

# Metals Detection in Compost and Leachate by Atomic Absorption Spectroscopy

<sup>1</sup>Mir syeda yuhannatul humaira, <sup>2</sup>Dara Singh Gupta and <sup>3</sup>Vishnu Shankar Sinha  
Kolhan University, Chaibasa

**Abstract:** Organic matter may be present in the form of nitrogen containing compounds and non-nitrogen containing compounds Urea, proteins, amines etc. Normally the fresh waste alkaline in nature but it becomes stale after two to six hrs. Fresh samples were used to determine compost moisture content, pH, Turbidity and EC. Moisture content was determined as weight loss upon drying at 105°C in an oven for 24 h. In this study pH, CONDUCTIVITY, TSS, TDS, BOD, COD, CHLORIDE, CADMIUM, CHROMIUM, ARSENIC, NITROGEN, PHOSPHORUS, POTASSIUM, IRON, COPPER, ZINC and LEAD were selected to assess the compost stability. Moisture and C/N ratio of samples were measured. For chemical analysis Indian standard method was followed by me to analyze Leachate and compost. Richness in essential plant micronutrients is one of the main characteristics of town waste compost. In relation to the application of composted residuals to soil, the main elements generally of concern include: Zn, Cu, Ni, Cd, Pb, Cr and Hg because they are potentially present in compost and leachate in amounts that may be greater than the background values in the receiving soil. Waste compost is rich in plant nutrients and OM, and is acidic in pH. It may therefore be used as a fertilizer. Due to the high salinity, frequent application and high rates are not recommended, especially for salt sensitive crops. It was demonstrated that the application of compost to soil improves some soil chemical properties. Compost application significantly increased soil pH due the reduced exchangeable acidity and the increased levels of exchangeable bases like K, Ca and Mg. Compost application also increased the nutrient content of P, K, Ca, Mg and Na in the topsoil.

**Keywords:** Nitrogen, phosphorus, lead, mercury, iron

**INTRODUCTION:** The solid waste and the surrounding stagnant water contain complex organic matter derived from the urine etc. Organic matter may be present in the form of nitrogen containing compounds and non-nitrogen containing compounds Urea, proteins, amines etc. Are present as nitrogen compounds while soaps, fats, carbohydrates are present as non-nitrogenous matters. Normally the fresh waste alkaline in nature but it becomes stale after two to six hrs.

**METHODOLOGY:** Fresh samples were used to determine compost moisture content, pH, Turbidity and EC. Moisture content was determined as weight loss upon drying at 105°C in an oven for 24 h. Electrical conductivity, turbidity and pH were determined from conductivity meter, turbidity meter and pH meter. Both the samples were titrated samples to know the value of DO and chloride. TDS, TSS, BOD and COD of the leachate was also evaluated. N, P, K<sub>2</sub>O, Mg, Ca, Fe, Cu, Zn, Pb and B were analyzed through Atomic Absorption spectrophotometer (AAS).

In this study pH, CONDUCTIVITY, TSS, TDS, BOD, COD, CHLORIDE, CADMIUM, CHROMIUM, ARSENIC, NITROGEN, PHOSPHORUS, POTASSIUM, IRON, COPPER, ZINC and LEAD were selected to assess the compost stability. Moisture and C/N ratio of samples were measured.

**TOTAL SOLIDS:** Different forms of solids are defined on the basis of method applied for their determination. Solids may affect water or effluent quality adversely in number of ways. Leachate with high dissolved solids

may include an unfavorable physiological reaction in the transient consumer and generally are of inferior palatability (Howard, 1933. Standard methods, 2005).

**pH VALUE:** The pH of a sample is measured as negative logarithm of hydrogen ion concentration. At a given temperature, the intensity of the acidic or basic character of a solution is indicated by pH or hydrogen ion concentration. pH values from 0 to 7 are diminishing acidic, 7 to 14 increasingly alkaline and 7 is neutral (Standard methods, 2005. American,1964).

**COLOUR:** In coloured sample, it is impossible to match the colour with standard. In these cases the yellow colour of the sample should be determined (Standard methods, 2005).

**TURBIDITY:** Turbidity can be measured by its effect on the scattering light, which is termed as Nephelometry. Turbidimeter can be used for sample with moderate turbidity and nephelometer for sample with low turbidity. Higher the intensity of scattered lights higher the turbidity (Standard methods, 2005.).

**CONDUCTIVITY:** Conductivity is the capacity to carry an electrical current and varies both with number and types of ions in the solutions, which in turn is related to the concentration of ionized substances in the liquid sample. Most dissolved inorganic substances in water are in the ionized form and hence contribute to conductance (Standard methods, 2005. Jones *et al*,1933).

**DISSOLVED OXYGEN (DO):** Dissolved Oxygen (DO) is also important in precipitation and dissolution of inorganic substances in water. DO levels in natural waters and wastewaters depend on physical, chemical and biological activities in water body. The solubility of atmospheric oxygen in fresh water ranges from 14.6mg/L at 0°C to about 7.0mg/L at 35°C under normal atmospheric pressure (Standard methods, 2005. Clair *et al*,1987).

**BIOCHEMICAL OXYGEN DEMAND (BOD):** The Biochemical Oxygen Demand (BOD) is an empirical standardised laboratory test which measures oxygen requirement for aerobic oxidation of decomposable organic matter and certain inorganic materials in water, polluted waters and wastewater under controlled conditions of temperature and incubation period (Standard methods, 2005.CPCB, 2001. Clair *et al*,1987).

**CHEMICAL OXYGEN DEMAND (COD):** Chemical Oxygen Demand (COD) test determines the oxygen requirement equivalent of organic matter that is susceptible to oxidation with the help of a strong chemical oxidant. It is important, rapidly measured parameters as a means of measuring organic strength for streams and polluted water bodies (Standard methods, 2005. Clair *et al*,1987. American 1995).

**TOTAL ORGANIC CARBON (TOC):** The Total Organic Carbon (TOC) estimate provides speedy way of estimating organic carbon but does not permit to differentiate between biologically and chemically oxidisable portion of organic compounds (Standards method, 2005).

**NITROGEN (Ammonia):** Ammonia is produced by the microbiological degradation of organic nitrogenous matter. It appears, therefore, in many groundwater as well as surface waters. Concentrations of ammonia above a certain level in water polluted either due to sewage or industrial waste is toxic to fish (Standard methods, 2005. Faires *et al*,1985. Barenes, 1978. Macifield *et al*,1985).

**FLUORIDE:** The fluoride ion selective electrode can be used to measure the activity or concentration of fluoride in aqueous sample by use of an appropriate calibration curve. However, fluoride activity depends on the total ionic strength of the sample. The electrode does not respond to bound or complexed fluoride (Standard methods, 2005. Harwood, 1969. Bellack, 1958. Bellack, 1969).

**ARSENIC (As):** Severe poisoning can arise from the ingestion of as little as 100mg of Arsenic trioxide. Chronic effects may result from the accumulation of arsenic compounds in the body at low intake levels.

Carcinogenic properties also have been observed to arsenic compounds (Standard methods, 2005. Aggett *et al*,1976. Irgolic, 1987. Howard *et al*,1980. Pandey, 1980).

**CADMIUM (Cd):** Cadmium occurs in sulphide minerals that also contain zinc, lead or copper. The metal is used in electroplating, batteries, paint pigments and in alloys with various other metals. Cadmium is usually associated with zinc. Cadmium is highly toxic and has been implicated in some cases of poisoning through food. Minute quantities of cadmium are suspected of being responsible for adverse changes in arteries of human kidneys. Cadmium also causes generally cancers in laboratory animals and has been linked epidemiologically with certain human cancers. BIS desirable limit is 1mg/L (Standard methods, 2005. Saltzman, 1953. Ganotes *et al*,1962).

**CHROMIUM (Cr):** Chromium is found chiefly in chome-iron ore. Chromium is used in alloys, in electroplating and in pigment. Chromium salts are used extensively in industrial processes and may enter a water supply through the discharge of wastes. Chromate compounds frequently are added to cooling water for corrosion control. Chromium may exist in water supplies in both the hexavalent and the trivalents state although the trivalent form rarely occurs in potable water (Faires *et al*, 1984. Barenes, 1978. Macifield *et al*, 1985. Saltzman, 1952. Allen,1958. US, 1966. Vitale *et al*,1997).

**IRON (Fe):** Iron occurs in the minerals as hematite, taconite and pyrite. It is widely used in steel and other alloys. Elevated iron levels in water can cause stains in plumbing, laundry and cooking utensils and can impart objectionable taste and colour to foods. (Burrell, 1975. Paus, 1973. Slavin, 1968. Caldwell, 1946. Reitz *et al*,1950. Shapiro, 1966. McMahon, 1969. Morris,1952. Skougstad, 1979)

**LEAD (Pb):** It is used in batteries, ammuniton, solder, piping, pigments, insecticides and alloys. Lead also was used in gasoline for many years as an anti-knock agent in the form of tetraethyl lead. The Food and drug administration regulates lead content in food and in house paints. (Snyder, 1947. Sandell, 1959. American, 1977.)

**NICKEL (Ni):** The nickel content of the sample is determined by atomic absorption spectrophotometry. For dissolved nickel the filtered sample may be directly aspirated to the atomizer. For total recoverable nickel, HNO<sub>3</sub>- H<sub>2</sub>S<sub>00</sub> digestion is to be carried out prior to aspiration of the sample. This method is applicable in the range from 0.3 to 10 mg/l. (Standard methods, 2005.<https://.54.2003.html>)

**ZINC (Zn):** Zinc is an essential and beneficial element for human growth. The zinc content of the sample is determined by atomic absorption spectrophotometry. For dissolved zinc, the filtered sample is directly aspirated to the atomizer. For total recoverable zinc, an acid digestion procedure is done prior to aspiration of the sample (Platte *et al*,1959. Rush *et al*,1954. Miller, 1979. Pande, 1980 <https://3025.49.html>).

**MERCURY:** The flameless atomic absorption procedure is a physical method based on the absorption of radiation at 253.7 nm by mercury vapour. The mercury is reduced to the elemental state and aerated from solution in a closed system. The mercury vapour passes through a cell positioned in the light path of mercury hallow cathode lamp of an atomic absorption spectrophotometer. Absorbance (peak height) is measured as a function of mercury concentration and recorded. (<https://3025.48.html>)

**OBSERVATION:** For chemical analysis Indian standard method was followed to analyze Leachate and compost

In this study pH, CONDUCTIVITY, TSS, TDS, BOD, COD, CHLORIDE, CADMIUM, CHROMIUM, ARSENIC, NITROGEN, PHOSPHORUS, POTASSIUM, IRON, COPPER, ZINC, LEAD AND BORON were selected to assess the compost stability. Moisture and C/N ratio of samples were also measured (Table 1 and 2).

**TEST FINDINGS:** Table1 showing compost analysis report

Sl. No.	Test Parameters	Indian standards	Unit	Results
01.	Color	Dark brown to black.	..	Dark brown to black
02.	Odour	Absence of foul odour	..	No foul odour
03.	pH	6.5-7.5	..	6.5
04.	C : N Ratio	<20	..	10.7 : 1
05.	Bulk Density	<1.0	gm/cc	0.65
06.	Conductivity	4.0	µS/cm	4.0
07.	Moisture content	15.0 - 25.0	%	19.20
08.	Nitrogen as N	0.8	%	0.91
09.	Phosphorous as P	0.4	%	0.44
10.	Total Potash as K <sub>2</sub> O	0.4	%	0.45
11.	Organic Carbon	12.0	%	12.4
12.	Lead as Pb	100.0	mg/kg	70.2
13.	Cadmium as Cd	5.0	mg/kg	1.66
14.	Chromium as Cr	50.0	mg/kg	46.4
15.	Copper as Cu	300.0	mg/kg	100.4
16.	Zinc as Zn	5.0	mg/kg	334.5
17.	Nickel as Ni	50.0	mg/kg	21.4
18.	Arsenic as As	10.0	mg/kg	2.05
19.	Mercury as Hg	0.15	mg/kg	0.11

Table 2 showing leachate analysis report

Sl. No.	Test Parameters	Indian standard	Unit	Results
01.	TSS	600	Mg/l	140
02.	TDS	220	Mg/l	31980
03.	pH value	5.5-9.0	..	8.42

04.	Amonical nitrogen	50	Mg/l	9.18
05.	Total Kjeldahl nitrogen	100	Mg/l	1030
06.	BOD	350	Mg/l	3400
07.	COD	250	Mg/l	8960
08.	Cyanide	2.0	Mg/l	BDL
09.	Fluoride	15	Mg/l	1.0
10.	Lead as Pb	1.0	mg/l	0.80
11.	Cadmium as Cd	1.0	mg/l	BDL
12.	Chromium as Cr	2.0	mg/l	0.50
13.	Copper as Cu	3.0	mg/l	0.80
14.	Zinc as Zn	15	mg/l	0.50
15.	Nickel as Ni	3.0	mg/l	BDL
16.	Arsenic as As	0.2	mg/l	BDL
17.	Mercury as Hg	0.01	mg/l	0.80

BDL- Below detectable limit

## RESULT AND DISCUSSION

Richness in essential plant micronutrients is one of the main characteristics of town waste compost. In relation to the application of composted residuals to soil, the main elements generally of concern include: Zn, Cu, Ni, Cd, Pb, Cr and Hg because they are potentially present in compost and leachate in amounts that may be greater than the background values in the receiving soil.

**Colour and odour:** The appearances of Leachate samples were dark brown and have very bad smell and the appearances of compost are black and have no foul odour. According to the (Standard methods, 2005) mature compost have no foul odour and have dark brown or black colour.

There is little need for waste management as no large volumes of solvents of hazardous chemicals are used. However, laboratory waste management practices must be followed consistently with all applicable rules and regulations, and protect the water and land by minimizing and controlling all releases from bench operations. Also, compliance is required with any sewage discharge permits and regulations, particularly the hazardous waste identification rules and land disposal restrictions

**pH & Electrical conductivity:** The pH of the compost sample was 6.5 and leachate sample was 8.42 are within the permissible range. Lower the pH value higher is the corrosive nature of water. pH was positively correlated with electrical conductance and total alkalinity (Gautam *et al*, 2010). The higher pH values observed suggests that carbon dioxide, carbonate-bicarbonate equilibrium is affected more due to change in physico-chemical condition (Bhalla *et al*, 2014).

The compost extract shows the electrical conductivity of compost was 4.0  $\mu\text{S}/\text{cm}$  and its standard is 4.0  $\mu\text{S}/\text{cm}$ . Conductivity shows significant correlation with ten parameters such as temperature, pH value, alkalinity, total hardness, calcium, total solids, total dissolved solids, chemical oxygen demand, chloride and iron concentration of water (Bitton *et al.*, 1988). It is measured with the help of EC meter which measures the resistance offered by the water between two Platinized electrodes. The instrument is standardised with known values of conductance observed with standard KCL solution.

Conductivity measurement is affected by the nature of the various ions, their relative concentration and the ionic strength of water, Dissolved  $\text{CO}_2$ , Turbidity, Temperature, the conductivity must be determined at  $25^\circ\text{C}$  (Standard methods, 2005. Jones *et al.*, 1933).

**Total dissolved solids and total suspended solid:** Leachate sample was found to have high concentration of dissolved solids 31980mg/l and TSS was 140. Indian standard of TDS is 220mg/l and TSS is 600mg/l

**C: N Ratio:** C:N is also the most important greenhouse gas on Earth. C:N ratio of the compost was 10.7:1 below permissible limit and its standard was  $<20$ . Its fluxes across the air-water or sediment-water interface are among the most important concerns in global change studies and are often a measure of the net ecosystem production/metabolism of the flora (Bryan *et al.*, 1991). The C/N ratio mainly influenced the maturity (degree of decomposition, humification, and decrease of phytotoxicity) of the compost as indicated by a seed germination index.

**Nitrogen:** Nitrogen is a macronutrient for plants. Nitrogen level of compost was 0.91% and its standard is 0.8. This might be due to the high pH value that favored formation of  $\text{NH}_3$  which subsequently volatilized with initiation of ammonification near the surface (Gautam *et al.*, 2010). In leachate sample the Ammonical nitrogen was 9.81mg/l and total kjeldahl nitrogen was 1030mg/l was observed. For determination of total N, samples were digested using concentrated  $\text{H}_2\text{SO}_4$  and catalyst mixture in Kjeldahl flask and subsequently N content in the digest was determined following steam distillation and titration method (Papafotio *et al.*, 2005).

The chemicals are used in micro quantities. No health-hazardous chemicals are used. There is little need for waste management as no large volumes of solvents or hazardous chemicals are used. The laboratory waste management practices be followed so that the protection of water and land by minimizing and controlling all releases from bench operations will be possible (Standard methods, 2005. Faires *et al.*, 1985. Barenes, 1978. Macifield *et al.*, 1985).

**BOD and COD:** In leachate the BOD level was 3400mg/l. Due to physical and chemical activities in waste, the level of dissolved oxygen may vary. BOD is a measure of organic material contamination in water, specified in mg/l. BOD is the amount of dissolved oxygen required for the biochemical decomposition of organic compounds and the oxidation of certain inorganic materials (e.g., iron, sulfites). Typically the test for BOD is conducted over a five-day period (Standard methods, 2005). Once the expertise is developed, use 125mL DO bottles instead of 300mL for volume reduction. The acidic liquid samples after titration of DO should be flushed with sufficient water for adequate dilution (Standard methods, 2005. CPCB, 2001. Clair *et al.*, 1987).

COD is another measure of organic material contamination in water specified in mg/l. In leachate the COD level was 8960 mg/l. COD is the amount of dissolved oxygen required to cause chemical oxidation of the organic material in water. Both BOD and COD are key indicators of the environmental health of a surface water supply. They are commonly used in waste water treatment but rarely in general water treatment (Standard methods, 2005). Since hazardous chemicals like silver and mercury salts, Sulphuric acid, dichromate are used in the test, the quantity of such chemicals can be minimized by selecting minimum suitable sample size. The liquid waste generated should be treated as hazardous waste. Adequate dilution of such waste before final

disposal is essential. The acidic liquid samples after titration of dissolved oxygen should be flushed with sufficient water for adequate dilution (Standard methods, 2005. Clair *et al*, 1987).

**Cyanide:** Dissolved organic matter in compost or leachate can effectively absorb and mobilize cyanide (Hue 1995). In leachate cyanide was below detectable limit and the standard of cyanide in leachate is 2.0mg/l. Bioavailability of cyanide can change with the type and maturity of the compost (Bhalla *et al*, 2014).

**Fluoride:** Toxicity is related to the physiological availability of the metals and depends on the target organism. Bioavailability of heavy metals can change with the type and maturity of the compost (Bhalla *et al*, 2014) The amounts of fluoride leached was 1.0mg/l the amounts of heavy metal leached were only moderately correlated with compost origin, compost age, or lysimeter column packing depth (Hue, 1995).

The chemicals are used in micro quantities. No health-hazardous chemicals are used. There is little need for waste management as no large volumes of solvents or hazardous chemicals are used. The laboratory waste management practices be followed so that the protection of water and land by minimizing and controlling all releases from bench operations will be possible (Standard methods, 2005. Harwood, 1969. Bellack, 1958. Bellack, 1969).

**Cadmium:** Dissolved organic matter in compost or leachate can effectively absorb and mobilize cadmium (Hue, 1995). In leachate sample cadmium was below detectable limit and in compost sample it was 1.66mg/kg. The standard of cadmium is 5.0mg/kg for compost and 1.0mg/l for leachate. Bioavailability of heavy metals can change with the type and maturity of the compost (Bhalla *et al*, 2014).

**Chromium:** Toxicity is related to the physiological availability of the chromium is depends on the target organism. Bioavailability of heavy metals can change with the type and maturity of the compost (Bhalla *et al*, 2014). The amount of chromium was 0.50mg/l and the Indian standard of chromium is 2.0mg/l. In municipal solid waste compost the value of chromium was 46.4mg/kg and its standard value is 50.0mg/kg in MSWC. Amounts of heavy metal leached were only moderately correlated with compost origin, compost age, or lysimeter column packing depth (Hue, 1995).

**Copper:** Toxicity is related to the physiological availability of the copper is depends on the target organism. Bioavailability of heavy metals can change with the type and maturity of the compost (Bhalla *et al*, 2014). The amount of copper was 100.4mg/kg in compost and in leachate it was 0.80mg/l. Amounts of copper leached were only moderately correlated with compost origin, compost age, or lysimeter column packing depth (Hue, 1995).

**Zinc:** Bioavailability of heavy metals can change with the type and maturity of the compost (Bhalla *et al*, 2014). The amount of zinc was 0.50mg/l and the Indian standard of zinc in leachate is 15mg/l.

**Nickel:** Amounts of heavy metal leached were only moderately correlated with compost origin, compost age, or lysimeter column packing depth (Hue, 1995) 21.4gm/kg was found in compost and standard of nickel in compost is 50.0gm/kg. In leachate the nickel value was observed below detectable limit and its standard value is 3.0mg/l.

**Lead:** Toxicity is related to the physiological availability of the chromium is depends on the target organism. Bioavailability of heavy metals can change with the type and maturity of the compost (Bhalla *et al*, 2014). In compost 70.2mg/kg lead was found and in leachate it was 0.80mg/l. The Indian standard of lead in compost is 100.0mg/kg and in leachate it is 1.0mg/l. Amounts of heavy metal leached were only moderately correlated with compost origin, compost age, or lysimeter column packing depth (Hue, 1995).

**Arsenic:** Amounts of heavy metal leached were only moderately correlated with compost origin, compost age, or lysimeter column packing depth (Hue, 1995). Indian standard of arsenic is 10.0mg/kg in

compost and 0.2mg/l in leachate. Arsenic was observed below detectable limit in leachate and in compost it was 2.05mg/kg. Bioavailability of heavy metals can change with the type and maturity of the compost (Bhalla *et al*, 2014).

**Mercury:** Toxicity is related to the physiological availability of the chromium is depends on the target organism. Bioavailability of heavy metals can change with the type and maturity of the compost (Bhalla *et al*,2014).0.80mg/l mercury was found in leachate and standard of mercury in leachate is 0.01mg/l. In compost the mercury was 0.11mg/kg and its standard value in compost is 0.15mg/kg. Amounts of heavy metal leached were only moderately correlated with compost origin, compost age, or lysimeter column packing depth (Hue, 1995).

It was found that all the heavy metals in municipal solid waste compost were within the Indian compost standard except nitrogen, phosphorus, potash and zinc in compost sample and TDS, BOD, COD and Total Kjeldahl nitrogen in leachate sample. The disparity among the modes might be due to differences in the different amalgamations of biowastes.

**CONCLUSION:** Waste compost is rich in plant nutrients and OM, and is acidic in pH. It may therefore be used as a fertilizer. Due to the high salinity, frequent application and high rates are not recommended, especially for salt sensitive crops. It was demonstrated that the application of compost to soil improves some soil chemical properties. The nitrogen availability of the municipal compost is closely related to the maturity of this material. Sequential compost application can reduce inorganic N inputs for paddy production, but must be balanced with P removal to avoid excessive soil P accumulation. Compost application significantly increased soil pH due the reduced exchangeable acidity and the increased levels of exchangeable bases like K, Ca and Mg. Compost application also increased the nutrient content of P, K, Ca, Mg and Na in the topsoil.

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