



Manganese (Mn) and Lead (Pb) Content in Lemna Culture Fertilized by Bioslurry

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Authors' contributions

This work was carried out in collaboration among all authors. Author Iskandar designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author YA managed the analyses of the study. Author IZ managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/APRJ/2019/v3i3-430068

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Complete Peer review History: <http://www.sdiarticle4.com/review-history/53911>

Original Research Article

Received 02 December 2019

Accepted 09 February 2020

Published 10 March 2020

ABSTRACT

Lemna minor is a small water plant that floats on water and has the potential to be fresh feed for fish. Bioslurry is a by-product of the management of biogas from livestock manure which is often used as fertilizer for plants because it contains nutrients in a readily available form. Among the contents contained in bioslurry, manganese and lead are important things related to their use for plants and fish. This study aims to determine the mineral (Mn) and lead (Pb) content in the medium of lemna cultivation which is fertilized with various doses of bioslurry. The study was conducted at the Ciparanje Experimental Pond, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran, Indonesia. This study used an experimental method with Completely Randomized Design (CRD) with four treatments with three replications. The treatment in the form of adding bioslurry to the lemna culture media was 0.00%, 0.25%, 1.00% and 2.50% of the volume of water. The minor density of Lemna used is 800 g/m². The culture was carried out in 4 cycles for 7 days. The parameters observed were Mn and Pb content in the lemna culture medium shortly after the

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addition of Bioslurry and after 7 days of lemna cultivation. Based on the results of the study, the use of 2.5% bioslurry concentration can produce the highest Mn content with a range of 2.0-4.6 ppm and 2.92 ppm Pb content after 7 days of lemna cultivation. In addition, the use of 2.5% bioslurry concentration resulted in Mn and Pb values in the culture medium shortly after stirring bioslurry in the lemna culture media. Based on the research results, the treatment of adding 2.5% bioslurry to the lemna culture media is the best dose for produced Mn for fish, as well as the safest Pb for aquaculture activities.

Keywords: Bioslurry; culture; Lemna minor; manganese; lead; fish feed; fertilizer.

1. INTRODUCTION

Fish is a source of animal protein that is increasingly favored by the consumers because it has healthier content compared to chicken and meat. The increasing consumer demand for fish places fish as a high economic value food and needs to be increased in production. One of the main obstacles faced by traditional fish farmers is expensive price of feed which causes high production costs in fish farming activities. Providing good quality feed can be a challenge for traditional fish farmers because of price of commercial feed is expensive. Thus, alternative feed ingredients must continue to be explore. One of the feed ingredients that can be explored is duckweed, which has been dominating the waters in Indonesia and has not been used optimally as an ingredient in feed (Hazrah, 2017).

Lemna (Duckweed) is a small-sized aquatic plant that floats on water and has the potential to be a fresh feed or feed ingredient because it has a high nutrient content [1]. In term of nutritional values, duckweed has the highest protein content (21.50%) and lipid (21.55%) compared to other aquatic plants, so it can be used as a source of vegetable protein [2,3]. The potential use of local raw materials that can substitute fish nutrition ingredients is a strategic step to deal with the high conditions of feed raw materials such as fish meal. Efforts to develop *L. minor* culture as a feed can be done by using organic fertilizer, one of which is bioslurry. Bioslurry is a by-product of biogas processing. Bioslurry has the potential to be used as fertilizer because it has nutrients that are needed for plant growth [4]. In the current integrated farming era, the availability of bioslurry will be continuously available because fisheries activities are integrated with agriculture and animal husbandry activities. Generally, the value of bio-slurry as fertilizer is fairly high, because it contains nutrients in a readily available form, e.g. the amount of nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients

on a fresh or dry matter basis [5]. Among the contents contained in bioslurry, manganese and lead are important things related to their use for plants and fish. Manganese is a tiny nutrient that is essential for plants and animals. This metal plays a role in growth and is one of the important components in the enzyme system, manganese deficiency can cause stunted growth and the nervous system and reproductive processes are disrupted. In plants, manganese is an essential element in the metabolic process [6].

Lead (Pb) is one of the most harmful heavy metals ions in the environment and is considered can be seriously endanger the environment. This metal is very toxic and very dangerous, according to the US Environmental Protection Agency the maximum contaminant level for Pb²⁺ in the minimum water is 0.015 mg/L. Minerals are inorganic materials needed by fish for the formation of body tissues, metabolic processes and maintaining osmotic balance and for the normal growth process of fish. The amount of minerals needed by fish is very small but has a very important function. In the preparation of artificial mineral mix feed, usually minerals are added in the range of 2-5% of the total amount of raw material and varies depending on the type of fish that will consume it [7]. This study aims to determine the mineral content (Mn) and lead (Pb) in the cultivation of lemna fertilized with various doses of bioslurry, so that it will be known bioslurry treatments that provide the highest mineral content and low Pb absorption.

2. MATERIALS AND METHODS

The research was conducted during 4 weeks at the Ciparanje Experiment Pond, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran, Indonesia. Proximate analysis of bioslurry and *Lemna minor* was conducted at the Nutrition Laboratory of the Faculty of Animal Husbandry, Universitas Padjadjaran. The instrument used during the study were 15 plastic containers (68x48x40 cm³) to be used as a container for *L. minor* culture, gauze to help the

process of water drainage from *L. minor*, and scales with an accuracy of 0.1 g to calculate the weight of *L. minor*. pH meter of brand Ultron PH-207 was used to measure the pH of water, thermometers, and beaker glass were used to place and measure the temperature of the water sample.

The materials used in this study are as follows: *L. minor* water plants used came from Ciparanje hatchery ponds, Universitas Padjadjaran. Bioslurry was used as a source of nutrition for *L. minor* growth. The used bioslurry came from the Batu Lonceng Village, Lembang, West Java. The water media used comes from the Manglayang mountain spring.

This study used an experimental method with a Completely Randomized Design (CRD) model consisting of 4 treatments and 3 replications. The treatment used was bioslurry added to culture media with a percentage of A=0.00% (control), B=0.25%, C=1.00%, D=2.50%. The parameters observed in this study were testing the content of Mn and Pb in lemna culture media shortly after the addition of Bioslurry and after 7 days of lemna cultivation. Measurement of Pb and Mn content were carried out using AAS (Atomic Absorption Spectrophotometry) method. The results of observations of the proximate test regarding the Pb and Mn content were analyzed descriptively.

3. RESULTS AND DISCUSSION

3.1 Mn and Pb Content in Bioslurry in Lemna Cultivation Media

The content of Mn and Pb in the lemna culture media on a weekly basis was shown in Figs. 1 and 2. Based on the results of the research, the

content of Mn and Pb in lemna cultivation media fluctuates on a weekly basis. The Mn content in the lemna culture media ranged between 18.6-55 ppm while the Pb content in the lemna culture media ranged from 0.1-4.29 ppm. Based on observations it can be seen that the Mn content in lemna culture media has decreased from the first week to the fourth week. The same thing happened in the observation of Pb content during the study with an increase in Pb value in the beginning of the research and then decreased until the last week. This shows that there is absorption of Pb and Mn carried out by lemna. Aquatic plants can absorb heavy metals, concentrate them and play an important role in storing and recycling heavy metals [8-11].

The mineral element is one of the most indispensable components for fish besides carbohydrates, fats, proteins and vitamins. Various mineral elements found in biological material, but not all minerals are proven essential, so there are essential and nonessential minerals. Essential minerals are minerals that are needed in the physiological processes of living things to help the work of enzymes or organ formation. Other mineral elements such as iron, iodine, copper and zinc are present in small amounts in the body, because it is called trace element or micro minerals [12].

The benefits or functions of minerals for fish are as main constituents of skeletal structures such as bones, heads, teeth and scales, for electron and cofactor (activating) transfers in metabolism, catalysts and activator enzymes, as regulation of acid-base balance and osmoregulation systems of blood or body fluids others, as well as important components of vitamins, hormones, enzymes and respiratory pigments [13].

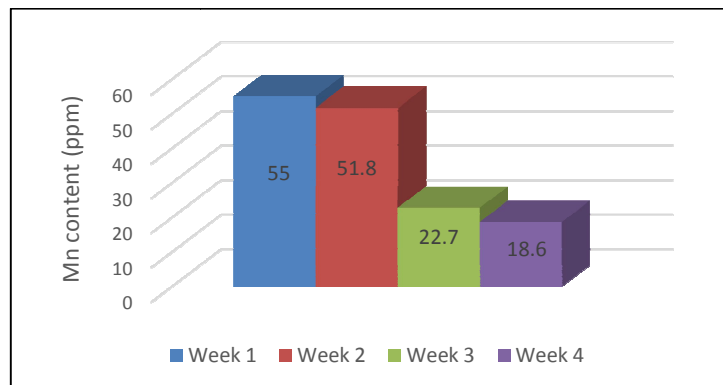


Fig. 1. The content of Mn in lemna cultivation media on every week

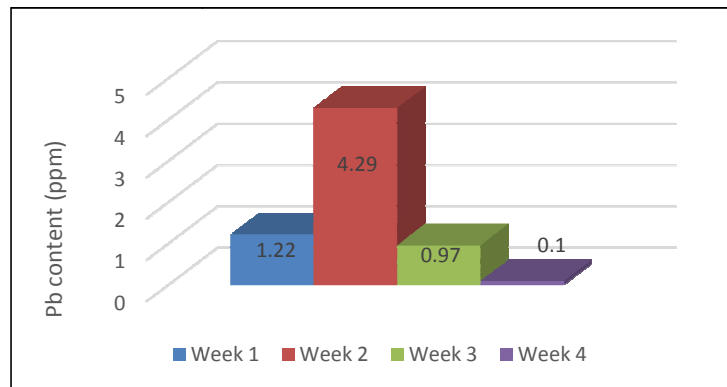


Fig. 2. Pb content in lemna cultivation media every week

Pb is categorized as heavy metals that are not essential or toxic to the body of living things. Heavy metal pollution can cause changes in the structure of aquatic ecosystems, food webs, behavior, physiological, genetic and resistance effects. In contrast to ordinary metals, heavy metals usually have dangerous effects on living things. Heavy metals can be toxic substances that will poison the bodies of living things [14]. Heavy metals in water are easily absorbed and buried in phytoplankton which is the starting point of the food chain, then through the food chain to other organisms [15].

The decrease in the Mn and Pb content in water is related to the availability of these metals in water. Metal concentrations in water will decrease along with the growth of Lemna. Organic matter contained in water will be remediated by Lemna and accumulated in Lemna. Lemna's ability to remediate heavy metals has been tested by Baruna [16] who cultivates Lemna in chromium-containing cultivation media.

3.2 Mn and Pb Content Shortly After Addition of Bioslurry in Cultivation Media

The Mn and Pb content shortly after the addition of bioslurry is shown in Figs. 3 and 4. Adding bioslurry in lemna cultivation media functions as organic fertilizer which can provide an increase in the productivity of lemna growth [17]. In addition, the provision of bioslurry can have a good effect on increasing the content of lemna one of which is on mineral content. The amount of minerals needed by fish is very small but has a very important function. Micro minerals are minerals whose concentrations in the body of each organism in small amounts (less than 100 mg/kg

of dry feed). Based on the results of research the highest mineral content during the study contained in the treatment with the addition of 2.5% bioslurry / volume from the first week to the fourth week. While the lowest mineral content is at 0% treatment. This provides an opportunity for lemna to absorb mineral content in maintenance media, so that when applied to fish, lemna can already meet the mineral needs of fish. The characteristics of Lemna as a phytoremediator are able to absorb organic matter from the water. Provision of organic chromium through the addition of chromium in *L. minor* culture media can increase the growth of carp due to more optimum glucose intake [18]. The need for fish in minerals is influenced by size, age, growth rate, environmental stress, and the relationship between nutrients. Mineral demand for fish is very dependent on water concentration [19].

The content of heavy metals during the study fluctuated based on treatment. The highest Pb content was in the 1% bioslurry treatment which occurred in the second week at 2.85 ppm and the lowest in the bioslurry treatment was 0.25% and 2.5%. However, in the third to fourth week, the Pb value decreased in all treatments. When viewed from the graph the results of the study show that the administration of 0.25 and 2.5% gives the Pb value to the lemna cultivation media. Heavy metal pollution can damage the aquatic environment in terms of stability, flora and fauna diversity. Heavy metal pollution can cause changes in the structure of aquatic ecosystem, foodweb, behavior, physiological, genetic, and resistance effects. If the culture media of lemna contains high Pb, it is feared that it can accumulate with lemna and eaten by the fish. This will cause damage, if it is ingested by the fish and enter into the body tissue of the fish.

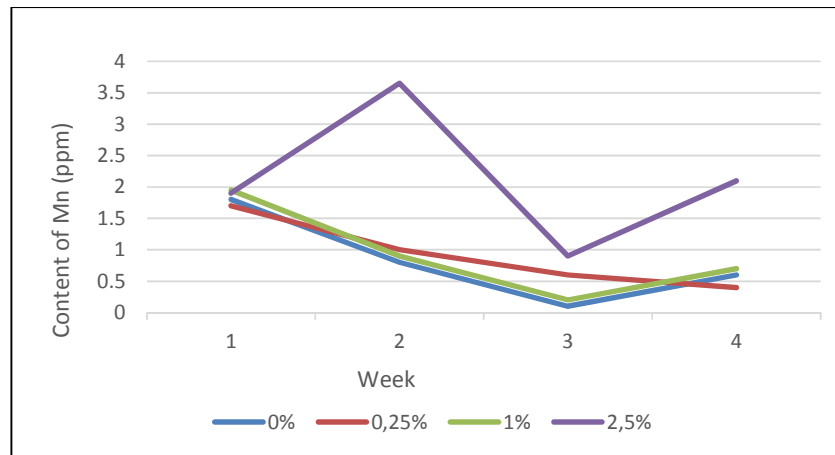


Fig. 3. Mn content in lemna cultivation media shortly after addition of bioslurry

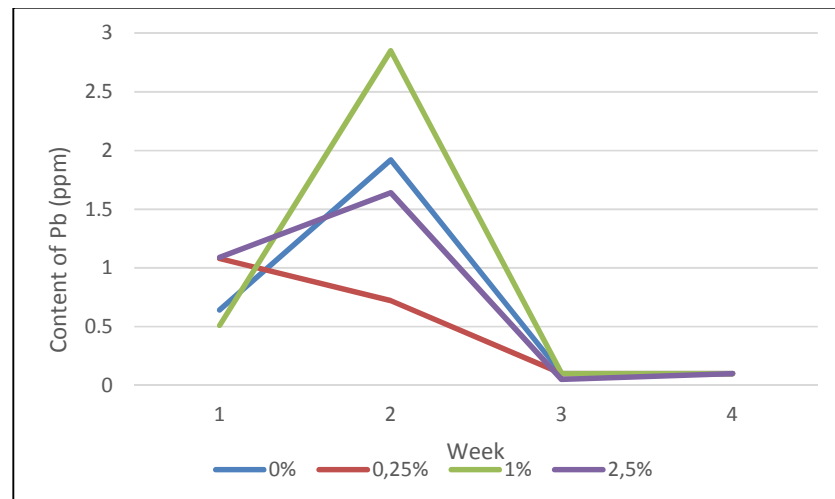


Fig. 4. Pb content in lemna cultivation media shortly after addition of bioslurry

The evaluation of the use of Lemna as a chromium heavy metal binder in safe doses for gourami feed was carried out. The provision of 4.95% chromium-loaded Lemna sp. + 15.05% Lemna sp. produces the best feed conversion ratio of 2.63 with chromium content in gourami fish flesh increasing simultaneously with the percentage of chromium-loaded Lemna sp. provision to the gourami fish [2,3].

4. CONCLUSION

Based on the research results, the treatment of adding 2.5% bioslurry to the Lemna culture media is the best dose for produced Mn for fish, as well as the safest Pb for aquaculture activities. The highest Mn value of 4.6 ppm and a Pb content of 2.92 ppm to the Lemna culture media.

ACKNOWLEDGEMENT

The authors are grateful to involve in this research through Gading/Profarm Project. The reported research was funded by Hivos Grant No. 1012621/2016.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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