS	8.45 \pm 0.045	1.14 2 \pm 0.005	1KmWSS	8.274 \pm 0.055	0.941 \pm 0.003

Note: EST=East Top Soil, NTS=North Top Soil, WTS=West Top Soil, ESS=East sub- soil NSS=North sub-soil, WSS=West sub-soil

Table 2 Results for Total Nitrogen

Sites	T.N	Sites	T.N
ETS1	0.156	ESS1	0.173
ETS2	0.196	ESS2	0.176
ETS3	0.249	ESS3	0.243
ETS4	0.309	ESS4	0.289
NTS1	0.148	NSS1	0.155
NST2	0.208	NSS2	0.169
NST3	0.261	NSS3	0.244
NST4	0.281	NSS4	0.275
WST1	0.165	WSS1	0.154
WST2	0.217	WSS2	0.195
WST3	0.201	WSS3	0.232
WST4	0.329	WSS4	0.301

Table 3 Heavy metal concentration (mg/kg) of reference soil

Metals	Maximum conc.	Minimum conc.	Mean
Cadmium(Cd)	0.03 \pm 0.002	ND	0.015 \pm 0.002
Lead(Pb)	3.87 \pm 0.005	1.78 \pm 0.003	2.825 \pm 0.003
Chromium(Cr)	9.98 \pm 0.003	7.00 \pm 0.006	8.49 \pm 0.004
Nickel(Ni)	10.0 \pm 0.003	8.39 \pm 0.005	9.195 \pm 0.001
Cobalt(Co)	5.07 \pm 0.003	3.12 \pm 0.002	4.095 \pm 0.001
Copper(Cu)	4.60 \pm 0.002	2.22 \pm 0.003	3.41 \pm 0.003
Zinc(Zn)	62.9 \pm 0.003	53.6 \pm 0.006	58.25 \pm 0.001

Table 4 Heavy metal concentrations of top soil samples collected from the area of Floriculture (mg/kg)

Sites	Pb	Cr	Ni	Cu	Zn	Co	Cd
100METS	4.44±0.14	9.65±0.32	13.76±0.04	5.89±0.55	66.16±0.75	5.71±0.04	0.03±0.001
250Mets	3.77±0.008	8.41±0.013	7.91±0.002	4.68±0.002	63.5±0.04	5.52±0.001	0.03±0.001
500mETS	2.64±0.002	7.58±0.003	7.72±0.002	4.01±0.002	60.58±0.03	5.22±0.006	ND
1KmETS	1.78±0.003	7.00±0.006	7.22±0.006	3.81±0.002	53.6±0.06	5.06±0.003	ND
100Mnts	7.01±0.007	14.2±0.005	11.6±0.009	5.94±0.002	70.9±0.08	5.7±0.003	0.08±0.001
250Mnts	5.02±0.015	12.2±0.007	11.4±0.004	5.01±0.001	67.0±0.03	5.53±0.004	0.07±0.001
500mNTS	4.79±0.005	11.9±0.007	10.85±0.02	4.68±0.001	62.42±0.08	5.22±0.001	0.07±0.002
1KmNTS	3.87±0.005	9.98±0.003	10.0±0.003	4.60±0.002	62±0.03	5.07±0.001	0.03±0.002
100mWTS	5.37±0.002	9.87±0.005	12.0±0.004	3.88±0.002	66.2±0.006	5.23±0.005	0.1±0.002
250mWTS	4.32±0.005	7.01±0.001	10.9±0.007	3.28±0.001	65.3±0.007	3.73±0.002	0.07±0.001
500mWTS	3.79±0.008	7.13±0.008	9.6±0.05	3.10±0.002	62.75±0.14	3.79±0.002	0.03±0.002
1km WTS	3.84±0.004	7.09±0.008	8.39±0.005	2.22±0.003	56.2±0.05	3.12±0.002	ND

EST=East Top Soil, NTS=North Top Soil, WTS=West Top Soil

Table 5 Heavy metals concentration of sub-soil samples collected from the study area (mg/kg)

Sites	Pb	Cr	Ni	Cu	Zn	Co	Cd
100mESS	3.3±0.007	9.4±0.001	12.4±0.002	4.6±0.002	64.6±0.005	4.7±0.001	0.07±0.001
250mESS	2.8±0.003	8.15±0.05	7.2±0.005	4.3±0.001	61.6±0.08	4.39±0.013	0.03±0.001
500mESS	2.7±0.005	7.01±0.04	6.94±0.004	3.9±0.004	59.6±0.04	3.21±0.001	0.02±0.001
1KmESS	1.7±0.003	4.03±0.002	6.45±0.005	2.0±0.002	40.75±0.02	3.0±0.001	ND
100mNSS	5.2±0.015	12.8±0.009	10.78±0.002	5.5±0.003	67.9±0.01	6.95±0.003	0.07±0.004
250mNSS	4.6±0.001	10.68±0.01	10.5±0.005	4.9±0.002	65.6±0.02	6.73±0.005	0.10±0.004
500mNSS	3.8±0.002	10.6±0.001	10.2±0.007	4.6±0.002	64.8±0.04	5.8±0.001	0.02±0.003
1KmNSS	3.4±0.006	9.6±0.006	9.73±0.001	4.4±0.003	63.1±0.005	5.58±0.008	0.02±0.004
100mWSS	4.1±0.001	13.8±0.01	16.8±0.003	4.8±0.001	65.97±0.04	5.5±0.004	0.07±0.004
250mWSS	3.9±0.003	8.67±0.083	15.6±0.002	3.7±0.002	66.2±0.01	4.38±0.004	0.01±0.003
500mWSS	3.6±0.001	8.15±0.028	14.2±0.004	3.6±0.002	65.4±0.03	4.30±0.002	0.03±0.002
1KmWSS	2.63±0.00	6.83±0.00	9.29±0.002	3.5±0.002	65.2±0.01	3.7±0.006	0.03±0.001

ESS=East sub-soil NSS=North sub-soil, WSS=West sub-soil

Table 6 Results of heavy metals concentration in vegetables around floriculture (mg/kg)

Code	Pb	Ni	Cr	Cu	Zn	Co	Cd
Vt1	0.325±0.01	21.65±0.002	1.36±0.003	2.68±0.003	34.78±0.001	1.39±0.003	0.475±0.001
Vt2	0.308±0.002	21.48±0.001	1.29±0.003	3.29±0.030	34.30±0.003	0.591±0.004	0.44±0.001
Vt3	0.508±0.001	19.59±0.004	1.20±0.005	2.60±0.003	33.80±0.012	0.533±0.001	0.441±0.001
Vt4	0.083±0.001	17.15±0.013	1.22±0.001	2.61±0.002	33.33±0.004	0.283±0.001	0.47±0.001
VC1	0.053±0.002	21.38±0.006	1.38±0.005	2.18±0.001	36.99±0.002	0.475±0.002	0.61±0.001
VC2	0.40±0.001	22.94±0.002	1.63±0.002	2.13±0.001	37.12±0.004	0.38±0.003	0.567±0.01
VC3	0.225±0.001	22.19±0.002	1.24±0.005	2.08±0.001	35.10±0.004	0.391±0.002	0.59±0.001
VC4	0.20±0.001	20.73±0.0061	1.34±0.003	1.61±0.002	35.80±0.018	0.35±0.003	0.50±0.015
VO1	1.67±0.002	34.46±0.009	3.01±0.002	2.10±0.002	40.53±0.006	0.225±0.001	0.258±0.001
VO2	1.48±0.006	33.19±0.012	1.22±0.001	2.04±0.001	36.47±0.003	0.167±0.001	0.391±0.046
VO3	1.35±0.003	30.14±0.008	1.53±0.003	2.1±0.002	35.28±0.010	0.15±0.001	0.3±0.002
VO4	1.03±0.003	23.65±0.003	2.34±0.005	2.00±0.001	31.20±0.004	0.13±0.003	0.267±0.001

Note: V = Vegetable, T= Tomato, C = Cabage, O = Onion