RESEARCH ARTICLE Bhartiya Krishi Anusandhan Patrika, Volume 37 Issue 3: 260-265 (September 2022)

Suitability of Agricultural Land of Jajmau Area, Kanpur Uttar Pradesh Ganga's Riverine Cities

R. Dwivedi, T.R. Chelliah, Deepak Khare

10.18805/BKAP377

ABSTRACT

Background: In this paper, study about the agricultural Land suitability at the Jajmau area in Kanpur Uttar Pradesh to find out the chemical pollution in soil due to industrial waste. The tanning industry in the Jajmau had been established since 1940, now the impact of such industries on the Landis a severe threat to human life.

Methods: The soil sample for three different seasons gets collected and stored, After wards with the help of leaching process and ICP- MS test, to find out the traces of heavy metals present in an agricultural field near the banks of Ganga River, namely Jajmau area.

Result: It is find that the traces of different elements of Soil samples for pre-monsoon are in parts per million (ppm) As 25-55 ppm, For monsoon season soil sample, the traces of elements like As 25-42 ppm Similarly, for the post-monsoon soil sample, the traces of elements are such as As 67-109 ppm. Toxic elements like Fe, Mg and as are the elements, Having exceeded value is very at most of the sample. It can hurt an ecosystem like human health, Environmental condition, aquatic life and life food cycle.

Key words: Agricultural land, Contamination, Heavy metals, ICP-MS.

INTRODUCTION

In today's world scarcity of water, it becomes a serious issue, now a day's wastewater is being used for irrigation purposes results in different types of harmful elements in agricultural soil (Fytianos *et al.,* 2001). These elements have not only an inverse effect on the environment but also get into the human food cycle, which results in various types of health problems. This is often caused by the release of industrial effluent or accidental release of chemicals. In developing countries like India, disposal of industrial effluent with proper treatment is one of the major challenges for the authorities (Gowd *et al.,* 2010). Metals such as Zn, Cu, Se, Mg, Mn, As, Pb and Cr are within permissible limit beneficial to vegetables, crops, plants and human life (Sharma *et al.,* 2006). However, the presence of such elements in an excessive amount becomes toxic.

Soil contamination exposure on human life occurs place when the heavy metals get a transfer from soil to plant (Cui *et al.,* 2003). The accumulation of heavy elements in crops and vegetables more than the permissible limit harms human health and plants. Heavy metals pollutants considered to be great risk for human food chain (Brombal *et al.,* 2015). Heavy metals are non-biodegradable and persistent, hence accumulated in vital organs of the human body such as kidney and bones, which cause various mental disorder (Duruibe *et al.,* 2007). Different metals have specific toxicity level and cause a different type of diseases like gastric problem, skin diseases, diarrhoea, paralysis, vomiting, depression and pneumonia (McCluggage *et al.,* 1991).

In this paper, author discussed the impact of treated tannery effluent being used for irrigation purposes which in turns cause the contamination in soils. The tannery effluent requires a special type of treatment unit, which is known as the effluent treatment plant (ETP). During the process of tanning and leather manufacturing goods several chemicals like $Cr(SO_4)3$, NaCl, $Ca(OH)_2$, H_2SO_4, *etc.* are extensively used. The tannery effluent is characterized by its strong colour (reddish dull-brown), high TDS, high pH, high BOD (Gowd *et al.,* 2010). In tannery effluent chromium is mainly present in the form of the trivalent form (Cr III), the trivalent chromium gets into hexavalent through oxidation. Hexavalent chromium is highly toxic. Irrigation of agricultural land by tannery effluent results in accumulation of heavy metals present in the soil. Due to repeated use of effluent for irrigation purposes, reduces the heavy metal retain the capacity of the soil (Chary *et al.,* 2007). Hence the metals leached into the groundwater and it get intake by the crops and vegetables (McLaughlin *et al.,* 1999).

In the Kanpur Jajmau area known as the centre of the tannery industry, the agricultural land in Jajmau got badly contaminated by irrigating through the polluted water supply. The water for irrigation purposes gets supplied from 27 million liter per day (MLD) common effluent treatment plant (CETP). The CETP plant in Jajmau used to treat mainly tannery effluent after the treatment final effluent from CETP get supplied to agricultural land for irrigation as well as

Department of Water Resource Development and Management, Indian Institute of Technology, Roorkee-247 667, Uttarakhand, India.

Corresponding Author: R. Dwivedi, Department of Water Resource Development and Management, Indian Institute of Technology, Roorkee-247 667, Uttarakhand, India. Email: rdwivedi@wr.iitr.ac.in

How to cite this article: Dwivedi, R., Chelliah, T.R. and Khare, D. (2022). Suitability of Agricultural Land of Jajmau Area, Kanpur Uttar Pradesh Ganga's Riverine Cities. Bhartiya Krishi Anusandhan Patrika. 37(3): 260-265. DOI: 10.18805/BKAP377.

Submitted: 27-09-2021 **Accepted:** 14-07-2022 **Online:** 24-08-2022

discharged into the Ganga river. The wastewater discharged from the pits and drums is collected through open drain connected to the pumping stations which pumps the tannery wastewater to 36 MLD CETP situated in the premises of STPs at Jajmau. This CETP is designed to treat 9 MLD tannery wastewater mixing with 27 MLD (Millions Litre Per Day) domestic sewage in the ratio of 1:3. But due to the increase in the number of tanneries and increased production, the excess discharge in drains are overflowing into stormwater drains, drains and reaching the river Ganga without any treatment. The conveyance system including pumping stations designed for 9 MLD capacities is not able to cope up with the flow and leads to failure of the entire collection network. The entire wastewater collection system and treatment plant are to be revamped or upgraded to meet the present discharge quantity. The objective of the study is to know about the accumulation of heavy metals in agricultural land in the Jajmau area of Kanpur. The purpose of the study is to know about the presence of heavy metals in soil by experimental procedure and its effect on human and environment.

Study area

Kanpur location coordinates 26.449 degrees north 80.331 degrees east, Population of Kanpur is 27, 67,348. Average high temp 40.7 degrees in May and Average low temp 7.9 degrees in the month January, Average maximum precipitation 300.8 mm (11.843 inches) and average minimum precipitation 5.1 mm (0.201 inches), Average rainy days 13.7 in July. The Stretch of the river along Kanpur in Uttar Pradesh has been identified as the most polluted due to the discharge of untreated domestic and industrial wastewater. The 75 per cent of pollution in the Ganga River mainly from the Kanpur city, Kanpur is known for the tannery. The tanneries located in the Jajmau of Kanpur city on the south bank of river Ganga are the major source of industrial waste being discharged into the river Ganga (UPJN report). Tanning is processed using which hides and skins are preserved from decay and converted into an imputrescible substance known as leather (UPJN, Kanpur Report). In India, the use of chromium salts in tanning came into practice in the later part of the 19th Century. There are around 400 tanneries in Kanpur city, The Kanpur's leather and tannery industry contribute to around Rs 6,000 crores worth foreign exchange for the country and also gives direct livelihood to more than one lakh people. The leather industry is one of the oldest industries in India (UPJN report). Kanpur is known to the centre for leather processing footwear manufacture and leather goods. The development of tanneries in Kanpur has a history of about 14 decades. The leather industry which is one of the major foreign exchange earners and an important participant in international commerce is often cited for its environmental pollution (UPJN Report) Fig 1.

MATERIALS AND METHODS

Sample collection

For sampling agricultural field in the Jajmau area of Kanpur city get selected. The agricultural field of the Jajmau area was contaminated due to irrigation by partially treated tannery effluent. The Jajmau CETP plant is not able to remove the chrome as well as heavy metals from tannery effluent, that's why the Jajmau area agricultural field gets selected for the study of soil contamination. The soil samples are from the same location or nearby previous location, but for different season pre-monsoon (Fig 2), monsoon (Fig 3) and post-monsoon (Fig 4) were collected from agricultural land. Soil samples were collected from the topsoil *i.e.*, 6-17 cm, sampling at such is usually suitable for contamination test study. The samples were collected in a durable plastic bag so that the sample will not get any type of outside contamination.

Soil leaching test

With the help of experimental setup in the lab as shown in Fig 5, the soil leaching test was performed. The experimental

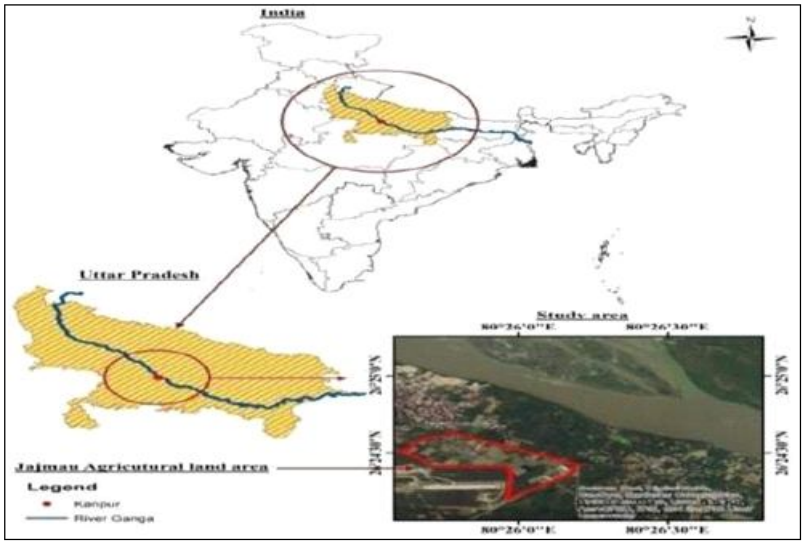

Fig 1: Study area location.

setup consists of a transparent fibre glass cylinder of the diameter of 10 cm (Centimetres), length 63 cm and cast iron stand. In the test soil sample is to be filled in the cylinder up to nearly 35 cm depth. Afterwards, tap water is passed through the soil sample by means capillary pipe at a slow flow rate. Leached water is collected through a tap at the bottom of the cylinder, this process is continued for 2-6 days. A flow rate of water is adjusted according to the require condition otherwise waterlogging takes place. Now collected leached water, a further test of heavy metals should be done.

Leached water sample preparation for heavy metal test

In the test of heavy metals, first, prepare the solution of 50 ml with the sample by using reagents like HNO_3 and H_2O_2. Then placed it on the heater to vaporize the extra water heat up to a 10 ml solution remains. When the heating process complete allow the solution to cool at room temperature, now pass it through the filter. At last by adding the distilled water again make the solution to 50 ml or 100 ml. After the sample got prepare metal detection test will be performed.

Inductively coupled plasma mass spectrometry (ICP-MS)

About ICP-MS

Inductively Coupled Plasma Mass Spectrometry (ICP-MS) was introduced in 1983 for many types of laboratories (Batsala *et al.,* 2012). ICP-MS is an analytical technique for the detection of heavy metals, it can detect up to parts per trillion. The application of ICP-MS for the detection of metals in different fields including Soil Science, Food Science, Metallurgy, Drinking water, Wastewater, *etc.* (Montaser *et al.,* 1998).

Following important points regarding argon ICP plasma are:

- Argon an excellent ion source having a temperature 6000-10000 degrees Kelvin.
- The ions formed by the ICP discharge are typically positive discharge ions rather than negative ions that's why negative ions are difficult to determine *via* ICP-MS.
- The amount of sample and sample introduction technique is important for variation of detection capabilities.
- Detection capabilities will vary with the sample matrix, which may affect the degree of ionization that will occur in plasma or allow the formation of species that may interfere with analyte determination.

Principle of ICP-MS

The technology couples use of an ICP with MS for the detection of heavy metals by the generation of ions (Taylor *et al.,* 2001). The ICP involved in the generation of high-temperature plasma at 10,000 degrees Celsius, through which the sample is passed. The elements in the sample at such high temperatures get ionized and directed further into the MS. The MS then sorts the ions according to their charge ratio followed by directing them to an electron multiplier tube detector. This detector then identifies and quantifies each ion.

Fig 2: Soil collection during pre-monsoon.

Fig 3: Soil collection during monsoon.

Fig 4: Soil collection during post-monsoon.

Fig 5: Soil column test set up at lab.

Functional components of ICP-MS

The various components of ICP-MS and its function described as shown in Fig 6.

The process of performing heavy metal detection

When the sample got introduce into the ICP-MS instrument following process is involved in the elemental analysis as shown in Fig 7.

i. Sample introduction generating an aerosol of the liquid (or solid) sample.
ii. Plasma source ionizing the aerosol.
iii. Sampling interface extracting ions from ICP.
iv. Ion optics and mass spectrometer focusing and separating ions.
v. Ion detector converting ions into an electronic signal processed by the data handling system.

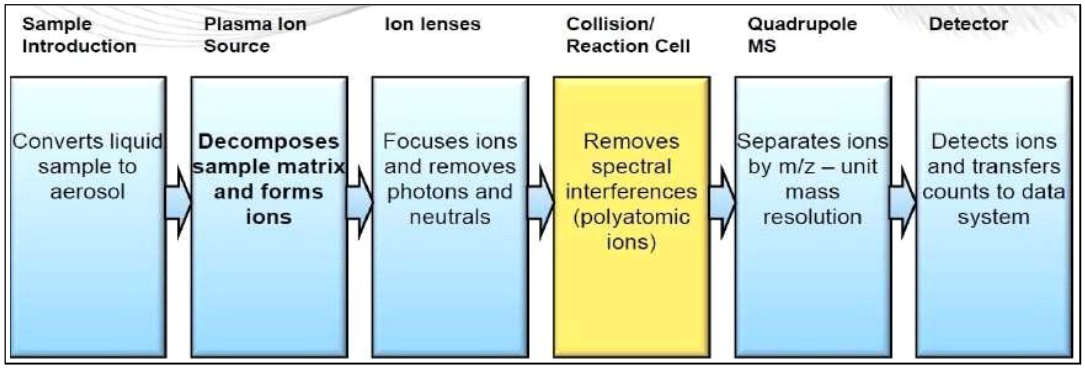

Fig 6: Component and its function.

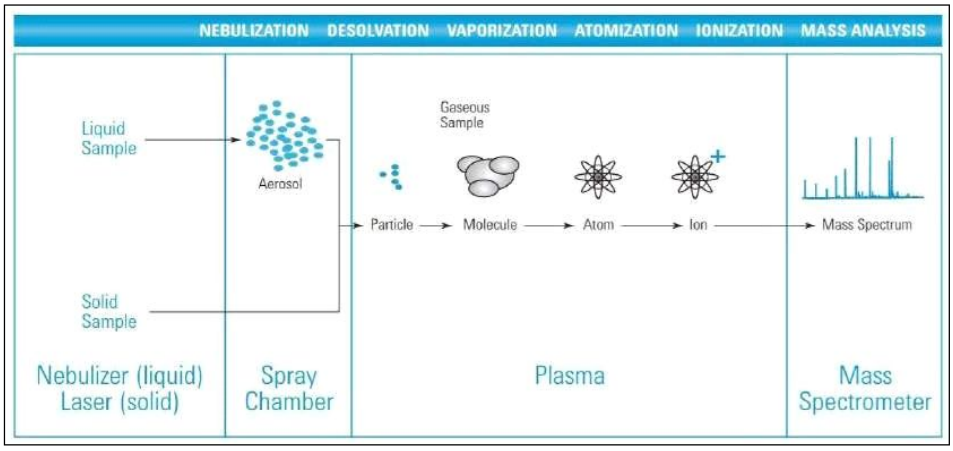

Fig 7: Process of metal detection in ICPMS.

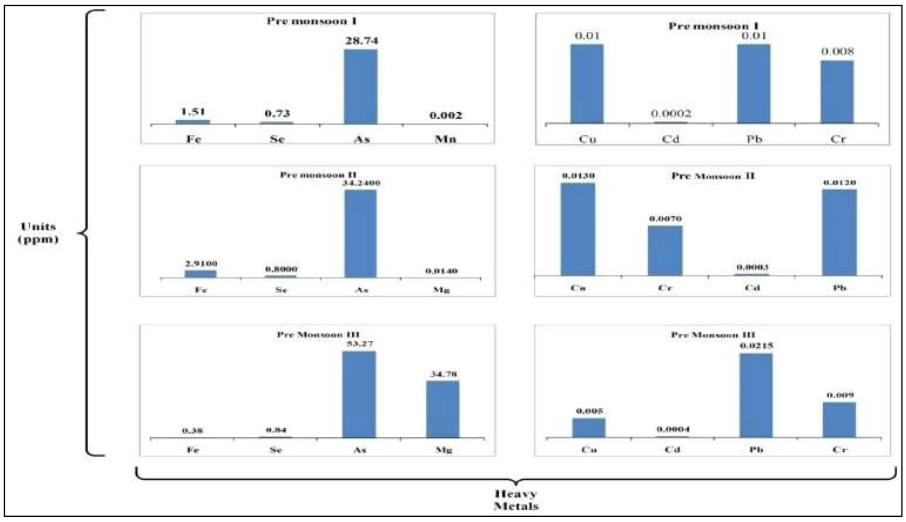

Fig 8: Concentration of different elements in pre monsoon soil sample.

RESULTS AND DISCUSSION

The result of heavy metals detection (Pre-monsoon)

From the result, it has been observed that the traces of the elements like iron (Fe), arsenic (As) and magnesium (Mg) are much more as compared to selenium (Se), chromium (Cr), copper (Cu) manganese (Mn), cadmium (Cd) and lead (Pb), it has been found in the agricultural land of the Jajmau area of Kanpur is contaminated, the traces of elements of Fe, Al and Mg were in excess. The traces of different elements of soil samples were in parts per million (ppm) as shown in Fig 8. ranges are such as Cr 0.006-0.01 ppm, Fe 0.38-3.0 ppm, Se 0.7-0.85 ppm, As 25-55 ppm, Pb 0.01-0.25 ppm, Cu 0.005-0.01 and Cd is much less as compared to other elements.

The result of heavy metal detection (Monsoon)

In the sample analysis of monsoon season, the ranges of different elements in soil are such as Mg 18-94 ppm, As 25-42 ppm, Fe 6-9 ppm, Cr 0.7-1 ppm, Se 0.8-0.83 ppm, Cu 0.06-0.07 ppm, Pb 0.02-0.04 ppm and Mn 0.03-0.05 ppm, whereas traces of Cd presence indistinct amount. From the test results, it has been concluded that the traces of magnesium and arsenic presence were in excess as compared to other elements like iron, chromium, lead, Selenium, Copper and Manganese (Fig 9).

The result of heavy metals detection (post-monsoon)

From the result, as shown below Fig 10, it has been found that the ranges of different elements are such as As 67-109 ppm, Mg 0.49-32 ppm, Fe 3-46 ppm, Cr 0.04-3 ppm, Se 0.6-1.58 ppm, Cd 0.007-0.29 ppm, Pb 0.012-0.8 ppm, Cu 0.1-.4 ppm and Mn 0.13 ppm. It had been observed that the traces of Arsenic, Iron and Magnesium are much high as compared to other elements. In post-monsoon result presence of Fe was higher as compared to pre-monsoon and monsoon results.

The presence of elements like As, Fe and Mg in agricultural land were in excessive amount, it shows that the land is unsuitable for any type of cropping pattern.

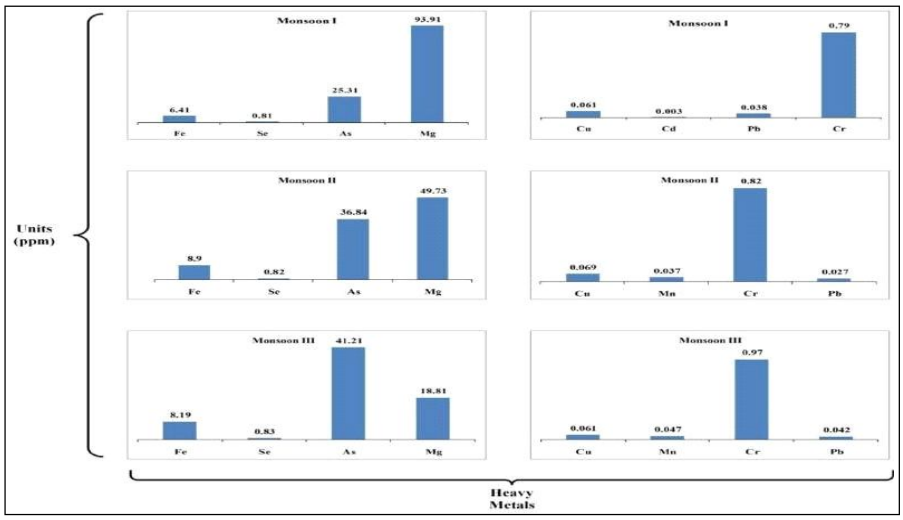

Fig 9: Concentration of different elements in the monsoon soil sample.

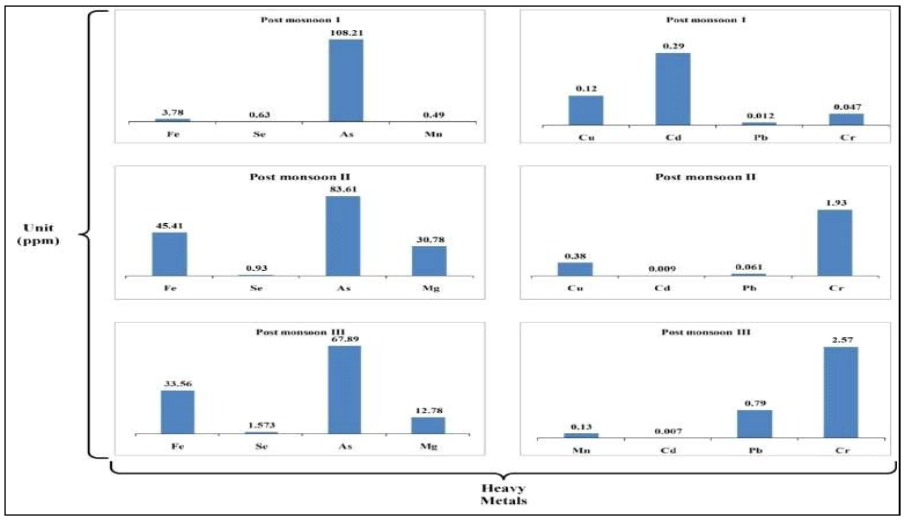

Fig 10: Concentration of different elements in soil sample post-monsoon.

The agricultural land in the Jajmau area being irrigated by improperly treated tannery effluent for many years hence results in agricultural land in that area were highly contaminated. From the results, it has been concluded that the soil samples collected in three different season traces of As and Mg presence were in excess. Minimum As is 25.31 ppm during Monsoon season sampling and Maximum As is 108.21 ppm during post-monsoon sampling, for Mg Min 0.014 ppm and Max 93.91 ppm. According to the UN report, Soil has a great potential to filter and buffer contaminants, degrading and attenuating the negative impact of pollutants, but this capacity is finite. Most of the pollutants originate from human activities, such as industrial activities, Unsustainable farming activities and mining, untreated urban waste and other non-environmental friendly practices.

Conclusion

The main adverse impact of soil contamination is food safety, which can not only affect the nervous system but also induce kidney, liver and bone damage, says a report published by Food and Agricultural Organization (UN Report May 2018). "Soil pollution affects the food we eat, the water we drink, the air we breathe and the health of our ecosystem," said Maria Helena Semedo, FAO Deputy Director-General. Heavy metals mostly enter the food chain through absorption by plant roots.

It goes on add to, for human, presence of Cadmium, which is one of the toxic elements for humans as it can "penetrate during pregnancy, damaging membranes and DNA and disrupting the endocrine system and can induce kidney, Liver and bone damage". Now comes to Lead, report says that the earlier researches have shown that lead affects several organs, causing a biochemical imbalance in the liver, kidney, spleen and lungs causing neurotoxicity, mainly in infants and children. Rather than consuming food the grown in polluted soil, how people can come in contact with contaminated soil are ingestion, dermal exposure, from using spaces such as parks and gardens or by inhaling soil contaminants that have been vaporized.

References

Batsala, M., Chandu, B., Sakala, B., Nama, S., Domatoti, S. (2012). Inductively coupled plasma mass spectrometry (ICP-MS). Int. J. Res. Pharm. Chem. 2: 671-680.

Brombal, D., Wang, H., Pizzol, L., Critto, A., Giubilato, E., Guo, G. (2015). Soil environmental management systems for contaminated sites in China and the EU. Common challenges and perspectives for lesson drawing. Land Use Policy. 48: 286-298.

Chary, N.S., Kamala, C.T., Raj, D.S.S. (2008). Assessing risk of heavy metals from consuming food grown on sewage irrigated soils and food chain transfer. Ecotoxicology and Environmental Safety. 69: 513-524.

Cui, Y.J., Zhu, Y.G., Zhai, R.H., Chen, D.Y., Huang, Y.Z., Qiu, Y., Liang, J.Z. (2004). Transfer of metals from soil to vegetables in an area near a smelter in Nanning, China. Environment International. 30: 785-791.

Duruibe, J.O., Ogwuegbu, M.O.C., Egwurugwu, J.N. (2007). Heavy metal pollution and human biotoxic effects. International Journal of Physical Sciences. 2: 112-118.

Fytianos, K., Katsianis, G., Triantafyllou, P., Zachariadis, G. (2001). Accumulation of heavy metals in vegetables grown in an industrial area in relation to soil. Bulletin of Environmental Contamination and Toxicology. 67: 0423-0430.

Gowd, S.S., Reddy, M.R., Govil, P.K. (2010). Assessment of heavy metal contamination in soils at Jajmau (Kanpur) and Unnao industrial areas of the Ganga Plain, Uttar Pradesh, India. Journal of Hazardous Materials. 174: 113-121.

McCluggage, D. (1991). Heavy Metal Poisoning, NCS Magazine. The Bird Hospital, Lakewood, Co.

McLaughlin, M.J., Parker, D.R., Clarke, J.M. (1999). Metals and micronutrients-food safety issues. Field Crops Research. 60: 143-163.

Montaser, A. (Ed.). (1998). Inductively Coupled Plasma Mass Spectrometry. John Wiley and Sons.

Sharma, R.K., Agrawal, M., Marshall, F. (2006). Heavy metal contamination in vegetables grown in wastewater irrigated areas of Varanasi, India. Bulletin of Environmental Contamination and Toxicology. 77(2): 312-318.

Taylor, V.F., Longerich, H.P., Greenough, J.D. (2003). Multielement analysis of Canadian wines by inductively coupled plasma mass spectrometry (ICP-MS) and multivariate statistics. Journal of Agricultural and Food Chemistry. 51: 856-860.