Original article

Kemampuan daun ketapang (*Terminalia cattapa*) dalam menurunkan kandungan logam berat tembaga (Cu) di air

Ability of ketapang leaf (Terminalia cattapa) *in reducing the content of heavy metals copper (Cu) in the water*

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Abstract

*Activities of tin mining in Bangka Belitung resulted in the formation of water contained-pit called Kulong that contains heavy metals copper (Cu). Copper is a heavy metal that is needed by organisms, but at higher concentrations will have a negative impact for the organisms. The compound contained in the biomass of Ketapang leaf (*Terminalia cattapa) *has the potential to reduce the concentration of copper in water. The purpose of this study was to know the capabilities and the best dosage of ketapang leaf in decreasing the concentration of copper in water. The experimental design used was Completely Randomized Design with 4 treatments and 3 replications per treatment. The results show that the leaf of ketapang has the ability to absorb the copper in the water with the best dosage was 5 g/L .*

Keywords*: Kolong, heavy metals, copper, C), ketapang leaf*

Introduction

Province of Bangka Belitung Islands is one of areas with many sources of fresh water, but most of which have low water quality. The low quality water is sourced from tin mining. Tin mining activities generate residual excavation mine lake called *kolong*. The type of *kolong* which has low quality water commonly under the age of 5 years.

Henny's research results (2011) states that the new kolong has a water pH ranging from 2.9 to 4.5 and a high content of heavy metals which reached 5-8 mg/L. The new *kolong* containing several types of heavy metals including heavy metals / essential and nonessential minerals. One of the essential minerals found in the kolong used for the growth of aquatic biota is heavy metal copper (Cu). The content of copper in the new and middle aged kolong in Bangka Island is 0.0125 to 0.11 mg/L (Gupron 2014, Musleh and Ambalika 2010, Henny 2009, Umrah 2007).

Copper is necessary for life in certain concentration, but at higher concentration it will give negative impacts. According to Notodarmojo (2015) high copper content in the water is potential to cause toxic effects to aquatic organisms that are rarely used for fish farming, although the new kolong is potential as a means of fish farming and other uses such as recreational water, livestock and irrigating crops. The alternative to make kolong as raw water resources is not easy and requires a long time, but there are some possible ways to reduce the content of heavy metal. One of them is by utilizing dry Ketapang leaf with a specific dose as biosorbent in absorbing copper in the water.

Ketapang leaf (*Terminalia catappa*) is a kind of leaves of plants commonly grown at beachfront as roadside. The leaves shed each day and become trash. The trash or waste of the leaves (WKL) is a high carbon source which can bind metal ions. The main constituent of the leaves are carbon, oxygen and other elements such as tannins, antioxidants, and other mineral elements (Mulyawan et al.2015). Carboxyl group, carbonyl and hydroxyl groups contained mainly in the leaves are likely used as a basic ingredient in decreasing levels of copper in the water.

The ability of Ketapang leaf in decreasing the copper content in the water of the new kolong needs to be learnt and researched in accordance of the high level of copper contamination in the water underneath. This is important in order to reduce the risk of toxicity to marine life and humans. One of the methods to reduce the copper is the adsorption method by using Ketapang leaf which have high ability to absorb heavy metals in the waters by taking into account factors that affect the adsorption of which the dose of the adsorbent, the contact time and the size of the adsorbent in order to improve the quality of the water.

The purpose of the study is to find out the ability and the best dose of Ketapang leaf in decreasing the content of heavy metal copper (Cu) in the water. The study expects that any treatments for decreasing the Cu metal will be the best doses to decrease the content of the metal in the water.

The study gives the information to either academia, institution or people for using Ketapang leaf as means of decreasing the heavy metals and as the reference for further study.

Materials and method

The study was conducted in January 2016. The research conducted at the Laboratory of Water Resource Management, University of Bangka Belitung. The copper content analysis was carried out in the Laboratory of the Environmental Agency of Bangka Belitung province. The method used was an experimental method by using a completely randomized design (CRD) with 4 treatments and each treatment 3 replications with the total of 12 experimental units. The experimental design in this study used one factor treatment which were dry Ketapang leaf.

The treatment factor in this study was by giving the dry leaves with the duration of observation for 1 week at the beginning of the research (before treatment) and the end of the research (after treatment). The researcher took the data of the heavy metal, pH, temperature, DO sample and muddiness of each observation.

The initial concentration of copper used in each treatment of all the experimental designs was 1 mg/L. The leaves dose range referred to the work of Hermana and Nurhayati (2006), while the initial concentration of copper referred to the work results of Henny and Susanti (2009) who studied the heavy metal content in kolong. The observation time was determined based on preliminary research conducted. In each experimental design was taken one best dose of Ketapang leaf treatment. All data analyses was done manually using a calculator Casio.

The area of trial unit using trial number design table can be seen in Figure 1.

KTP G_{23}	KTP G_{21}	KTP G_{32}
KTP G_{13}	KTP G_{31}	KTP G_{33}
KTP G_{12}	KTP G_{22}	KTP G_{11}
KTP G_{43}	KTP G_{41}	KTP G_{42}

Figure 1. Completely randomized design from each treatment and three replicates affected by Ketapang leaf dose againts decreasing content of the heavy metal copper.

Note :

KTPG : Ketapang leaf

$KTPG_{11}$: Treatment with dose 0 gr/L at 1^{st} replication

KTPG $_{22}$: Treatment with dose 5 gr/L at 2^{nd} replication

KTPG $_{33}$: Treatment with dose 9 g/L at 3^{rd} replication

KTPG $_{43}$: Treatment with dose 13 g/L at 3^{rd} replication

Preparation phase

1. The making of copper solution

The heavy metal Cu was made artificially. The method aimed to obtain the heavy metal concentrate on the water as expected. The process was done by using Cu 1000 ppm standard liquid. The solution used was $CuSO_4$. The Cu 1000 ppm standard solution was diluted with aquades to obtain the Cu concentrate as 1 mg/l.

2. Preparing container for Treatment

Containers for treatment were 12 units aquarium 14 X 14 X 40 cm in size. The water samples will be added to each aquarium as much as 1 liter.

3. Collecting the ketapang Leaf

The amount of dried Ketapang leaf taken from campus of University of Bangka Belitung was ± 200 g. The leaves were separated into different containers, and the leaves were dried in an oven at temperature of 70 ° C for 48 hours. The dried leaves were then blended to be smooth. The treatment on the leaves draws on work of Mulyawan et al. (2015) on biosorption of lead by leaf biomass. The leaves were divided into the aquarium treated respectively as much as 5 g/L, 9 g/L, 13 g/L.

4. Preparation Tools for Research

Aerator used for aeration the leaves would be included in the sample water with the aim to accelerate contacts between the metal ion with ketapang leaves. Tools to take water parameters were such as temperature, pH, DO and turbidity.

Implementation Phase

The second phase is the implementation phase. The implementation stage is divided into several sections, including:

1. Dividing the treated leaves into 12 aquariums, each tank containing 1 liter of water containing copper concentration of 1 mg/L.
2. Placing the leaves to the aquarium containing water sample each: Ketapang leaf with doses of 0 g/L, 5 g/L, 9 g/L, and 13 g/L.
3. Placing aerator in 12 aquarium aeration treatment and having the aeration in all the aquarium for one week until the heavy metal copper in water decreases.
4. After 1 week the leaves were filtered out of the container and the content of copper was measured and water quality such as temperature, pH, DO and turbidity as well.

Analysis phase of copper content in the Water

The method of analysis of copper content in water refers to the Indonesian National Standard (SNI) using Atomic Absorption Spectrophotometer (AAS). Cu loss results will then be compared with water quality standards according to PP 82 of 2001 on water quality management and water pollution control.

Data Analysis

Analysis of the data used in this research was a completely randomized design (CRD) of the factors with three replications. The treatments were Ketapang leaf

Design model:

$$Y_{ij} = \mu + \tau_i + \varepsilon_{ij}$$

Where Y_{IJ} is observation value on individual effect of the addition of Ketapang leaf powder, μ is common average of treatment effects, τ_i is the effect of dose of Ketapang leaf, and ε_{ij} is experimental error.

Analysis of data using analysis of variance (ANOVA). If the results of analysis of variance was significantly different, then followed by Tukey test at the level of significance 5 % :

The parameter of observation

1. **The content of copper in water**

The method of analysis of copper content in water refers to the Indonesian National Standard (SNI) using Atomic Absorption Spectrophotometer (AAS). Cu loss results will then be compared with water quality standards according to PP 82 of 2001 on water quality management and water pollution control.

2. **Temperature**

The temperature of the water samples before and after treatment was measured by using a thermometer. The use of the thermometer was by dipping it into 12 experimental units then showing the numbers and recording the results.

3. **pH *(Potential hydrogen)***

pH of water samples before and after treatment was measured by using a pH meter. The use of pH meters was done by dipping a calibrated pH meter into 12 sample bottles containing water samples. The pH value could be read directly on the device, then the results were documented.

4. **DO *(Dissolved Oxygen Demand)***

DO or oxygen dissolved in the water is an important factor as a regulator of the body's metabolism of organisms to grow and reproduce (Silalahi, 2009). The DO was measured by dipping the calibrated into a measuring cup containing water samples. Its values can be read directly on the tool.

5. **Turbidity**

Turbidity describes the optical properties of water which is determined by the amount of light absorbed and emitted by the materials contained in water, and it was caused by the presence of organic and inorganic material suspended and dissolved (Effendi, 2003). The tools used for analysis of turbidity of the water / solution is Turbidimeter. Water samples before and after treatment was measured by using a turbidimeter.

Results and discussion

The content of copper in the water at the beginning of treatment measured using absorbent Atomic Spectrophotometer (AAS) was 0.772 ± 0.008 mg/L. This value was based on PP 82 of 2001 on the quality of raw water quality management, and water pollution control was above the quality standard threshold or exceeded the quality standard limits (Cu = 0.020 mg/L) for allotment of fish farming activities (class III). The initial concentration of Cu at all experiment is equal. After the treatment process, the result as shown in Table 1.

Table 1. The average value of copper (Cu) content after the addition of Ketapang (*Terminalia cattapa*) leaf.

Dose	Remaining Cu content in Water		Remarks
	Cu Heavy metal (mg/L)	Persentage of Decrease (%)	The quality standard (PP No. 82 of 2001) (mg/L)
0 g/L	0,572±0,317[a]	26	
5 g/L	0,123±0,083[b]	84	
9 g/L	0,091±0,023[b]	88	Class III : Cu < 0,020
13 g/L	0,134±0,017[b]	83	

Note. : The equal *Superscript* shows insignificant results. Class III : Water allocation can be used for freshwater fish cultivation, animal husbandry, field irrigation or other uses that require the same water with these purposes.

The percentage and the best dose to reduce the content of copper in water using Ketapang leaf is 84% with a dose of 5 g/L. At Henny's study (2011), the content of copper in new kolong was equal to 0.11 ± 0.08. The use of leaf ketapang a dose of 5 g/L with a percentage decline of 84% were able to reduce the content of heavy metals in the water to be 0,018. This means that the value of copper remaining in the water underneath is under the quality standard limits which is determined based on Government Regulation No. 82 of 2001 (Cu <0.02 mg/L).

Based on Table 1 can be graphed the average concentration of copper remaining in the water by the minimization process using ketapang leafs at each dosage(Figure 6).

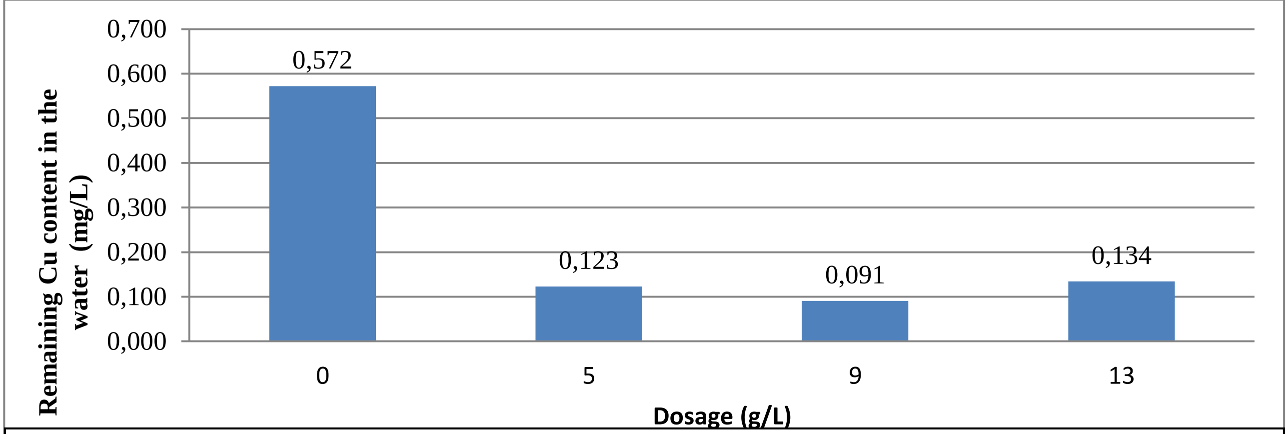

Fig. 6 The average contents of copper in the water after the treatment of ketapang leaf treatments

According to the observation on the process of minimization of the copper content in water by using Ketapang leaf indicate that the leaves are capable of adsorbing copper seen from the low copper remaining in the water. The content of the initial copper before treatment was 0.772 ± 0.008 mg/L in which the initial concentration of Cu at all doses was the equal, while the copper content after treatment, the content of Cu was decreased at each dose of Ketapang leaf. The reduced content of heavy metals is caused by the effect of Ketapang leaf given.

The reduction percentage in each dose of Ketapang leaf (5 g/L, 9 g/L and 13 g/L) is quite high which is above 80%, and without the leaves (0 g/L) the reduction percentage is very low. Values of the copper content and copper content reduction percentage obtained showed that the content of Ketapang leaf can reduce heavy metals although it remained above the threshold (Cu <0.020) intended for fish farming activities (class III). This is because the initial content of copper in the water is too high. The results of study on the condition of copper content in new kolong by Henny (2011) is 0.11 mg/L with the reduction percentage above 80%, the remaining content of the heavy metal is below the threshold and meet the quality standards specified limits for fish farming activities (Cu<0.02) based on Government Regulation No.82 of 2001.

Based on the statistical test showed that there are differences from the doses of Ketapang leaf in the process of minimizing the metal Cu content in the water. A further test using the Test of Tukey showed that doses of leaves 0 g/L is significantly different from the dose of 5 g/L, 9 g/L and 13 g/L while the dose of 5 g/L, 9 g/L and 13 g/L do not differ significantly from the treatment doses. Therefore, it is concluded that the dose of 5 g/L is the best dose to minimize potential of Cu in the water because it is more efficient in the use of the dose.

The graph in Figure 6 shows that the reduction on the amount of copper remaining in the water is influenced by the dose of Ketapang leaf. Different doses results in different amount of Cu left in the water. The dose of 0 g/L (without ketapang leaf) leaves the most high content of Cu. The dose of 13 g/L looks higher in leaving Cu when compared with a dose of 5 g/L and 9 g/L.

Water quality parameter

The results of water quality measurements at the beginning and end of the treatment show different results. It depends on the dose of Ketapang leaf used as the heavy metal adsorption. Before treatment, the water quality in all doses of Ketapang leaf treatment was the same. The pH value of the water before treatment was have as the result of the use of acid Cu standard when it is mixed with water. Table 2 shows the water quality before and after treatment of Ketapang leaf.

Table 2. The water quality before and after treatment of Ketapang leaf.

Dose of Ketapang Leaf	Quality Standards (PP No 82/2001)	pH	DO (mg/l)	Temperature (°C)	Turbidity (NTU)
Before treatment		3.58±0.079	2.66±0.017	29.000±0.000	1.82±0.291
0		4.303±0.992	4.857±0.065	27.833±0.058	2.723±2.190
5		4.949±0.302	4.497±0.240	27.667±0.058	2.910±0,212
9		4.729±0.090	4.353±0.681	27.900±0.100	16.600±3.253
13		4.450±0.174	2.033±0.012	28.000±0.000	8.495±2.553
	Class III	6-9	4	27	-

The water quality during the process of adsorption of heavy metals by Ketapang leaf at the beginning and end of the treatment shows different results. It depends on the amount of Ketapang leaf used as the heavy metal adsorption. The pH value after the leaves ketapan given is increasing. The pH value without treatment is 4.3030, while the pH value after treatment shows different values but the difference was not significant, which is 4.4500 to 4.9490. This is because the leaves contain lots of negative functional groups on the surface of the cell wall or in the extracellular polymers that can bind positive ions (H^+) causing the acid which results in the increasing of the pH in the water. The quality of water consisting of temperature, pH and turbidity at the end of treatment leaves ketapan is still suitable for use as the maintenance of fish and water plants at the dose of 5 g/L and 9 g /L. In general, the water quality at the end of treatment is still proper for use.

Content of Heavy Metal Cu in the Water

The results of the study showed that the leaves of Ketapang (Terminalia cattapa) can decrease the content of copper in water samples containing copper with an initial concentration of 0.772 ± 0.008 mg/L. The percentage of reduction in the dosage of each leaf ketapan is high at above 80% whereas without giving leaves ketapan (0 g/L) percentage of reduction is very low. The values of copper and percentage drop after treatment at each dose of Ketapang leaf can be seen in Table 1. The study on adsorption of heavy metals by using leaves of ketapang with different doses of the leaves in aerated conditions shows good results because it can reduce the content of copper. Based on laboratory tests showed that at a dose of 5 g/L, 9 g/L and 13 g/L showed different results. At a dose of 5 g/L, 9 g/L and 13 g/L of copper remaining in the water are respectively 0.123 mg/L, 0.091 mg/L and 0.134 mg/L with a percentage decrease respectively 84%, 88% and 83%.

Based on the results of the study at a dose of adsorbent (Ketapang leaf) with different adsorption capacity adsorbent down on increasing from 0 g/L up to a dose of 13 g/L is also different. Pada dosis 9 g/L memiliki persentase penurunan kandungan logam berat Cu paling tinggi yaitu sebesar 88 %. At the dose of 9 g/L had the highest reduction percentage of copper at 88%. This is due to the dose of 9 g /L increase in the number of active sites for binding Cu^{2+} is higher than the dose of 5 g/L although the difference was not significant and was not statistically significantly different. At the dose of 13 g/L of copper remaining higher than the dose of 9 g/L. This is because an increase in the number of active sites for binding Cu with an increased number of doses of Ketapang leaf at a certain range causes the increase becomes insignificant adsorption capacity that is at a dose of 13 g/L. Increasing too much active side of the leaves causing saturation of the pore surface of the adsorbent which has been met by heavy metals so that the adsorbent is unable to absorb back. This data is in line with the Langmuir adsorption theory which states that the adsorbent surface has a certain amount of the active site adsorption. Mulyawan *et al*. (2015) stated that in a situation where the adsorption place is saturated with adsorbate then increases of the amount of adsorbent tends to not increase the amount of adsorbed substances. The excessive dose of the leaves will cause adsorption capacity decreased at a certain time span because at each active center is only one molecule or an ion that can be absorbed.

The values of copper and the percentage of reduction of copper obtained showed that the leaves can reduce heavy metals although it remained above the threshold (Cu <0.020) intended for fish farming activities (class III). The percentage and the best dose to reduce the content of heavy metals copper (Cu) in water using the leaves that is 84% with a dose of 5 g/L. According to Henny's study (2011), the content of copper in new kolong is 0.11 ± 0.08. The use of the leaves at the dose of 5 g/L with the reduction percentage of 84% is able to reduce the content of copper in the water of kolong to be 0,018. This means that the value of copper remaining in the water is under the quality standard limits determined based on Government Regulation No. 82 of 2001 (Cu <0.02 mg/L).

Decreasing the concentration of heavy metals in the water due to the addition of Ketapang leaf dried for 48 hours in oven at a temperature of 70 ^{o}C consists of organic acids. Heavy metals can easily bind organic materials. The process of adsorption of heavy metals by biomass occurs through chemical and physical mechanisms, such as ion exchange, complex bond formation involving ionic interactions, polar interactions and mineralization joint between the metal and biopolymers (macromolecular) constituent biosorbent (Mawardi *et al*., 2014). According Mulyawan *et a*l., (2015) Ketapang leaf when heated (temperature 70 ^{o}C) can activate the functional groups contained in the leaves and have the ability to bind heavy metals. Typical compounds which is able to play a role in the formation of complex compounds and ion exchange in organic acids contained in the leaves of Ketapang is the functional groups. The functional groups such as carboxylic (-COOH), a primary alcohol group (C-OH), carbonyl (= C = O) and hydroxyl (OH) can reduce the copper in water. Cu adsorption process in aqueous media occurs by the deprotonisation of H^{+} ions in the functional groups (separated from the group of compounds) that becomes negatively charged functional groups and the metal cation Cu^{2+} binds to the negatively charged functional groups. This is in line with the work of Tangio (2012) on the adsorption of lead using water hyacinth biomass where ion exchange mechanism occurs when the carboxylate groups (COOH) in the amino acids deprotonisate due to the presence of hydroxide ions (OH) to the carboxylic group turned into negatively charged (COO) and very reactive to bind with Pb^{2+}.

Interactions between organic adsorbent (Ketapang leaf) and metal ions contained in the water will occur physical interaction and chemical interaction. Physical interaction occurs through hydrogen bonds in which the metal particles will be closer to the surface of the adsorbent. During the adsorption process using the biomass of Ketapang leaf hydrogen bonds at the beginning of adsorption. According Tangio (2012) hydrogen bonding occurs when two atoms of high electronegativity met with prototic hydrogen. Hydrogen bonding that occurs in adsorption of Cu^{2+} metal leaf biomass use in medium water occurs not only at the metal atom but also possible atom bonded to H^{+} in the OH group. Chemical interaction occurs when chemical bonds are formed between substances absorbed by the adsorbent active center and form a single layer on the surface of the adsorbent (Mawardi *et al*.,2014). In this case there is the chemical bond between the metal ion Cu^{2+} with the active center of the adsorbent which Ketapang leaf through functional group that acts as ligand or electron donor with metal ions to form a single layer on the surface of the adsorbent.

The mineral content of positive ions contained in the leaves of Ketapang including carbon, oxygen, sodium, magnesium, and calcium silicate can have ion exchange with Cu in the water. According to Soeprijanto (2014) biosorption occurs because of the events in which the ion exchange of monovalent and divalent ions such as Na^{+}, Mg^{2+}, Ca^{2+}, K^{+} in the cell walls are replaced by ions of heavy metals. The mineral content of positive ions contained in the leaves of Ketapang exchanges the cation minerals through the process of exchange of heavy metal lighter cation on the adsorbent so that the heavy metal content of Cu in the water decreased. According to Prasetiyono's work (2012) on the adsorption of heavy metals lead (Pb) using compost found that heavy metal cations which are divalent ions will be easily exchanged with positive monovalent ions contained in the adsorbent. The content of the leaves is in the form of organic substance that has positive monovalent ions which are potential to bind the Cu^{2+} cations (divalent ions) because it can form complexes or chelate compounds.

The treatment of the leaves (roasted and ground) before the treatment also affects the adsorption capacity of Ketapang leaf to absorb heavy metals. According Mawardi *et al*. (2007), the smaller the particle size the more biomass adsorbent surface area, so theoretically will increase the amount of metal ions absorbed. The treatment of the smoothed leaves influences on the adsorption capacity of Ketapang leaf absorbing heavy metals because heavy metal ions (Cu) would be more quickly absorbed in the small particle size. Relative biomass heating (temperature 70 ^{o}C) also increases the absorption of ions, changing the physical properties of biomass such as pores and does not alter the chemical properties of biomass concerned. In this case the leaf biomass used is the dried leaves for 48 hours in the temperature of 70 ^{o}C and blend until smooth so that the heavy metal absorption by the leaves is more effectively.

The contact time on the process of absorption of Cu^{2+} cations by the leaves also affects the adsorption capacity. Based on the work of Nopitasari *et al*. (2014) concerning the waste carbonization of Ketapang leaf for biosorption of Cr in the water stating that the optimum adsorption occurs at a time of 120 minutes, where at the beginning of the adsorption of the active sites on the surface of the leaf bioarang is still empty so it can absorb chromium (Cr) maximally. The effect of contact time of biomass to metal ions was also investigated by Mawardi *et al*. (2014) in which the process of biosorption achieves a relatively constant at 30 minutes, because of the time it reaches a state of balance between ions adsorbed ions which are not absorbed so that the amount of metal ions adsorbed significantly does not change in time. The duration of treatment (1 week) influences the adsorption capacity of Cu by the leaves although the optimum time of absorption occurs at the beginning of the adsorption but at the next additional time, the active site leaves remain little and still be able to absorb even with small adsorption capacity.

Analysis on water quality

The process of absorption of heavy metal ions by ketapang leaf biomass was also influenced by the quality of the water, including pH, temperature, DO (dissolved oxygen) and turbidity. Ketapang leaf are materials that have negatively charged functional groups. The negative charge is in addition to bind certain metal ions in water is also to bind hydrogen ions which cause acidity in aqueous media where the pH of the water to rise despite the increase in the pH of the water after the treatment is given is not significant. This is because Ketapang leaf also contain tannins that can lower the pH of the water. According to Tangio (2013), the metal contained in the water with a pH more acidic the greater solubility will be, otherwise if the solution is more alkaline, the solubility of the less marked sediment. It is clear that the cation Cu absorbed by the adsorbent is maximally at acidic pH (4-5) because this happens at pH greater ionization and adsorption can occur if metal ions are formed and will be bound by the active group on ketapang leaf biomass. Based on research of Mulyawan et al (2015) on biosorption of lead (Pb) by ketapang leaf biomass states that the effect of pH on the adsorption of Pb2 + by adsorbent Ketapang leaf is significant and at acidic pH (3-4) lead (Pb) adsorption capacity increases. The Cu reduction process in acidic water conditions is affected by the exchange reaction involving metal ions with functional groups contained in the leaves of Ketapang. Carboxyl group, carbonyl and hydroxyl groups contained in the leaves of Ketapang can react with Cu^{2+} in acidic pH conditions.

The temperature has an important role for the physics, chemistry and biology in water. Increasing temperatures may cause an increased rate of evaporation, volatilization and chemical reactions in the water. The increase in water temperature can cause reductions in gas solubility in water, including gas O_2, CO_2, N_2, CH_4, and so on (Haslam, 1995 in Effendi, 2003). The temperature on this study before treatment was 29 ^{o}C and after the treatment decreased ranged between 27-28 ^{o}C. This was because the research was conducted in a closed room with a homogeneous condition. The temperature value on this observation is within tolerances for aquatic life, especially fish in general where aquatic organisms have the optimum temperature ranging between 20-30° C.

The concentration of dissolved oxygen contained waters depends on the conditions of temperature and salinity of the water itself, as well as the activity of turbulence (agitation) which leads to the diffusion of oxygen from the air into water (Wibowo, 2009). The results of dissolved oxygen before and after treatment showed differences where the dissolved oxygen before treatment that was 2,66 mg/L, after treatment shows results between 2.700 to 4.857 mg/L.

This concentration increases the dissolved oxygen in the water due to the supply of oxygen from the aerator tool used.

Turbidity describes the optical properties of water which is determined by the amount of light absorbed and emitted by the materials contained in water; it is caused by the presence of organic and inorganic material suspended and dissolved (Effendi, 2003). In general it is influenced by organic material contained in the leaves suspended and dissolved in water. It is stated in unit of turbidity and a turbidity unit stated in unit of 1 NTU. The doses of Ketapang leaf of 9 g/L and 13 g/L had the highest turbidity values than the dose of 0 g/L and 5 g/L. This is influenced by the higher dose which contains more organic and inorganic material suspended and dissolved in water. At dose of 5 g/L has a turbidity <5 NTU where the turbidity value can still be tolerated by organime in the waters because the high turbidity (> 5 NTU) can lead to disruption of the osmoregulation system, such as respiratory and vision of aquatic organisms, and can inhibit the penetration of light into the water.

Conclusion

From the study results, the writer concluds that:

1. The Ketapang leaf (*Terminalia cattapa*) is capable and has quite high capacity to reduce the content of copper from an initial concentration of 0.772 g/L to 0.123 mg/L, 0.091 mg/L and 0.134 mg/L at each dose of 5 g/L, 9 g/L and 13 g/L with the reduction percentage above 80% in average.
2. Based on the statistical test the best doses in reducing copper in water using ketapang leaf (Terminalia cattapa) is 5 g/L because it is more efficient and is not significantly different from doses of 9 g/L and 13 g/L.
3. It is necessary to lengthen the duration of aeration on the treatment aeration phase to determine the optimal contact time between heavy metal and the leaves.

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