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Impacts of Leachate in Rice of Solid Waste Disposal Site of Roi-Et Municipality; Case Study: Heavy Metals

Jurairat Kurukodt
Faculty of Environment and Resource Studies,
Mahasarakham University, 44000 Mahasarakham, Thailand

Abstract: The study on impacts of Leachate in rice from waste disposal site where in the areas of Roi-et municipality landfill was conducted. Heavy metals were analyzed in Leachate, soil and rice tissues; root, stem, leaf and grains. Studied heavy metals were included Lead (Pb), Copper (Cu), Zinc (Zn) and Iron (Fe). Leachate samples were collected at different 3 locations whereas soils and rice were collected at the distance of 100, 500 and 900 m from the landfill site. The study showed that Fe was found at the highest level in Leachate, soil and rice tissue samples. All heavy metals were found in the rice tissues, except Cu. For all distances from the landfill, Zn was found in the root and stem tissues and Pb was observed in root tissues. Fe was observed in all plant tissues only at the distance of 100 m, however at the distances of 500 and 900 m, Fe content was found in root, stem and leaf tissues but not in the grains. Amount of heavy metals were found in rice tissues which can not toxic for rice. When compared Scotia in relation to the standard of heavy metals that can have food. From this study, heavy metal substances in the soil and rice depend on the distance from the landfill and type of heavy metal. The further distance from the landfill relatively varies with the amount of heavy metal decrease.

Key words: Heavy metal, Leachate, rice, municipality, landfill, tissues

INTRODUCTION

Sanitary landfill is a waste disposal by burying in the preparatory lands which importantly needs an appropriate waste disposal management according to the standard of sanitation policies in order to protect an impact that might be caused in the future.

Buried waste disposal immethodically causes contaminative problems for environmental condition such as waste pollution, air and soil pollution that is a source for germs to grow and also is a habitat for animals that are carriers of the disease such as fly, cockroach, rat and as well as causing annoyances from offensive smell of waste spoilage, smoke from waste burning and minute dust, etc. Apart from smell, smoke and minute dust, Leachate that caused from water permeability via waste layers which needs control measures and protections because Leachate highly has dirtiness and may be capable of having metal contamination when it fall to the ground, it would accumulate themselves and percolate to the underground water level and causes quality of underground water a reduction. Moreover, heavy metal that contaminated in water and soil resources spread to animals, vegetations and as well into food chain which is very much dangerous for human health and risky to cause sicknesses. Problem of heavy metal contamination from places of waste disposal is one of the important problems that should be accompanied and inspected heavy metal contamination in vegetations in order to reduce an impact for human consumers and is beneficial for people who live in neighborhood in order to find regulation in waste disposal and appropriate ways in problems' prevention and solving for the coming future.

Research objectives: To educate quantity of contaminated metal in soil and Leachate from waste disposal station of Roi-et municipality. To educate quantity of contaminated metal in rice in the areas of waste disposal station of Roi-et municipality.

Research hypothesis: Quantity of contaminated heavy metal in Leachate has an effect on metal accumulation in rice. Different distances of the sample rice's collection points that have an effect on quantity of heavy metal in rice.

Areas of research: To study quantity of heavy metal in soil, Leachate from the waste disposal station Roi-et municipality. The studied heavy metal were lead, copper, iron and zinc. To study quantity of heavy metal in rice's root, seed, trunk and leaf in the harvest period of 120 days from the Roi-et municipality waste disposal station. The studied heavy metal were lead, copper, iron and zinc.

MATERIALS AND METHODS

Site surveying: To survey at the waste disposal station of Roi-et Municipality by specifying rice and soil collection points in order to analyze in 3 length of 100, 500 and 900 m from the waste disposal station.

Sample collection: This can divide the studied sample as following:

Sample Leachate collection: To collect sample Leachate in the polyethylene format and keep its' quality with nitric acid in order to adjust pH value to be under 2 and keep it in the cool temperature at 4°C.

Sample soil collection: To collect a sample, soil at the depth of 15-30 cm and keep it in plastic bag.

Sample rice collection: In case of this sample soil and rice collection used a specification collecting point according to the flowing dictions of Leachate by specifying collection point in 3 distances of 100, 500 and 900 m from the waste disposal station (Fig. 1-3).

Sample analysis

Qualitative heavy metal analysis in Leachate: Shake the sample Leachate together and pour into beaker 250 mL for the sample water and put 5 mL of nitric acid into it and have it volatilized on a hot plate to be qualitatively reduced to 50 mL and repeatedly add 5 mL of intense nitric acid and close the beaker with watches' mirror and put it on the hot plate till water's quantity reduced to 25 mL then percolate it with Whatman filter paper No. 42 and finally bring the water to analyze the heavy metal with Atomic absorption spectrophotometer.

Qualitative heavy metal analysis in soil: Bring the sample soil to dehydrate in hot air over at the temperature of 103°C for 48 h and riddling it for 1 g of dried soil then put it into 250 mL beaker then add 10 mL of intense nitric acid (HNO_3).

After that dehydrate on a hot plate and leave it till it cooled down then add 10 mL of intense hydrochloric acid and have it dehydrated when its temperature is cooled down then pouring distilled water into beaker that already has the sample of dehydrated soil then having it percolated with No. 110 of Whatman filter paper and wash the soil fragment that stick on beaker's surface with an intense hydrochloric acid for one normal after that bringing the percolated parts to adjust its volume to be 100 mL then finally analyze quantity of heavy metal with Atomic absorption spectrophotometer.

Qualitative heavy metal analysis in vegetations: Bring the sample of vegetation which is rice and wash it by running water then divide its parts for the analysis which are root, stem, leaf and grains then chop them to smaller sizes in order to be easier for dehydration then put them into a preparatory aluminum foil and roast them in hot air oven at the temperature of 103°C for 24 h. When the roasting time is due then bring the sample to dedicatedly crush and weigh it for 1.000±0.005 g and put it into 100 mL size of beaker and digesting with 20 mL of intense nitric acid (Conc. HNO_3) and 5 mL of 65% perchloric acid ($HClO_4$) (Ratio 4:1) on the hot plate at the temperature of 100°C for 3 h until gets a clear solution and leave it cooled down then adding 20 mL of drilled water and leave it for half an hour. After that filtering the digested solution with No. 110 Whatman filter paper then adjust its volume to be 100 mL and finally bring the sample to analyze quantity of heavy metal with Atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

From the impact study of Leachate in the surrounding areas of the waste disposal station of Roi-et local government which has an effect on rice. From the case study, the used heavy metal in this study were copper, lead, zinc and iron which quantitatively analyzed heavy metal in Leachate from 3 sampling collection points in the waste disposal area, collecting the samples of soil, root, stem, leaf and grains of rice at the length of 100, 500 and 900 m that have the result as following:

Quantitative heavy metal in soil: The samples of soil that has been let Leachate run through from the local government's waste disposal station were collected in 3 length of 100, 500 and 900 m in order to use for quantitatively analyze of heavy metal in soil which the study result are shown in Table 1.

According to the Table1, there is finding that all 4 types of heavy metal that are copper, lead, zinc and iron were mostly found at the length of 100 m because this length is the closest length to where let out Leachate that is why these soil is full of quantity of heavy metal

Table 1: Analysis result of quantities of copper, lead, zinc and iron in soil at the length of 100, 500 and 900 m

Length of sample collection (m)	Quantity of heavy metals soil (mg kg^{-1})			
	Cu	Pb	Zn	Fe
100	2.30±0.000^b	29.80±0.000^a	1.90±0.001^b	1,876.97±0.003^b
500	0.78±0.001^a	28.44±0.000^a	1.26±0.001^a	1,634.42±0.007^b
900	0.51±0.000^a	26.23±0.000^a	0.92±0.003^a	837.08±0.007^a
CV (%)	0.44	0.90	0.64	42.09

The vertical letters are the same means there is statistically indifferent at the reliability level of 95% when comparing to mean value by Duncan's Multiple Range Test (DMRT); ±SD (Standard Deviation)

Table 2: Analysis result of quantities of copper, zinc and iron in Leachate from 3 sampling collection points

Collection points	Quantity of heavy metal in water leaching waste (mg L^{-1})			
	Cu	Pb	Zn	Fe
Point no. 1	0.84±0.004^{b}	0.69±0.000^{c}	3.52±0.041^{b}	17.04±0.004^{b}
Point no. 2	0.16±0.002^{a}	0.22±0.001^{b}	0.24±0.001^{a}	13.81 ±0.002^{a}
Point no. 3	0.17±0.002^{a}	0.94 ±0.001^{a}	0.15± 0.001^{a}	13.59±0.002^{a}
CV (%)	38.87	43.32	48.73	13.73

The vertical letters are the same means there is statistically indifferent at the reliability level of 95% when comparing to mean value by Duncan's Multiple Range Test (DMRT)

intensively and more than other lengths where orderly found a reduction of quantity of heavy metals and iron was found most in soil 1,689.2 mg kg^{-1} at the length of 100 m because iron is a type of metal that mostly found in nature (Panichsakpattana, 1997). In case of copper, lead and zinc, they were found at the normal level when compare to the standard quantity of heavy metals in soil generally (Culbard *et al*., 1988).

From the analysis of copper, lead and iron at all 3 length, there was a statistical difference at the significant level of 0.05, lead analysis at all 3 length was statistically indifferent at the significant level of 0.05.

Analysis result of quantitative heavy metal in Leachate: Samples of Leachate were collected at 3 collection points where Leachate was let out from Roi-et local government's waste disposal station, in order to analyze them for quantity of heavy metals in Leachate that is let out to environment which the result of quantitative heavy metal analysis is shown in Table 2.

From the analysis, copper in Leachate from the 3 sampling collection points statistically has difference at significant level of 0.05 which inspected copper at the collection point No. 1 at the level of 0.84 mg L^{-1}, lead significantly has a difference of lead in Leachate by finding that lead was most found at the collection point No. 3 at the level of 0.94 mg L^{-1}, zinc was statistically found difference at the significant rate of 0.05 which iron substance was mostly found at the collection point No. 1 at the level of 17.04 mg L^{-1}.

From the analysis, quantity of Iron substance was found most and zinc, copper and lead substances were orderly found at all collection points due to the reason that quality of Leachate mostly contains N, Cl, SO_4, Fe, Mn.

According to the qualitative analysis of Leachate from the Roi-et municipality waste disposal station, BOD value of Leachate was not found because of high dirtiness in Leachate causes water less oxygen effecting iron substance to be non-dissolvable condition with water but when iron substance is in non-oxygen condition it would transform itself to be dissolvable. So if there is high iron substance in water resources it indicates non-oxygen condition in that water resources (Suwajittanon *et al*., 1998).

Table 3: Analysis result of quantities of copper in root, stem, leaf and grains at 3 length of 100, 500 and 900 m

Length of sample collection (m)	Quantity of copper substance in rice (mg kg^{-1})			
	Root	Stem	Leaf	Grains
100	ND	ND	ND	ND
500	ND	ND	ND	ND
900	ND	ND	ND	ND

ND = Non Detectable

Table 4: Analysis result of quantitative iron substance in rice's root, stem, leaf and grains at the length of 100, 500 and 900 m

Length of sample collection (m)	Quantity of iron in rice (mg kg^{-1})			
	Root	Stem	Leaf	Grains
100	1,778.96±0.003^{a}	159.17±0.001^{b}	131.02±0.001^{c}	22.53±0.001
500	1,957.13±0.005^{a}	110.98±0.001^{a}	102.94±0.001^{b}	ND
900	1,921.89±0.004^{a}	85.58±0.001^{a}	80.65±0.001^{a}	ND
CV (%)	15.05	1.88	0.77	-

The vertical letters are the same means there is statistically indifferent at the reliability level of 95% when comparing to mean value by Duncan's Multiple Range Test (DMRT); ±SD (Standard Deviation); ND = Non Detectable

Quantitative copper substance in rice: From the quantitative study of copper substance in rice, samples were collected in the areas of Roi-et municipality waste disposal station in 3 distances of 100, 500 and 900 m by dividedly analyzing rice's parts such as root, stem, leaf and grains as shows in Table 3.

According to Table 3, copper is not found in rice (root, stem, leaf and grains) at all lengths but found in soil instead because of copper easily react with ore and organic compounds that is why it is able to precipitate with various anions such as sulphy, carbonate and hydroxide. Copper is grouped in substance that cannot move in soil so copper will be in soil storably and vegetations have it limitation in consuming even though soil has a lot of copper substance (Panichsakpattana, 1997).

Quantitative iron substance in rice: From the quantitative study of iron substance in rice, there was a sample rice collection that is in the areas where are let out Leachate from waste disposal station of Roi-et municipality in 3 length of 100, 500 and 900 m by dividedly analyze in rice's parts (root, stem, leaf and grains) as shown in Table 4. The quantitative study of iron substance in rice's root at all 3 length there was statistically indifferent at the significant level of 0.05 in case of rice's stem and leaf at all 3 length was statistically different at the significant rate of 0.05 at the length of 100 m found iron substance in very parts of rice which mostly was in its' root at the level of 1,778.96 mg kg^{-1} for the length of 500 m mostly

Table 5: Analysis result of quantitative zinc substance in rice's root, stem, leaf and grains at the length of 100, 500 and 900 m

Length of sample collection (m)	Quantity of zinc in rice (mg kg^{-1})			
	Root	Stem	Leaf	Grains
100	18.92±0.002^{b}	0.69±0.004^{b}	ND	ND
500	16.43±0.003^{b}	0.31±0.001^{a}	ND	ND
900	11.23±0.002^{a}	0.27±0.004^{a}	ND	ND
CV (%)	22.46	36.34	-	-

The vertical letters are the same means there is statistically indifferent at the reliability level of 95% when comparing to mean value by Duncan's Multiple Range Test (DMRT); ±SD (Standard Deviation); ND = Non Detectable

found in its' root and orderly found in its' stem and leaf which were at the levels of 1,957.13, 110.98 and 102.94 mg kg^{-1} orderly in case of the length of 900 m found iron substance in rice's root, stem and leaf only which were at the levels of 1,921.89, 85.58 and 80.65 mg kg^{-1} orderly which could not see in rice's grains because just small amount of iron substance in rice's root would be able to circulate via phloem so, transportation of heavy metals via phloem from root to above ground parts would be less quantity (Yongyuth Osotsapa and Party, 1998) which quantitatively causes the above ground rice's parts a reduction.

Quantitative iron substance in rice: From the quantitative study of zinc substance in rice which was samplingly collected from the areas where were let out Leachate from Roi-et municipality waste disposal station in 3 length of 100, 500 and 900 m by dividedly analyzing in parts of rice's root, stem, leaf and grains which results are shown in Table 5.

From the analysis of zinc in rice's root there was a finding that all 3 distances were statistically different at the significant rate of 0.05 in rice's root and in case of zinc in rice's stem at all 3 distances were statistically different at the significant rate of 0.05, especially found mostly in the distance of 100 m at the level of 18.92 and 0.69 mg kg^{-1} at distance of 500 m found zinc substance in rice's root at the level of 16.430 mg kg^{-1}, in rice's stem at the level of 0.31 mg kg^{-1} and at the distance of 900 m found zinc substance in rice's root at the level of 11.23 mg kg^{-1} and in stem at the level of 0.27 mg kg^{-1} which the detected iron substance in all 3 distances have rates under the specified standard of the quantity of heavy metal substance in soil and vegetations and the poisonous level in rice (Panichsakpattana, 1997). Detection of zinc substance in vegetations is more than in soil because of zinc substance is able to dissolve greatly when comparing to other substances, opportunity in environmentally contaminating is possibly high and vegetations can suddenly absorb (Panichsakpattana, 1997).

Table 6: Analysis result of quantitative lead substance in rice's root, stem, leaf and grains at the length of 100, 500 and 900 m

Length of sample collection (m)	Quantity of lead in rice (mg kg^{-1})			
	Root	Stem	Leaf	Grains
100	12.45±0.000^{a}	ND	ND	ND
500	9.46±0.000^{a}	ND	ND	ND
900	1.94±0.000^{a}	ND	ND	ND
CV (%)	11.44	-	-	-

Quantitative iron substance in rice: From the quantitative study of lead substance in rice was samplingly collected from the areas where were let out Leachate from Roi-et municipality waste disposal station in 3 length of 100, 500 and 900 m by dividedly analyzing in parts of rice's root, stem, leaf and grains which results are shown in Table 6. From the analysis, lead substance was only found in rice's root which statistically indifferent at the significant rate of 0.05 which mostly found in the distance of 100 m and was in the level of 12.45 mg kg^{-1}, orderly 500 and 900 m were in the levels of 9.46 and 1.94 mg kg^{-1} which the detected lead quantity in all 3 distances were not over the specified standard and did not cause a poison in rice due to the reason of lead absorption by root and circulates to its' above ground parts would have less chance because of lead substance is cumulatively absorbed in rice's tissue mostly and lead has a chance to be absorbed via root more than other substances which most of lead substance cumulate at rootlet of vegetations (Panichsakpattana, 1997).

CONCLUSION

The study of impact of Leachate which effect on rice in the areas of Roi-et municipality waste disposal station, case study of heavy metals can conclude the experiment as following. The quantitative analysis of heavy metal substances in Leachate was detected lead, copper, zinc and iron which iron was mostly found at the level of 17.04 mg L^{-1} at the collection point No. 1, in case of copper, lead and zinc quantities were detected value similarly in each sample collection points.

The quantitative analysis of heavy metal substances in soil was detected lead, copper, zinc and iron in all distances of 100, 500 and 900 m which distances are related to heavy metals quantity, means further distance causes heavy metals quantity a reduction. The quantitative analysis of heavy metal substances in rice, lead substance was only detected in rice's root which mostly found at the distance of 100 m, there was unfound copper substance in all parts of rice at all distances of 100, 500 and 900 m, zinc substance was found in root and stem parts only, especially mostly found at the 100 m distance following with 500 and 900 m orderly, iron substance was

detected in all parts of rice which found mostly in root at the distance of 100 m and orderly found in stem, leaf and grains in case of distances of 500 and 900 m only detected in rice's root, stem and leaf and did not detect in rice's grains which means distances are related to the quantity of heavy metal substances.

RECOMMENDATIONS

In this research, soil was analyzed just during the harvest season so there should be soil analysis before and during harvest in order to informatively compare quantity absorption of heavy metals. There should be a finding analysis on acid and alkaline in soil because acid and alkaline condition means capability in leaching of heavy metals.

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