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Absorption Reduction Capacity with Chromium (Cr) and Cadmium (Cd) Contaminants of Vetiver Phytoremediation Process on Compost Soil

Ahamad Zubair*, Mary Selintung**, Lawalena Samang***, and Hanapi Usman****

*Student of Doctoral in Civil Engineering, Hasanuddin University, Indonesia
**Professor, Department of Civil Engineering, Hasanuddin University, Indonesia
*** Professor, Department of Civil Engineering, Hasanuddin University, Indonesia
**** Professor, Department of Chemestry, Hasanuddin University, Indonesia

ABSTRACT
This study aims to analyze the large of reduction capacity of chromium metals and cadmium in the soil compost media and absorption capacity of chrome and cadmium in phytoremediation process of vetiver; to compare the reduction-absorption capacities of chromium and cadmium metals in phytoremediation process of vetiver (*Vetivera zizanioides*). The study was carried out for 2 months with a range of sampling every 7 days, and then analyzed by using Atomic Absorption Spectrophotometer (AAS). Contaminants used as artificial contaminants containing heavy metals chromium (Cr) and cadmium (Cd). This study is an experimental research includes two variables. First, the variations of Cr concentrations used were 400 ppm, 600 ppm and 800 ppm and Cd concentrations used were 40 ppm, 60 ppm, 800 ppm. Secondly, the variations of total plant are 3, 6, and 9 plant. The period of observation is made every week. Planting media used is compost soil with compost and clay composition of 20%, 30% and 40%. The results of study showed that there are a significant relationship between the reduction capacity of Cr and Cd of compost soil and the absorption capacity of Cr and Cd for vetiver (*Vetiveria zizanioides*). The higher of Cr and Cd decreases in soil followed by increased levels of Cr and Cd in vetiver (*Vetiveria zizanioides*). The capacity of Cr reduction varies between 57% - 86% and Cd 36% - 64% where as the absorption capacity of vetiver on Cr between 38% - 75% and Cd between 34%-74%. The capacity of reduction-absorption of Cr is relatively higher than Cd in phytoremediation process of vetiver.
Keywords: Pollution, Chromium and Cadmium, Phytoremediation, Absorption, Reduction, Vetiver

I. INTRODUCTION

Today, the sectors of industry, mining, and agriculture are a sector that plays an important role for economic progress and prosperity. However, industrial, mining and agriculture activities are not responsible can lead to pollution of heavy metals in soil and water which has become a serious concern because it can be a potential contamination on the surface of soil and ground water and can spread to surrounding areas through water, wind, absorption by plants, and bioaccumulation in the food chain [1,2] Developments in technology and industry have a negative impact in the form of waste containing heavy metals that potentially cause environmental problems such as soil contamination.

The content of heavy metals such as Pb, Cd, Cr and Hg sourced from industrial waste, the use of fertilizers and pesticides agrochemical, mining waste, and the majority of household waste such as batteries. Cd threshold in the soil is 20 - 60 ppm and in the plant is 45 - 48 ppm, while Cr threshold in the soil is 20 -600 ppm and in the plant 5 - 18 ppm [3] Cadmium is utilized in various fields of chemical industry, because the nature of cadmium is soft and corrosion resistant [4] Cadmium (Cd) is one kind of heavy metal that is dangerous because these elements are at high risk for blood vessel, it affect humans for a long time and it can accumulate in the body, especially in liver and kidneys [5] while Chromium (Cr) in certain levels can cause digestive disorders, such as stomach pain, vomiting, and bleeding, wounds in the stomach, convulsions, kidney and liver damage, and even cause death [6].

Efforts to recover the heavy metals contaminated soil are necessary so that the condition of soil is safe for reuse. An effort to do for the remediation of contaminated soil is phytoremediation. Phytoremediation can be defined as the leaching of pollutants mediated by plants, including trees, grasses and aquatic plants. Leaching could mean the destruction, inactivation or pollutant mobilization into harmless forms [1,2]. According to Hidayati et.al [1] a number of plants proven can adapt to the marginal and extreme environments like waste soil that contaminated a lot of toxic substances and has the physical, chemical and biological very low. Plants that have the ability to absorb heavy metals from the soil are known as hyper-accumulator plant [7, 8, 9] In addition to low cost, phytoremediation is very easy to implement *in situ* and the process used is naturally [10] Phytoremediation as a recovery of contaminated soil that using plants as an effective technology, inexpensive and environmentally friendly. Effectiveness of process is influenced by the quantity and absorption ability of plants and a kind of contaminants metal [11] The use of vetiver in phytoremediation process is highly expected to recover polluted-soil quality faster, easier by offering a lower cost compared with the use of engineering-based methods such as chemical leaching and dredging. The mechanism of phytoremediation consists of a few basic concepts that are *phytoextraction, phytovolatilization, phytostabilization, rhizofiltration* and interaction with pollutant-degraded microorganisms [12, 13, 14]

II. METHODOLOGY OF STUDY

In this study, the plant will be used for the remediation of contaminated soil is vetiver (*Vetiveria zizanioides*) that grown on soil compost media, and metal to be remediated is Cr and Cd as one of dominant metal pplantuced from residual of industrial processes. This plant can be remediate heavy metals including Cr and Cd because it is hyper accumulator plant. By phytoremediation is expected to restore the quality of land that has been polluted faster than without such processes. The pollutant used is artificial wastewater containing Cr and Cd

Time and Location of Study

This study was started in February - March 2015. Location of plant acclimatization, making of pollutant waste, sampling, and examination of samples before and after treatment were conducted at the Laboratory of Agricultural Technology Maros - South Sulawesi.

Framework of Study

$$KAv = \frac{\text{Concentration of Heavy Metal for Vetiver}}{\text{Initial Concentration of Heavy Metal of Planting Media}} \times 100\% \quad [1]$$

The first step is a preliminary study that includes: identification of strategic issue, literature review, formulation of problem, and assumption of research outcome. The second step includes; preparation and preliminary test, design and treatment, and data analysis and experimental model

$$KRt = \frac{\text{Reduction of Heavy Metal Concentration of Planting Media}}{\text{Initial Concentration of Heavy Metal of Planting Media}} \times 100\% \quad [2]$$

Sample Design and Research Data

Clay used in this study is obtained from the local clay in around the complex of Soil Development and Research Center Maros, while seed planting of vetiver comes from Soppeng regency. Natural compost soil is livestock compost and heavy metals Cr and Cd as diluted contaminant fabrication.

Material and Tools

Materials; clay, natural compost, pollutant metals Cr and vetiver seeds was prepared as required and selection as physically and chemically criteria for planting media and plants.

Tools and supplies required in the testing were prepared according to the availability and presence of test tools, including:

- Test tool for soil chemical properties: the composition of elements and chemical compounds, scales, pipette, ruler.
- Test tool for heavy metal detection: atomic absorption spectrophotometer (AAS).
- Test tool for supplies: *green house*, shovel, pot reactor processes.

Treatment Design

The design of treatment has a matrix of 3 x 3 x 3 = 27 samples (Cr metal), and 3 x 3 x 3 = 27 samples (Cd metal) with the composition as follows;

- Observation of phytoremediation behavior was performed 5 weeks i.e 0, 7, 14, 21, 28, and 35 days.
- Injections of heavy metal Cr have concentration variations 400, 600, and 800 ppm and Cd is 40, 60 and 80 ppm.
- The numbers of clumps of vetiver are designed 3, 6, and 9 plant/clumps.
- Planting media used is compost soil

Data Analysis

Experimental studies conducted in laboratory scale and pot reactor process, experimenting to see the interaction of variables effect studied with 3 treatments.

Data processing and testing to measure the absorption capacity of heavy metals Cr and Cd on vetiver for phytoremediation process, it is expressed by absorption capacity and heavy metal reduction. Phytoremediation is the success rate of plants in absorbing Cr and Cd contents with different concentrations, it is formulated as follow :

While the reduction capacity of heavy metals Cr of planting media during phytoremediation process as follow:

III. RESULTS AND DISCUSSIONS

Reduction Capacity of Cd on Composted Planting Media

By using the formula (2), it obtained calculation results of reduction capacity of Cr in soil compost as presented in Table 1.

Tale 1. Reduction capacity of Cr content in compost soil media

Variation of Planting	Variation of Vetiver Clump	Variation of Chromium Concentration	Reduction Capacity of Cr in Soil (%) T0	T1	T2	T3	T4	T5	Average	
Compost 20% Soil 80% (M2)	3 (R1)	400 (K1)	0,00	47,67	53,70	59,35	60,80	64,21	57,14	63,66
	6 (R2)		0,00	54,14	67,32	70,11	71,68	73,69	67,39	
	9 (R3)		0,00	55,35	61,14	65,83	72,47	77,43	66,44	
	3 (R1)	600 (K2)	0,00	42,13	53,64	69,54	72,12	74,67	62,42	63,64
	6 (R2)		0,00	43,64	54,85	64,01	69,77	76,17	61,69	
	9 (R3)		0,00	60,06	59,82	65,92	72,44	75,83	66,81	
	3 (R1)	800 (K3)	0,00	41,89	73,71	73,93	76,68	78,40	68,92	71,74
	6 (R2)		0,00	43,44	76,23	78,12	79,44	80,92	71,63	
	9 (R3)		0,00	49,70	77,58	81,06	81,99	83,04	74,67	
Compost 30% Soil 70% (M3)	3 (R1)	400 (K1)	0,00	49,28	59,01	63,96	67,11	69,85	61,84	69,73
	6 (R2)		0,00	66,58	74,85	77,97	79,50	80,75	75,93	
	9 (R3)		0,00	58,98	70,90	73,32	76,02	77,91	71,43	
	3 (R1)	600 (K2)	0,00	49,67	56,63	72,58	73,35	74,67	65,38	68,64
	6 (R2)		0,00	52,23	66,06	69,31	74,41	76,08	67,62	
	9 (R3)		0,00	63,06	70,66	75,43	77,04	78,43	72,92	
	3 (R1)	800 (K3)	0,00	54,70	75,56	77,34	79,17	80,13	73,38	77,56
	6 (R2)		0,00	68,53	78,86	81,58	82,90	83,50	79,07	
	9 (R3)		0,00	63,13	81,38	84,99	85,47	86,15	80,22	
Compost 40% Soil 60% (M4)	3 (R1)	400 (K1)	0,00	57,16	64,29	67,10	69,49	72,74	66,16	70,70
	6 (R2)		0,00	68,05	76,49	67,62	72,05	78,52	72,55	
	9 (R3)		0,00	61,87	77,29	72,06	75,56	80,17	73,39	
	3 (R1)	600 (K2)	0,00	58,38	61,88	70,53	72,41	74,43	67,52	73,25
	6 (R2)		0,00	62,99	67,82	73,63	74,40	80,35	71,84	
	9 (R3)		0,00	69,20	75,38	84,61	86,32	86,42	80,39	
	3 (R1)	800 (K3)	0,00	73,36	76,86	79,43	82,07	82,47	78,84	82,22
	6 (R2)		0,00	78,28	81,50	83,48	85,07	85,64	82,79	
	9 (R3)		0,00	81,71	84,25	85,56	86,57	87,04	85,03	

Table 1 shows the reduction capacity of Cr in the planting media M2. The given of Cr 400 ppm obtained the largest metal reduction capacity for the number of treatment plants 6 plant as much 67.39%. However, for the given of Cr 600 ppm obtained the largest metal reduction capacity for the number of treatment plants 9 plant as much 66.81%. And for the given of Cr 800 ppm obtained the largest metal reduction capacity for the number of treatment plants 9 plant as much 74.67%. The similar thing occurs in compost soil media M3 and M4, where the number of plants and initial concentration of Cr affects the reduction capacity of Cr in soil.

Reduction Capacity of Cd on Composted Planting Media

To calculate the reduction capacity of Cd content in compost soil media in phytoremediation process of vetiver can be used formula (2) and the results are presented in Table 2.

Table 2. Reduction capacity of Cd in compost soil media

Variation of Planting Media	Variation of Vetiver Clump (plants)	Variation of Cadmium Concentration	Reduction Capacity of Cd in Soil (%)							
			T0	T1	T2	T3	T4	T5	Average	
Compost 20% Soil 80% (M2)	3 (R1)	40 (L1)	0,00	8,16	18,64	32,62	49,47	70,57	35,89	41,52
	6 (R2)		0,00	15,23	26,71	38,18	53,68	75,27	41,82	
	9 (R3)		0,00	23,05	34,54	45,81	57,25	73,56	46,84	
	3 (R1)	60 (L2)	0,00	18,77	38,52	58,20	70,25	76,26	52,40	56,13
	6 (R2)		0,00	24,62	43,12	66,37	69,45	73,29	55,37	
	9 (R3)		0,00	28,75	44,20	72,57	77,06	80,52	60,62	
	3 (R1)	80 (L3)	0,00	29,29	43,79	66,53	72,91	79,58	58,42	61,27
	6 (R2)		0,00	33,00	48,26	70,44	74,35	83,09	61,83	
	9 (R3)		0,00	37,19	51,68	72,91	77,06	78,91	63,55	
Compost 30% Soil 70% (M3)	3 (R1)	40 (L1)	0,00	10,69	17,43	36,61	50,21	71,30	37,25	42,25
	6 (R2)		0,00	15,19	27,98	42,10	55,33	67,69	41,66	
	9 (R3)		0,00	19,86	37,00	46,37	59,81	76,13	47,83	
	3 (R1)	60 (L2)	0,00	19,59	40,89	62,63	67,35	79,06	53,90	57,99
	6 (R2)		0,00	30,67	48,45	68,40	70,99	75,21	58,75	
	9 (R3)		0,00	33,09	53,01	67,11	73,89	79,52	61,32	
	3 (R1)	80 (L3)	0,00	28,83	44,39	55,20	66,67	73,45	53,71	58,73
	6 (R2)		0,00	35,86	48,58	65,77	69,49	76,36	59,21	
	9 (R3)		0,00	40,39	53,14	69,24	74,11	79,46	63,27	
Compost 40% Soil 60% (M4)	3 (R1)	40 (L1)	0,00	4,65	19,15	48,84	56,31	75,05	40,80	43,17
	6 (R2)		0,00	16,71	30,56	44,66	51,98	60,92	40,97	
	9 (R3)		0,00	20,15	35,04	50,10	61,33	72,12	47,75	
	3 (R1)	60 (L2)	0,00	23,48	40,78	52,98	68,83	73,87	51,99	56,08
	6 (R2)		0,00	36,18	44,35	56,89	72,56	69,40	55,88	
	9 (R3)		0,00	35,59	53,18	61,76	75,04	76,32	60,38	
	3 (R1)	80 (L3)	0,00	30,53	45,84	56,44	64,32	67,82	52,99	56,59
	6 (R2)		0,00	39,77	51,53	57,01	66,75	63,15	55,64	
	9 (R3)		0,00	43,11	53,22	61,85	73,08	74,44	61,14	

Table 2 shows the reduction capacity of Cd in the planting media M2. The given of Cd 40 ppm, 60 ppm and 800 ppm are obtained the largest metal reduction capacity for the number of treatment plants 9 plant were 46.34%, 60.62% and 63.5%, respectively. The similar thing occurs in compost soil media M3 and M4, where the largest metal reduction capacity of Cd for the number of treatment 9 plant. This shows that the variation of the number of plants and Cd concentrations in the soil significantly influence the metal reduction capacity of Cd in soil compost media.

Absorption Capacity of *Vetiver* Against Cr

The ability of vetiver (*Vetiveria zizanioides*) in absorbing Cr as a whole can be seen from the absorption of plant. The calculations of absorption rate are based on Cr concentration that absorbed by plants during observation period 35 day and dry weight of plants. The calculation result of Cr absorption of each plant can be calculated using the formula (1) and the results are presented in Table 3.

Table 3. Absorption capacity of vetiver against Cr

Variation of Planting Media	Variation of Vetiver Clump (plants)	Variation of Chromium Concentration	Initial Consentration Cd of Soil (ppm)	Dry Weight (gr)	Cr Content of Plant (ppm)		Cr Absorption By Plant (ppm/day)		Absorption Capacity of Plant	
					Initial	Final	Per Clump	Per Plant	(%)	Average
Compost 20% Soil 80%	3 (R1)	400 (K1)	426,45	40,3	60,72	221,36	4,59	1,53	37,67	47,94
	6 (R2)		426,45	78,3	60,72	268,27	5,93	0,99	48,67	
	9 (R3)		426,45	96,7	60,72	305,8	7,00	0,78	57,47	
	3 (R1)	600 (K2)	626,45	39,1	60,72	315,45	7,28	2,43	40,66	50,10
	6 (R2)		626,45	72,4	60,72	398,91	9,66	1,61	53,99	
	9 (R3)		626,45	93,5	60,72	409,35	9,96	1,11	55,65	
	3 (R1)	800 (K3)	826,45	35,1	60,72	427,81	10,49	3,50	44,42	50,62
	6 (R2)		826,45	70,2	60,72	483,18	12,07	2,01	51,12	
	9 (R3)		826,45	90,5	60,72	526,27	13,30	1,48	56,33	
Compost 30% Soil 70%	3 (R1)	400 (K1)	428,36	41,8	62,18	234,54	4,92	1,64	40,24	50,58
	6 (R2)		428,36	80,9	62,18	280,16	6,23	1,04	50,89	
	9 (R3)		428,36	99,8	62,18	321,81	7,42	0,82	60,61	
	3 (R1)	600 (K2)	628,36	36,8	62,18	319,27	7,35	2,45	40,91	51,09
	6 (R2)		628,36	70,2	62,18	408,45	9,89	1,65	55,11	
	9 (R3)		628,36	91,9	62,18	421,99	10,28	1,14	57,26	
	3 (R1)	800 (K3)	828,36	34,9	62,18	444,8	10,93	3,64	46,19	52,20
	6 (R2)		828,36	76,7	62,18	502,17	12,57	2,10	53,12	
	9 (R3)		828,36	95,9	62,18	536,72	13,56	1,51	57,29	
Compost 40% Soil 60%	3 (R1)	400 (K1)	430,72	40,5	67,36	270,35	5,80	1,93	47,13	55,85
	6 (R2)		430,72	87,7	67,36	312,72	7,01	1,17	56,97	
	9 (R3)		430,72	107,9	67,36	340,63	7,81	0,87	63,44	
	3 (R1)	600 (K2)	630,72	55,4	67,36	352,18	8,14	2,71	45,16	52,14
	6 (R2)		630,72	69,5	67,36	390,72	9,24	1,54	51,27	
	9 (R3)		630,72	93,7	67,36	445,81	10,81	1,20	60,00	
	3 (R1)	800 (K3)	830,72	54,5	67,36	475,27	11,65	3,88	49,10	65,81
	6 (R2)		830,72	69,9	67,36	674,75	17,35	2,89	73,12	
	9 (R3)		830,72	130,7	67,36	692,18	17,85	1,98	75,21	

Table 3 shows the absorption capacity of Cr by plants on the compost soil media (M2) indicates that Cr concentration of 400 ppm, 600 ppm and 800 ppm, the highest Cr absorption capacity in each clump of plants is contained in the amount of 9 plants, 57.47%, 55.65% and 56.33% respectively. The similar thing occurs in compost soil media M3 and M4, where the absorption capacity of vetiver agains Cr is increase with the increasing of Cr concentrations in the soil and high levels of compost in the soil. Similarly, the number of plant per pot is significantly affect absorption capacity of Cr by vetiver.

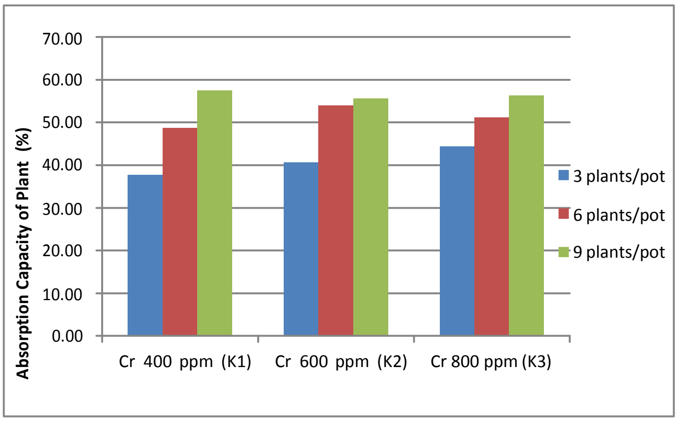

Figure 1. Absorption capacity of Cr on compost soil media (M2)

Figure 1 shows that the highest Cr absorption are contained in plants with the number of variation of plant 9 plants on all concentration of Cr pollutant metal and the lowest capacity are contained in plant with the number of variation of plant 3 plant. The high of absorption capacity of Cr on vetiver (*Vetiveria zizanioides*) is supported by the growth rate of plants. This shows that the more of plants, the higher of absorption capacity value of vetiver.

Absorption Capacity of vetiver against Cd Table 4. Absorption capacity of vetiver against Cd

Variation of	Variatio Dry Planting Consentration	Variation of Weight Media	n of Vetiver	Initial Cadmium	Cd Content of Capacity Plant (ppm)		Cd Absorption By Plant (ppm/day)		Absorption of Plant (%)	
					Initial	Final Average	Per	Per		
Compost 20% Soil 80% (M2)	3 (R1)	40 (L1)	70,45	38,9	5,4	35,6	0,86	0,29	42,87	55,59
	6 (R2)		70,45	70,9	5,4	42,3	1,05	0,18	52,38	
	9 (R3)		70,45	90,8	5,4	55,8	1,44	0,16	71,54	
	3 (R1)	60 (L2)	90,45	36,9	5,4	36,5	0,89	0,30	34,38	47,36
	6 (R2)		90,45	69,8	5,4	49,6	1,26	0,21	48,87	
	9 (R3)		90,45	88,8	5,4	58,6	1,52	0,17	58,82	
	3 (R1)	80 (L3)	120,45	37,8	5,4	48,6	1,23	0,41	35,87	40,60
	6 (R2)		120,45	65,9	5,4	52,2	1,34	0,22	38,85	
	9 (R3)		120,45	86,5	5,4	62,1	1,62	0,18	47,07	
Compost 30% Soil 70% (M3)	3 (R1)	40 (L1)	67,63	43,2	6,3	40,5	0,98	0,33	50,57	61,17
	6 (R2)		67,63	81,8	6,3	46,8	1,16	0,19	59,88	
	9 (R3)		67,63	97,2	6,3	55,7	1,41	0,16	73,04	
	3 (R1)	60 (L2)	87,63	40,9	6,3	44,9	1,10	0,37	44,05	57,06
	6 (R2)		87,63	78,4	6,3	59,1	1,51	0,25	60,25	
	9 (R3)		87,63	93,7	6,3	64,9	1,67	0,19	66,87	
	3 (R1)	80 (L3)	117,63	40,6	6,3	53,8	1,36	0,45	40,38	46,22
	6 (R2)		117,63	75,6	6,3	58,9	1,50	0,25	44,72	
	9 (R3)		117,63	88,9	6,3	69,3	1,80	0,20	53,56	
Compost 40% Soil 60% (M4)	3 (R1)	40 (L1)	65,81	46,9	7,8	45,9	1,09	0,36	57,89	62,71
	6 (R2)		65,81	88,7	7,8	47,5	1,13	0,19	60,33	
	9 (R3)		65,81	105,9	7,8	53,8	1,31	0,15	69,90	
	3 (R1)	60 (L2)	85,81	50,4	7,8	60,3	1,50	0,50	61,18	67,67
	6 (R2)		85,81	89,9	7,8	65,4	1,65	0,27	67,13	
	9 (R3)		85,81	110,7	7,8	71,9	1,83	0,20	74,70	
	3 (R1)	80 (L3)	115,81	52,2	7,8	63,8	1,60	0,53	48,36	57,16
	6 (R2)		115,81	95,4	7,8	69,3	1,76	0,29	53,10	
	9 (R3)		115,81	113,4	7,8	88,9	2,32	0,26	70,03	

To calculate the reduction capacity of vetiver against Cd can be used formula (1) and the results are presented in Table 4.
Table 4 shows the absorption capacity of Cd by plants on the compost soil media (M2) indicates that Cd concentration of 40 ppm, 60 ppm and 80 ppm, the highest Cd absorption capacity in each clump of plants is contained in the amount of 9 plants, 71.54%, 58.83% and 47.07% respectively. The similar thing occurs in compost soil media M3 and M4, where the absorption capacity of vetiver against Cd is increase with the increasing of Cr concentrations in the soil and high levels of compost in the soil. Similarly, the number of plant

per pot is significantly affect absorption capacity of Cd byvetiver.

Figure 2 shows that the highest Cd absorption are contained in plants with the number of variation of plant 9 plants on all concentration of Cd pollutant metal and the lowest capacity are contained in plant with the number of variation of plant 3 plant. However, the high of absorption capacity of Cd in the soil cause the absorption capacity of vetiver decrease. The decrease of absorption capacity of Cd by vetiver (*Vetiveria zizanioides*) are caused by the sensitivity of vetiver on the toxicity of Cd.

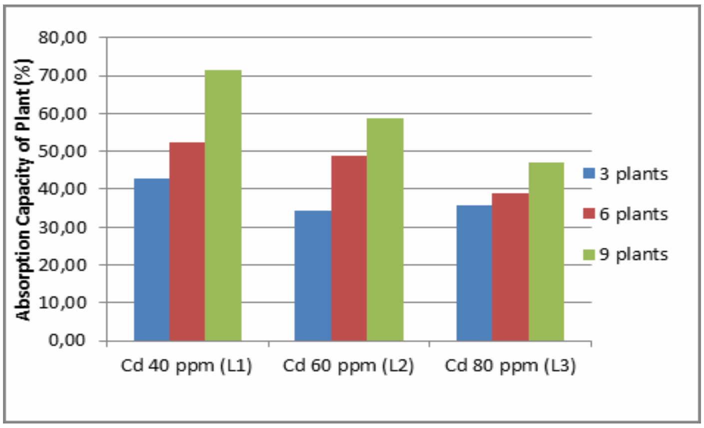

Figure 2. Absorption capacity of Cd on compost soil media (M2)

The Comparison of Absorption-Reduction Capacities of Cd and Cr on Phytoremediation Process of Vetiver

Table 5.The Comparison of Absorption-reduction capacities of Cd and Cr

Variation of Planting Media	Variation of Clump (plants)	Variation of Cd and Cr Consentration (ppm)	Reduction Absorption Capacity of Cd: Reduction Capacity of Soil (%)	Average	Absorption Capacity by Plant (%)	Average	Reduction Absorption Capacity of Cr: Reduction Capacity of Soil (%)	Average	Absorption Capacity by Plant (%)	Average
	3 (R1)		35,89		42,87		57,14		37,67	
	6 (R2)	40 (L1)	41,82	41,52	52,38	55,59	67,39	63,66	48,67	47,94
	9 (R3)		46,84		71,54		66,44		57,47	
	3 (R1)		52,40		34,38		62,42		40,66	
Compost 20% Soil 80% (M2)	6 (R2)	60 (L2)	55,37	56,13	48,87	47,36	61,69	63,64	53,99	50,10
	9 (R3)		60,62		58,82		66,81		55,65	
	3 (R1)		58,42		35,87		68,92		44,42	
	6 (R2)	80 (L3)	61,83	61,27	38,85	40,60	71,63	71,74	51,12	50,62
	9 (R3)		63,55		47,07		74,67		56,33	
	3 (R1)		37,25		50,57		61,84		40,24	
	6 (R2)	40 (L1)	41,66	42,25	59,88	61,17	75,93	69,73	50,89	50,58
	9 (R3)		47,83		73,04		71,43		60,61	
	3 (R1)		53,90		44,05		65,38		40,91	
Compost 30% Soil 70% (M3)	6 (R2)	60 (L2)	58,75	57,99	60,25	57,06	67,62	68,64	55,11	51,09
	9 (R3)		61,32		66,87		72,92		57,26	
	3 (R1)		53,71		40,38		73,38		46,19	
	6 (R2)	80 (L3)	59,21	58,73	44,72	46,22	79,07	77,56	53,12	52,20
	9 (R3)		63,27		53,56		80,22		57,29	
	3 (R1)		40,80		57,89		66,16		47,13	
	6 (R2)	40 (L1)	40,97	43,17	60,33	62,71	72,55	70,70	56,97	55,85
	9 (R3)		47,75		69,90		73,39		63,44	
	3 (R1)		51,99		61,18		67,52		45,16	
Compost 40% Soil 60% (M4)	6 (R2)	60 (L2)	55,88	56,08	67,13	67,67	71,84	73,25	51,27	52,14
	9 (R3)		60,38		74,70		80,39		60,00	
	3 (R1)		52,99		48,36		78,84		49,10	
	6 (R2)	80 (L3)	55,64	56,59	53,10	57,16	82,79	82,22	73,12	65,81
	9 (R3)		61,14		70,03		85,03		75,21	

The capacities of reduction and absorption of Cd and Cr are highest in the number of clump 9 plant for the highest concentrations used are Cd 80 ppm and Cr 800 ppm. The highest reduction capacity of metal is 61.27% for Cd 80 ppm and 71.74% for Cr 800 ppm. This shows that more and more total clumps and the higher of concentration used the higher of reduction capacity value of Cd and Cr.

Based on the table 7 above, shows that Cd is more difficult to adsorb on the high Cd metal concentrations. The absorption capacity of Cd will decrease when the concentration of metal increases. As well as the absorption capacity of Cr will decrease when the concentration of metal increases. The highest level of Cd absorption capacity was 71.54% for Cd 40 ppm, while the highest levels of Cr absorption capacity was 56.33% for Cr 800 ppm. This shows that the higher of Cr concentration used the higher of Cr absorption capacity value. In contrast to Cd, that the higher of Cd concentration used, the lower of Cd absorption capacity value

The highest undetected metal of Cd and Cr were found on the concentration of Cd 80 ppm and Cr 800 ppm, with a value of 39.93% for Cd 80 ppm and 30.16% for Cr 800 ppm. This shows that more and more of total clumps and the higher concentrations used the higher of concentration of undetected-metal. The large of Cr absorption capacity by vetiver indicates that vetiver are better able to absorb Cr compared Cd.

The high of undetected metal content for both Cr and Cd can be influenced by the activity of microorganisms or there has been a process of evaporation by vetiver, so the content of Cd and Cr in the planting media is decreased. The percentage of undetected metal content of Cd about 5 - 40% and 20 – 30 % of Cr.

IV. CONCLUSION

Reduction capacity of Cr and Cd in compost soil media is increases along with the increasing of Cr and Cd concentration in compost soil media.
Absorption capacity of Cr by vetiver is increases along with the increasing of Cr concentration in the soil, but the otherwise occurred in Cd.
Reduction-absorption capacities of Cr and Cd are significantly influenced by the number of clumps of plants per pot, metal concentrations in compost soil media and compost content in the planting media.

REFERENCES

[1] Chaney RL *et al*, 1995. Potential use of metal hyperaccumulators.*Mining Environment Manage* 3:9-11.
[2] Hidayati, Nuril. 2005. Fitoremediasi dan Potensi Tumbuhan Hiperakumulator. Pusat Penelitian Biologi. Hayati, Vol 12 (1) : 35-40
[3] Truong P. 1999.*Vetiver grass technology for mine rehabilitation.Tech. Bull. No. 1999/2.* Bangkok, Thailand: Office of the Royal Development Project Board, Bangkok.
[4] Darmono. 2001. Lingkungan Hidup dan Pencemarannya. Jakarta: Universitas Indonesia (UI- Press). Jakarta.
[5] Palar, H. 1994.*Pencemaran dan Toksikologi Logam Berat*. PT. Rineka Cipta, Jakarta.
[6] Widowati, W, 2008. *Efek Toksik Logam Pencegahan dan Penanggulangan Pencemaran.* Penerbit Andi, Yogyakarta.
[7] Hardiani, Henggar. 2009. *Potensi Tanaman dalam Mengakumulasi Logam Cu pada Media Tanah Terkontaminasi Limbah Padat Industri Kertas*.Balai Besar Pulp dan Kertas. Bandung
[8] Putri, Litany Mega & Sarwoko Mangkoedihardjo.*Pengaruh Penambahan pH terhadap Removal Logam Berat Timbal (Pb) oleh Tumbuhan Lidah Mertua (Sansevieria trifasciata) di Kelurahan Tambak Wedi, Kecamatan Kenjeran, Surabaya*.Jurusan Teknik Lingkungan FTSP-ITS, Institut Teknologi Sepuluh Nopember (ITS). Surabaya
[9] Purwani, J. 2007.*Remediasi Tanah dengan Menggunakan Tanaman Akumulator Logam Berat Akar Wangi(Vetiveria Zizanioides L.).* Balai Penelitian Tanah.
[10] Mangkoedihardjo, S dan Samudro, G. 2010.*Fitoteknologi Terapan*. Edisi Pertama. Graha Ilmu :Yogyakarta
[11] Fahruddin, 2010. Bioteknopologi Lingkungan. Penerbit Alfabeta, Bandung.
[12] Kelly.E.B.1997. Ground Water Polution: *phytoremediation*. Downloading available at http:www.cee.vt.edu/program_areas/enviromental/teach/gwprimer/phyto/ hyto/html.
[13] Priyatno B dan Prayitno J, 2002.*Fitoremediasi Sebagai Sebuah Teknologi Pemulihan pencemaran*, Khususnya Logam Berat http://www.Iti.bppt.tripod.com/sublab/ifloral1.htm.Diakses tanggal 4 Juli 2014.
[14] Widyanto, L. S dan H. Susilo, 1997.Pencemaran Air oleh Logam Berat dan Hubungannya dengan Akar Wangi (*Vetiveria Zizanioides*). BIOTROP. Bogor, Indonesia