Environmental Observation and Potency of Lindur Fruit (Bruguiera gymnorrhiza) as Alternative Food Substance

by Turnitin cek5

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Abstract

The purpose of this paper is to know the content of heavy metal Pb in water, sediment and lindur (*Bruguiera gymnorrhiza*) at Ecotourism Mangrove Wonorejo Surabaya. The research methodology of this paper using descriptive quantitative method and with use water, sediment and lindur (*Bruguiera gymnorrhiza*) as the sample that taken at station I, II, III with 3 replications. Physical parameter including temperature, pH, and salinity were tested directly in the field, while the heavy metal content of Pb was tested using AAS method. Finding of the research showed that water, sediments and lindur (*Bruguiera gymnorrhiza*) in Ecotourism Mangrove Wonorejo has been contaminated by heavy metals Pb. Originality of this research explain that the average content of heavy metal Pb in water at station I 0,92 mg/L, station II 0,86 mg/L, and station III 1,08 mg/L, heavy metal concentration of Pb in water has exceeded the limit of the quality standard of water according to Decision of Environment Minister Number 51 of 2004 that is 0,05mg/L. The content of heavy metal Pb in sediments at station I 2,69 mg/Kg, station II 2,92 mg/Kg, and at station III 2, 98 mg/Kg, heavy metal Pb is still below the limit according to the government regulation of Indonesia Number 85 of 1999 is 5,0 mg/Kg. The average content of heavy metal Pb on lindur (*Bruguiera gymnorrhiza*) are at station I 0,13 mg/Kg (epidermis layer 0,10 mg/Kg, mesodermis 0,04 mg/Kg, and endodermis 0,26 mg/Kg), station II 0,15 mg/Kg (epidermis 0,13 mg/Kg, mesodermis 0,05 mg/Kg and endodermis 0.27 mg/Kg), station III 0,16 mg/Kg (epidermis layer 0,14 mg/Kg, mesodermis 0,06 mg/Kg and endodermis 0,29 mg/Kg), which has not exceeded the limit set by Directorate General of Food and Drug Administration Decree Number 03725/B/SK/VII/1989 of 2,0 mg/Kg.

Keywords
Pb, *Bruguiera gymnorrhiza*, Alternative Food Substance.

1. INTRODUCTION

The pace of development in all sectors under current conditions has led to an increase in urbanization rates. The logical consequence of all this is the increase in urban activity in various areas, including housing, industry, trade and other sectors (Satterthwaite, *et al*, 2010). One of the consequences of this development is the depletion of agricultural land used as a food source, and the increasing demand for food continues to increase as the population grows (Cervantes Godoy et al., 2014).

Food is a fundamental human need, and the fulfilment of food needs should be relatively equitable and based on independence (FAO, n.d.) and not contrary to the belief of society as mandated by Law No. 7 of 1996 on food.

In 2014, Mangrove Forest Management Hall I Bali provided advice on alternative food ingredients, one of which is lindur (*Bruguiera gymnorrhiza*). Fruit lindur (*Bruguiera gymnorrhiza*) is one of the mangrove fruit plants commonly known as mangrove leaves. Fruit lindur (*Bruguiera gymnorrhiza*) used as a rice substitute. Lindur (*Bruguiera gymnorrhiza*) is suitable for exploration as a new high-quality carbohydrate-containing 85.1 g/100 g of ingredients (Tempo.co, 2005).

The habitat of the lindur plant (*Bruguiera gymnorrhiza*) itself is the current problem. Where the lindur plant (*Bruguiera gymnorrhiza*) is one type of mangrove that lives in coastal waters with low salinity and dryness, and the soil has proper aeration (Kodikara, *et al.*, 2018).

Ecotourism Mangrove Surabaya is one of the places where lindur plants (*Bruguiera gymnorrhiza*) grow. Mangrove waters in Ecotourism are waters that are influenced by tides, and the sea is affected by the process of sedimentation. Ecotourism of mangroves located on the coast that place for the collection of pollutants or waste from the river. Waste comes from industrial activities in urban areas, households and visitors to mangrove forest ecotourism.

A lot of waste that exists in coastal areas; heavy metal waste is the most hazardous waste because it causes human toxic effects (Boran & Altinok, 2010). Coastal waters are waters with a high potential for metal accumulation (Hasegawa, *et al.* 2016). Heavy metals are said to be hazardous pollutants because they are toxic, non-degradable and easily absorbed. The pollution of heavy metals entering the aquatic environment of the river will dissolve in water and accumulate in the sediment and may increase over time, depending on the environmental conditions of these waters (Wulan, dan Thamrin, 2013).

Heavy metal Pb is one of the most hazardous heavy metals, and in both low and high levels, heavy metal Pb is toxic and has a negative impact, one of which is for lindur (*Bruguiera gymnorrhiza*). If the plant contains heavy metal Pb, it will lead to poisoning when consumed by humans (Yunita, 2011).

Lindur (*Bruguiera gymnorrhiza*) has a heavy metal content of Pb which is 16.04 ± 2.09 mg/kg in the Dead River area and 12.85 ± 0.61 mg/kg in the Pemogan area. In the study, it stated that the heavy metal content of Pb exceeded the threshold according to the Directorate-General for Food and Drug Administration Decree No. 03725/B/SK/ VII/1989 on the maximum level of heavy metal contamination allowed in food (Pb of 2.0 mg/kg) (Kalifika Devi, *et al.*, 2015). This problem formulation research is the water and sediment found in Wonorejo Mangrove Ecotourism Surabaya containing Pb heavy metals. It is Lindur (*Bruguiera gymnorrhiza*) used as an alternative food containing Pb heavy metal.

2. LITERATURE REVIEW

Several regional names from *Bruguiera gymnorrhiza*, namely taheup, tenggel (Aceh); wax, red tinjang (Jakarta); putut, tumu (Riau); lindur, long red (Bali); bangko (NTT); salasala, totongkek (NTB); tancang (West Java); tancang, tumu (Central Java); tancang, putut (East Java); lindur (Madura); tokke-tokke, sala-sala, tancang, tokke (South Sulawesi); and big mouth (East Kalimantan) (Permatasari, 2011). Based on its taxonomy, the classification of lindur (*Bruguiera gymnorrhiza*) is as follows (Taxonomic Serial, 2011):

Kingdom : Plantae (plants)
Sub kingdom : Tracheobionta (vicious)
Super division: Spermatophyta (yielding seed)
Division : Magnoliophyta (flowering)
Class : Magnoliopsida (double-dikotil)
Subclass : Rosidae 4
Order : Myrtales
Family : *Rhizophoracea*
Genus : *Bruguiera*
Species : *Bruguiera gymnorrhiza* (L.) Lamk.

Lindur (*Bruguiera gymnorrhiza*) has a tall tree that reaches 20 m, a small knee-rooted knee, simple opposite leaf arrangement, ellipse, crossed, tapered end, leaf length 8-15 cm (BPHM, 2014). The leaves are slick and thick, with no rough and thin ends. The bark is dark grey, raw, with the mouth of the bark.

Blossoms all year round. Flower width, single in leaf armpit, large, red, 3-5 cm long, petals 10-14 strands, white to the brown crown, the tip of each shaped head made up of 3 stems.Fruit shaped cylinder, slippery, 1,7-2,0 cm long, 20-30 cm long, dark green to purple with brown spots. When the grain falls, the petals blend, they can float, spread by water.

The fruit usually divided into pure fruit and fake fruit. Fruit lindur (*Bruguiera gymnorrhiza*) is said to have classified as false fruit (Fructus spurius). Phoney fruit divided into three: single pseudo fruit, double wrong fruit and pseudo compound fruit. Fruit lindur (*Bruguiera gymnorrhiza*) can be classified as a single pseudo-fruit because it comes from a single flower with one will fruit. In this fruit, other than going to fruit, other parts of the flowers form the fruit (Tjitrosoepomo, 1990).

Lindur (*Bruguiera gymnorrhiza*) is the dominant species in high mangrove forests and is characteristic of late coastal forest development as well as early stages of transformation into mainland vegetation types. They are growing in acreage with low and dry salinity and well-aerated soil. This species is tolerant of both sunny and sheltered areas. They grow from mangroves edge of the mainland, along with the ponds, as well as retro and brackish. Found on the beach only if there is erosion on the ground. The substrate is composed of mud, sand and sometimes black peat soil. This species is also sometimes found in rivers that are less affected by seawater. It caused by the carrying of lindur (*Bruguiera gymnorrhiza*) by water or tidal waves. Regeneration is often limited in quantity. The flower is relatively large, has red petals, hangs, and invites birds to pollinate (Permatasari, 2011)

Lindur plant (Bruguiera gymnorrhiza) capable of helping to stabilize the soil, to protect the beach and the habitat of various faunas. Wood can be used as firewood and for the production of charcoal. Pepagan (bark) used as a tannery material and a good fishnet preservative because it contains an average tannin content of 28.5-32.2 per cent (Utari, 2012). Also, the residents of Solomon use pepagan to heal burns. In small islands, Indonesia is used to treat diarrhoea and fever, while in Cambodia, it used as antimalaria (Allen & Duke, 2006). Residents in remote islands are using their young leaves as vegetables or vegetables. The inside of the hypocotyl lindur (*Bruguiera gymnorrhiza*) can eat (candy), mixed with sugar. The eastern Indonesian population uses lindur (*Bruguiera gymnorrhiza*) as a food source during the famine season (SANBI, 2005).

3. METHODS

Tools used in this study include drill, AAS, evaporator, modified DO bottle, glass cup, capillary tube, plastic, cater, preparation, pH water meter, pH meter and Erlenmeyer.

Materials used include 10 mL of water, 10 grams of sediment and 10 grams of lindur (*Bruguiera gymnorrhiza*), 10 mL of HNO3 and 25 mL of HCl, 100 mL of aquades, oxygen, asitelin, NO3, NaCl.

To perform the research procedure through several methods ie first method (1) Testing of Physics Parameters on Water and Sediment (Temperature, pH, Salinity) (2) Water and sediment sampling The first method (1) Testing of Physical Parameters on Water and Sediment (Temperature, pH, Salinity) (2) Water and sediment sampling (3) The lindur (*Bruguiera gymnorrhiza*) samples used are lindur (*Bruguiera gymnorrhiza*) which is old and has the characteristics of brown fruit and red petals. Samples of lindur (*Bruguiera gymnorrhiza*) taken at each station with three replicates.

The second method (1) Heavy Metal Pb test on the water. Water up to 10 ml, inserted into a cup of glass, then evaporated to dryness using an evaporator tool. The residue formed is transferred to the turbidity of the porcelain so that it becomes ash. Then added 25 mL of HCl, 100 mL of HNO3 and 100 mL of aqua dest. Then, in a stirred and filtered clear filtrate, add 217 nm of absorbance to the AAS tool. (2) Heavy Metal Pb tests on sediment. The sediments were weighed as much as 10 grams and fed into a cup and then heated to dryness. The resulting residue transferred to the porous plate to burned to the ash, then added 25 mL of HCl, 100 mL of HNO3 and 100 mL of aqua. Stirred in such a way that the ash dissolve, filters clear filtrate and inserts 217 nm into the AAS absorbance tool. (3) Testing of Heavy Metal Pb on Lindur Fruit (*Bruguiera gymnorrhiza*). The lindur sample (*Bruguiera gymnorrhiza*) was washed away with water. The sample then is taken from the epidermis layer, the mesoderm layer and the endoderm layer every 10 grams. Then the layer burned to dry. The resulting residue transferred to the porcelain plate to burned to the ash, then added 25 mL of HCl, 100 mL of HNO3 and 100 mL of aqua dest. Then, stirred to dissolve the ash, filter filter filter filtered and inserted into the 217 nm AAS absorbance tool.

4. RESULTS AND DISCUSSION

Water physics parameters observed in this study include temperature, pH and salinity. The results of the measurement of the parameters of aquatic physics shown in Figure 1.

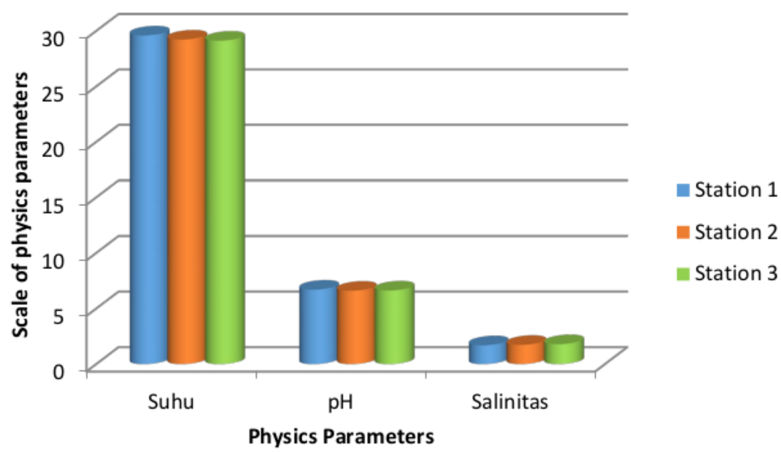

Figure 1: Aquatic Physics Parameters.

The average temperature condition shown in Figure 1 is 29,59 ^{0}C, 29,22 ^{0}C, 29,12 ^{0}C. The higher the intensity of sunlight on the body of water, the higher the temperature of the river water (Effendi, 2003). Dense vegetation lowers the temperature of the air around. Heat is still within the limits of the water quality standard according to Decision No 51 of the Minister for the Environment of 2004 (Setiawan, 2015), where the standard water temperature is 28-32 degrees Celsius, the mean pH values were 6.70, 6.60 and 6.62. Rain will affect the pH of the aquatic environment to acid (Supriyantini & Soenardjo, 2016). The pH of the water is more acidic to the inlet due to the addition of organic materials which release the CO2 when it decomposes.

If rainwater falls on the ground, then it meets carbon dioxide in the soil cavity, then the water is again more acidic, and then the acid salts are formed. It will last a long time if there is a lot of CO2, if there is no more CO2, then the acid salt will decompose into CaCO3. The reactions are as follows.

$$CaCO3 + H2CO3 \rightarrow Ca\ (HCO3)\ 2 \text{ decompose}$$
$$Ca\ (HCO3)\ 2 \rightarrow CaCO3 + H2O + CO2$$

The higher the temperature of the water, the lower the pH. The pH conditions of the three stations are below the water quality standard limit set out in Decision No 51 of the Environment Minister of 2004, where the pH quality standard is between 7 and 8.5 (Anggraini, *et al.*, 2018).

The average salinity is 1.69 per cent, 1.73 per cent and 1.79 per cent. The average salinity value is below the threshold set by the 2004 Decision of the Environment Minister, i.e. 33 to 34% salinity value. Land and sea are affected by the conditions of the estuary waters (Takarina, *et al.*, 2019). High salinity value occurs when the influence of the oceans is more dominant than the power of the land when pairs occur while the low salinity value is due to the impact of the area when freshwater enters the water through the flow of the river.

Physical parameters of the sediment observed in this study include temperature, pH and salinity. The physical condition of the water may affect the physical and chemical content of the soil as it accumulates and absorbed by the sediment (Amelia, *et al.*, 2014; Sari, *et al.*, 2012). The results of the measurement of physical parameters in sediments shown in Figure 2.

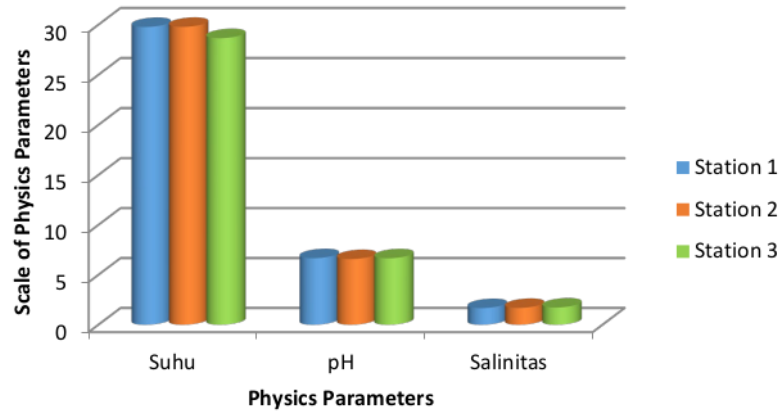

Figure 2: Parameters of Sediment Physics.

The average temperature shown in Figure 2 is 29.78 ^{0}C, 29.78 ^{0}C and 28.66 ^{0}C. Average pH values of 6.67, 6.58 and 6.66. Rainfall affects the pH value of sediments (Supriyantini & Soenardjo, 2016). In addition to rainwater, soil pH also affects the residual metabolism of microorganisms present in sediments. During the growth of microorganisms, the pH of the deposit often changed, whereas when protein and amino acid metabolism is released, ammonium ions cause the pH to be alkaline (Neina, 2019). The average salinity is 1.67 per cent, salinity is 1.69 per cent, and salinity is 1.73 per cent. The salinity of the soil, which is lower than the salinity of the waters, can be caused by mangroves, a freshwater plant that can alter the salt content found in the soil by negotiating metabolic processes requiring freshwater (Reef & Lovelock, 2015).

The result of the measurement of the heavy metal content of Pb on the water in Wonorejo Mangrove Ecotourism shown in Figure 3.

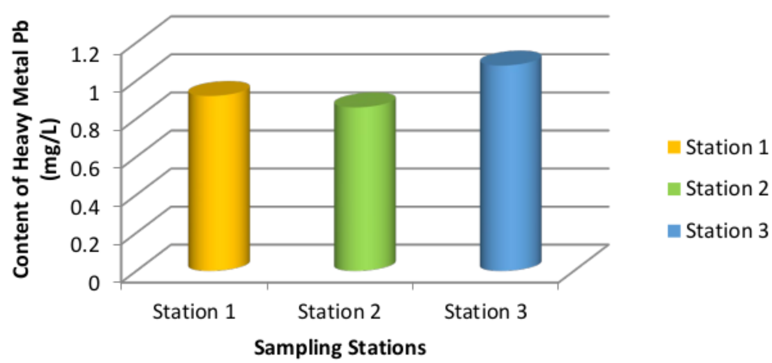

Figure 3: The Content of Heavy Metal Pb on Water.

The mean values of the heavy metal concentrations of Pb of water shown in Figure 3 are 0.92 mg/L, 0.86 mg/L and 1.08 mg/L. Although the levels of heavy metals in water are relatively small, they are readily absorbed and biologically accumulated by plants or aquatic animals and will be involved in food tissue systems. Low level of heavy metal in water due to the dilution process in water, then the heavy metal is absorbed by suspended particles going to the bottom of the water, which causes heavy metal content in low water (Tchounwou, *et al.*, 2012). The concentration of heavy metal Pb in Wonorejo Mangrove Ecotourism exceeded the water quality standard threshold according to Decision of Environment Minister No. 51 of 2004 is 0.005 mg/L. (Hamuna, *et al.*, 2018).The result of the measurement of the Pb heavy metal content on sediment can see in Figure 4.

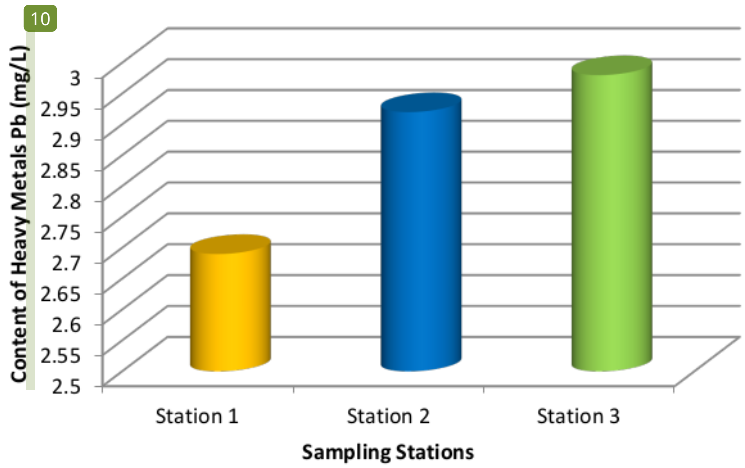

Figure 4: The Content of Heavy Metals Pb in Sediments.

Figure 4 shows that the heavy metal content of Pb in sediments was 2.69 mg/kg, 2.92 mg/kg and 2.98 mg/kg. Heavy metal levels in sediments are higher than in water, indicating the presence of heavy metal accumulation in sediments, possibly because heavy metals in water undergo dilution processes with the effect of current patterns (Rochyatun, *et al.*, 2010). The heavy metal content of Pb sediment is still below the threshold due to Government Regulation of the Republic of Indonesia No. 85 of 1999, which is equal to 5.0 mg/kg (Setiyono, 2001).The result of the measurement of the heavy metal content of Pb for lindur fruit (*Bruguiera gymnorrhiza*) can see in Figure 5.

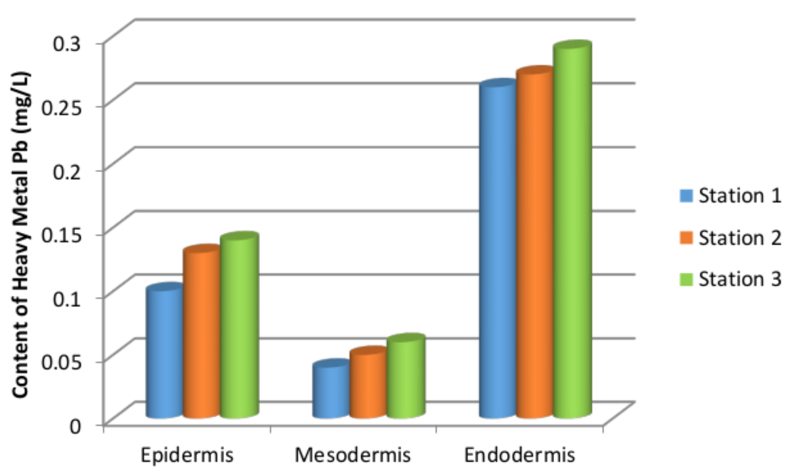

Figure 5: Heavy Metal Content of Pb on Lindur Fruit (*Bruguiera gymnorrhiza*).

The fruit is the last place of translocation and the essential part that must protect from something that can damage or inhibit its growth because new plants will produce in the fruit. The use of mangrove fruit as a food ingredient has long become a social habit. Fruit lindur (*Bruguiera gymnorrhiza*) is used as an alternative food because the mangrove fruit has a higher content of carbohydrates (Tempo.co, 2005).

Shown in figure 5 above, the average weight of Pb on lindur (*Bruguiera gymnorrhiza*) at Station I was 0.13 mg/kg, Station II was 0.15 mg/kg, and Station III was 0.16 mg/kg. The highest content of Pb heavy metal found in Station III. It is because the sediment and water at Station III also have a high content of heavy metal Pb so that Lindur (*Bruguiera gymnorrhiza*) can absorb more Pb metal. The heavy metal content of Pb most accumulated in lindur mangrove plants (*Bruguiera gymnorrhiza*) is due to the ability to transmit heavy metals higher than the fruit of other types of mangroves (Grant, *et al.*, 1998).

The level of Pb in water and soil affects the level of Pb in lindur (*Bruguiera gymnorrhiza*). Pb in the water that enters the land will be absorbed by the roots and distributed to other parts of the plant (Amelia, *et al.*, 2015). At the root, the substance enters the cell by diffusion either by active diffusion or by passive diffusion (Taiz, 2009). The binding of heavy metals to plants is due to the formation of complex compounds and, in the presence of root-eating root-crop extracts, several organic acids, such as malic acid, citric acid, fumarate, phenols, which cause a reduction in pH around rooting (Tan, 2000). As a result, many heavy metal compounds and ions are dissolved so that the plant is absorbed. Heavy metals penetrating endodermic roots cause other metals to be transported through the transpiration stream to the top of the plant via the transport network (xylem) to other parts of the plant (Amelia *et al.*, 2015). Cells and tissues of massive metal plants Pb will undergo a detoxification mechanism, e.g. by storing (hoarding) metals in specific organs, such as fruit, leaves and roots of plants (Emamverdian, *et al.*, 2015).

Mean value of heavy metal Pb in lindur (*Bruguiera gymnorrhiza*) at Station I, epidermal layer 0.13 mg/kg, mesodermal layer 0.15 mg/kg, and endodermal layer 0.16 mg/kg. The mean pb heavy metal content in the epidermal layer is 0.10 mg/kg, the mesodermal layer is 0.04 mg/kg and the endodermal layer is 0.26 mg/kg, the epidermal layer is 0.13 mg/kg at Station II, the mesodermal layer is 0.05 mg/kg and the endodermal layer is 0.27 mg/kg, the epidermal layer is 0.14 mg/kg at Station III, the mesodermal layer is 0.06 mg/kg and the endodermal layer is 0.29 mg/kg.

The three stations show that the heaviest layer of heavy metal Pb is found in the endodermic layer compared to the epidermal and mesodermal layers. It is suspected in the epidermal layer and the mesodermal layer has a thin layer and a large intercellular space so that the heavy metal content of Pb dissolved in water easily penetrates the layers. The epidermal layer on the Lindur (Bruguiera gymnohhiza) tightly arranged together to form a square without intercellular space (Utari, 2012). The epidermis layer has a thin cell wall in the absence of kutin thickening on the Lindur (Bruguiera gimnorrhiza). There is a cortex in the mesodermal layer where the lindur cortex (*Bruguiera gymnorrhiza*) is composed of thin-walled cell layers with intercellular space for gas exchange. It's a role as a food storage reserve. The vacuole is also present in lindur (*Bruguiera gymnorrhiza*), the vacuole is a space in fluid-filled cells, a membrane of membranes (tonoplasts) (Tjitrosoepomo, 1990) as a means of transportation. Lindur (*Bruguiera gymnorrhiza*) has a water content of 62.92% (Utari, 2012). It results in the accumulation or accumulation of Pb heavy metals in the endodermal layer.

The high content of Pb heavy metal also supported by the surrounding medium, such as temperature, pH and salinity. Decreased salinity and acid pH increase the solubility potential of heavy metals (Deri, 2013). The higher the water temperature, the higher the solubility of heavy metals such as Pb, and vice versa (Rosmaria, 2009).

The high content of heavy metal Pb in Lindur (*Bruguiera gymnorrhiza*) may also be due to the maturity or age of lindur (Bruguiera gymnorrhiza) itself, the higher the heavy metal content of Pb in Lindur (*Bruguiera gymnorrhiza*) and vice versa (Faisal & Setiawan, 2010).

However, Lindur (Bruguiera gymnorrhiza) has a heavy metal content of Pb that has not exceeded the threshold set by the Food and Drug Administration Directorate-General by Decree No. 03725/B/SK/VII/1989 of 2.0 mg/kg, so that lindur (*Bruguiera gymnorrhiza*) is still entirely safe for consumption (Kalifika Devi *et al.*, 2015). However, if lindur (*Bruguiera gymnorrhiza*) consumed continuously, it will have a negative health impact as it contains Pb heavy metals.

5. CONCLUSION

Based on the results and discussions, some conclusions can draw from this research that the water and sediments found in Ecotourism Mangrove Wonorejo Surabaya have contaminated by heavy metals Pb. Although Lindur (*Bruguiera gymnorrhiza*) contained in Ecotourism Mangrove Wonorejo Surabaya heavy metal content Pb does not exceed the threshold Decree number 03725/B/SK/VII/1989 on 2.0 mg/kg was established by the Directorate-General for Food and Drug Administration.

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