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Research Article

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Utilization of Planting Media of Coconut Fiber and Charcoal Rice Husk in Lettuce (*Lactuca sativa* L.) to Reduce Ammonia, Sulfides, Phosphate, Zinc and Iron in Hydroponics Systems

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ABSTRACT

Research on the hydroponics system with axis has been done. Data was analyzed using completely randomized design, with 5 treatments and 3 replicates. For testing the concentration of ammonia and phosphate dilution of the sample solution by using double distilled water, while to test the concentration of sulfide, zinc and iron samples treated early with wet destruction process using HNO_3 65%. For ammonia and phosphate levels in the analysis using UV/Vis whereas content analysis sulfide, zinc and ferrous metals using atomic absorption spectrophotometry (AAS). It was obtained optimum time for the absorption of planting media at 30 days with the hydroponics system. At this optimum time to do the hydroponics system with a variety of media using lettuce plants (Lactuca sativa L.), as a plant that will help reduce the levels of ammonia, phosphate, sulfide, zinc, and iron. Ammonia analysis showed a good combination of planting medium on charchoal rice husk (CRH): coconut fiber (CF) (50:50) with 79.14 mg/L concentration. While the analysis of phosphate and sulfide good planting medium CRH at 100% with a concentration of 74.05 mg/L and 0.86 mg/L. Analysis of Zn at 100% CF media with concentration 0.04 mg/L and Fe on a combination of CRH : CF = 1: 4 mg/L. From these data indicate that with the hydroponics system can reduce the concentration of ammonia, phosphate, sulfide, Zn, and Fe.

Keywords: Hydroponics; Ammonia; Sulfides; Phosphates; Charchoal rice husk; Coconut fiber

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INTRODUCTION

As the population grows, there will be new problems for agricultural land, in the form of limited land for the production process. Cultivation system without water change is widely applied by the community because it is able to increase fish production on limited land and water. One of the problems in aquaculture system without water change is a decrease in water quality. Water quality degradation can be caused by aquaculture waste such as faces, inedible feed residues that will produce ammonia (NH_3), nitrite (NO_2-), and CO_2 that can increase very quickly and are toxic to aquaculture [1]. To overcome this problem one of the technological innovations that can be applied is the cultivation of fish that is integrated with the plant through the hydroponics system. Hydroponics is an agricultural cultivation system without the use of soil but uses water containing the nutrient solution or cultivated without using soil as a growing medium [2]. Utilization of planting media in the hydroponic system on the absorption of ammonia, phosphate, sulfide, Zn, and Fe metals in pellet water has not been done.

In this study, developed the hydroponic model by utilizing planting media that is coconut fiber (CF) and charchoal rice husk (CRH) for a cultivation of lettuce. In this hydroponic system does not use fish, but only use fish feed as a source of hydroponic plant nutrients. Hydroponics is chosen as the object of research because the hydroponics system can recycle the waste of feed in the waters into nutrients for plants. Likewise, the waste from the remaining fish feed that dissolves in the waters can be used as natural fertilizer for hydroponics plants. Basically, fish waste in the waters still contains macro and micro nutrients that can be used as nutrients for plants. Indirectly, waste

generated from a biological system can be utilized as a nutrient for subsequent biological systems through direct filtration and biological filtration. This metabolic result is beneficial because it still has economic value. In addition, environmental improvements can be solved by mutualism by utilizing biofilter plants that require such waste as a nutritional growth [3-5]. The aims of this research are:

(1) Studying coconut fiber and rice husk planting ability to reduce ammonia, phosphate, sulfide, metals Zn and Fe in hydroponics system.

(2) To know the ratio of good planting composition to reduce ammonia, phosphate, sulfide, Zn and Fe metals.

(3) Obtain water quality data before and after the application of the hydroponics system.

This research is expected to give information about good planting medium for cultivation of lettuce crop, so that the result of faster harvest and yield of plant get more, and also give information about the variation of good planting composition in reducing the concentration of toxic chemical compound, used as the basis for the research of the aquaponic system.

EXPERIMENTAL SECTION

Tools and Materials

The equipment used in this study is the Atomic Absorption Spectrophotometer (AAS) (spectra AA-240 Variants), Spectrophotometer UV-Vis (PDA-303S), Balance analytical, jars, flower pots, plastic bottles, wicks stove, scissors, filters and glassware Commonly used in laboratories.

Materials used in this study are forage fish, the planting medium coconut husk and rice husk, plant seeds of lettuce, potassium hydrogen phosphate (KH_2PO_4) (Merck), sulfuric acid (H_2SO_4) (Merck), ammonium molybdate (Merck), potassium antimony tartarat (K_2Sb_2 ($4H_2O$) (Merck), acid ascorbate ($C_6H_8O_6$) (Merck), ammonium chloride (NH_4Cl) (Merck), reagent Nessler, sodium hydroxide (NaOH) (Merck), ferric chloride ($FeCl_3$) (Merck), Zn $(NO_3)_2$ 1000 mg/L (Merck) parent solution, Fe $(NO_3)_2$ 1000 mg/L (Merck) main solution, and doubly distilled water.

Research Stages

The research was conducted using completely randomized design with 5 treatments planting medium 3 repetitions, with P_0 as a control without using a planting medium CRH or CF, P_1 as a growing medium CF, P_2 as a growing medium CRH, P_3 comparison planting medium CF: CRH = 75 : 25, P4 as CF : CRH = 50:50, and P_5 as CF : CRH = 25:75.

Preparation of 5% Pellet Solution

A total of 900 g of pellets were weighed, smoothed and dissolved in 18 L of water for experiments with variations of time. For media variations, 750 g of pellets were weighed, drenched and dissolved in 15 L water. For each jar filled with 1 L of soluble pelleted water. The pellets used here are fish pellets containing protein, fat, carbohydrates, vitamins and minerals.

Making of Planting Media

Flower pots that have been installed axis, filled with planting medium in the form of CRH 100% and CF 100% made 3 times repetition, installed in accordance with the series of tools for the variation of time. For media variations, potted axes have been filled with CRH: CF 50%: 50%; 25%: 75%; 75%: 25%; CRH 100%, and CF 100%, as much as 3 replicates.

Hydroponic Modeling

The jar filled with a solution of 5% pellets, then a flower pot fitted with a long axis of 60 cm, filled with planting medium comparisons of CRH and CF in accordance with predetermined, mounted flower pot with axes touching the pellet solution.

Sample Preparation For Analysis

A sampling of each treatment was done (0; 15; 30, and 45 days), by separating the jars containing fish feed solutions with pots containing the plant medium and hydroponic axis. The solution of fish pellet contained inside the jar is stirred until homogeneous, then let stand for ± 10 minutes and then separated the solution with the sediment. The stored deposit is discarded. The results of filtration are inserted into bottles that have been cleaned and then closed. The sample is ready to be analyzed ammonia, phosphate. As for the analysis of sulfide, Cu metal, and Zn samples were done by continued preparation by wet destruction using HNO_3 65% (Figure 1).

Figure 1: (a) Hydroponic model for time variation; (b) the hydroponic model of the variation in the composition of the media

Hydroponics System Analysis

Water quality analysis was first conducted on water pellet without plant media treatment (control) was analyzed phosphate, ammonia, sulfide, Cu and Zn metals were carried out at 0; 15; 30, and 45 days. After the analysis of the solution using a fish pellets planting media were analyzed at the same time and system analysis hydroponic with using spinach crops on day 30. The analysis process performed on feed water fish that have previously been separated from the sediment.

RESULTS AND DISCUSSION

Water quality analysis was carried out on pellet water without planting medium (control) where the pellet water which was kept for 0, 15, 30, and 45 days analyzed the content of ammonia, sulfide, phosphate, zinc, and iron to know percent absorption, the chemical compound was analyzed Because the compound is present in the water environment of the water pellet fish composition, then analyzed by using hydroponic system in the absence of lettuce plant, aims to determine the maximum absorption time of planting medium to reduce the ammonia, sulfide, phosphate, zinc and iron compounds carried out at a time variation of 0 , 15, 30, and 45 days. Hydroponic analysis using the lettuce plant was analyzed on the 30^{th} day.

Analysis of Ammonia Content

Ammonia is a major contamination of fish culture waste, and fish feed is a major source of cultivation system contamination. Analysis of ammonia is divided into two: ie with time variation, but without the use of plants, that is at 0, 15, 30, 45 days, and with the variation of planting media plus plant.

The hydroponic system is capable of reducing the concentration of ammonia by absorbing cultivated wastewater or waste by using plant roots so that the ammonia absorbed through the oxidation process with the aid of oxygen and bacteria is converted to nitrate. In aquaculture without cultivation, bacteria have an important role in removing ammonia through the nitrification process [6].

Analysis of variations of time 0, 15, 30, 45 days:

Based on Figure 2 obtained ammonia concentration at 0 days ie 66.99 mg/L. In the 15 day time variation, the average concentration of ammonia from planting medium CF 100% is 68.39 mg/L, whereas with planting medium CRH 100% is 69.94 mg/L. In the 30 day time variation, the average concentration of ammonia with CF 100% plant medium was 119.94 mg/L, while with CRH planting medium was 115.14 mg/L. In the 45 day time variation, the average concentration of ammonia from CF plant media was 126.09 mg/L, whereas with CRH planting media was 112.11 mg/L. The results of the analysis show that the ammonia concentration has exceeded the allowed upper threshold in the fishery, 0.05 mg/L [7].

Analysis on variations of media composition by using plants:

Based on Figure 3, the lowest average ammonia concentration was obtained on the variation of CRH : CF=50% : 50% and the highest mean concentration was on media variation with CRH : CF=0% : 100%. Media variations in the ratio of CRH : CF=50% : 50% both in absorbing ammonia and media variation with CRH : CF=0% : 100% were the opposite. Because the ammonia concentrations contained in the sample are getting smaller then the concentration is absorbed more.

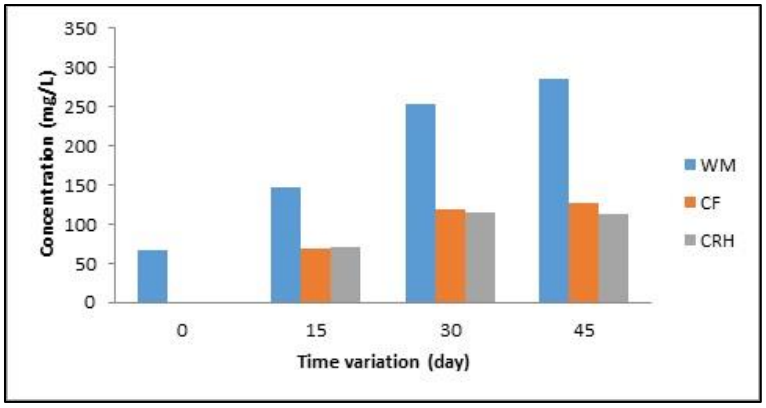

Figure 2: The relationship between ammonia concentration with time variation

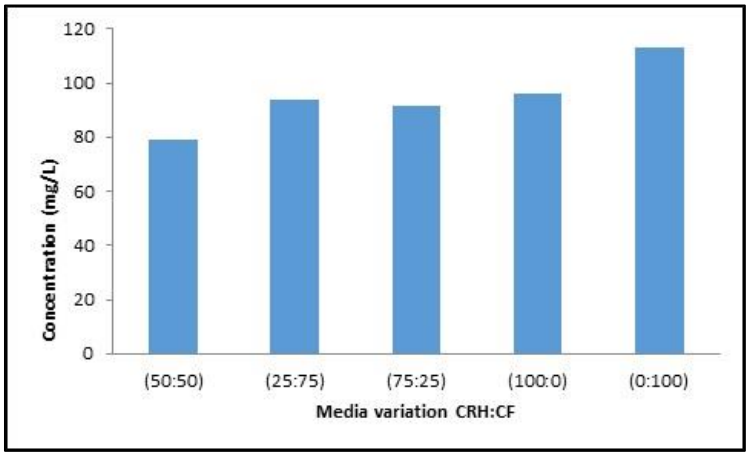

Figure 3: Ammonia concentration relationship with media variation (CRH: CF) within 30 days

The hydroponic system is capable of reducing the concentration of ammonia by absorbing cultivated wastewater or waste by using plant roots so that the ammonia that is absorbed through the oxidation process with the aid of oxygen and bacteria is converted to nitrate through nitrification process. From that process can produce the necessary nitrates of lettuce plants to increase plant growth and increase the production of foliage.

Analysis of Phosphate Content

Analysis on variations of time 0; 15; 30; 45 days without the use of plants:

Analysis of phosphate content in fish feed water samples was done to determine the ability to plant media in reducing phosphate in the fish feed water. Phosphate analysis was performed using a spectrophotometer and measured at a wavelength of 720 nm as the maximum wavelength of phosphate. Determination of phosphate concentration in the sample by planting medium was done for every time 0; 15; 30, and 45 days.

Phosphates present in the water or wastewater environment can be as orthophosphate, polyphosphate, and organic phosphate. In the organic water, phosphate environment is present in the water sourced from the waste water of the population (feces) and food waste, but also in orthophosphates dissolved through biological processes because both plants and bacteria absorb phosphates for their growth [8]. Based on Figure 4, the phosphate content of 0 days is very high at 95.33 mg/L.

The 0 day time was the control of this study, which in 0 days did not use planting media as reducing of phosphate. At 15 day and 30-day variations of phosphate concentration increased on CF and CRH plant medium, but at 45 day time variation decreased. Compared with the controls used, there was a reduction of phosphate levels at 30 and 45 days. However, at 45 days still experience increased levels of phosphate, while the reduction of phosphate content using the planting medium is not too reduced. Therefore, 30 days is the optimum time of the medium used to absorb the phosphate contained in the pellet solution.

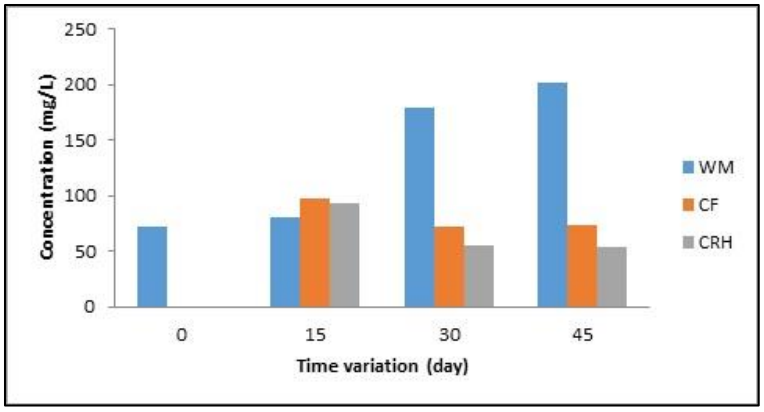

Figure 4: Phosphate concentration relationship with time variation

Phosphate Analysis on Media Variations Using Lettuce Plants

Phosphate content analysis was also done on hydroponics by using lettuce plants. According to Figure 5, lettuce can reduce the concentration of phosphate content in fish feed water, characterized by reduced concentration of phosphate in the presence of plants. The lowest phosphate concentration on day 30 was 74.05 mg/L contained in 100% CRH planting medium. This fact shows that CRH planting medium is able to reduce the phosphate content in pellet water well.

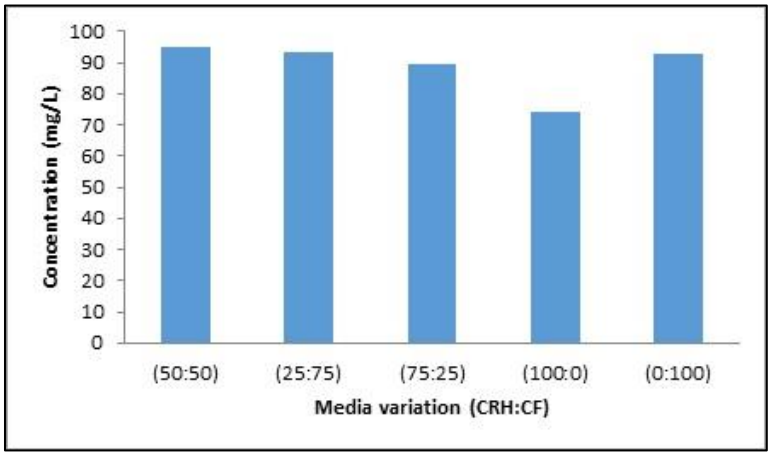

Figure 5: Phosphate concentration relationship with media variation (CRH: CF) within 30 days

Physical observation is also done on plants growing on planting medium. The growth of lettuce on CRH media grows more fertile than CF planting media because media and nutrients are factors that can affect growth and yield of plants hydroponically [9]. Phosphate containing phosphorus nutrients this serves to help lettuce plants develop in early growth in the formation of roots and young leaves.

Sulfide Content Analysis

Sulfide content analysis was done only on samples with planting medium, whereas in the determination of the maximum day was not done analysis because the distance of filtration time with the measurement is too long so that the effect on the sulfide concentration in the water pellet. The result of research showed that the highest sulfide concentration on variation of CRH: CF medium with ratio 50%: 50% with concentration 1.21mg/L while for the lowest sulfide concentration was on variation of planting medium with 100% CRH composition with concentration 0.86 mg/L. The condition shows that CRH planting media is a good medium to reduce the sulfide content in the pellet solution used.

Figure 6 shows the smallest concentration of CRH media 100% which means that the sulfide content is absorbed more in comparison with other variations of the media because CRH contains a lot of silica and has larger pores so that its absorption is better. In the growth of lettuce, sulfide absorption helps the formation of green leaves of leaves so that the leaves become greener. Another function for lettuce is to increase protein and vitamin content in lettuce plants, so sulfide is needed in the cultivation of lettuce plants [10].

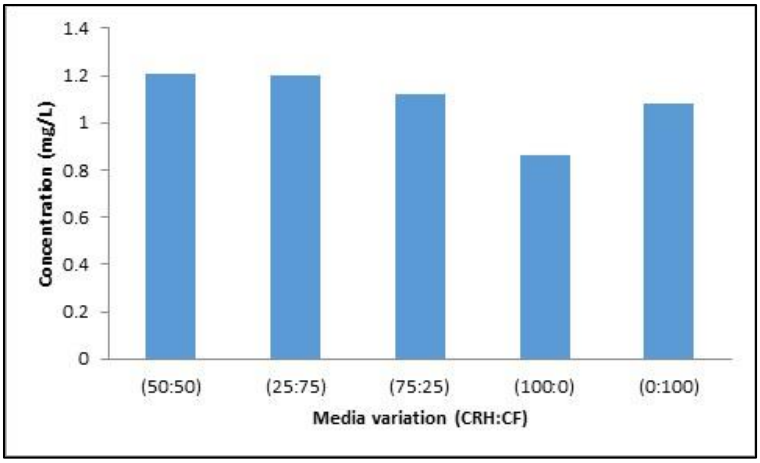

Figure 6: Sulfide concentration relationship with media variation (CRH: CF) within 30 days

Zn Content Analysis

Analysis on variations of time 0, 15, 30, 45 days without the use of plants:

The Zn content was analyzed using AAS, the analyzed sample had to be destructed by adding 5 mL concentrated nitric acid. The most frequent and effective acid solution is used because it can break down the sample into a biodegradable compound and the solvent nitric acid itself is volatile, the samples are destructed and heated at (200-300)^{o}C for 3-4 hours.

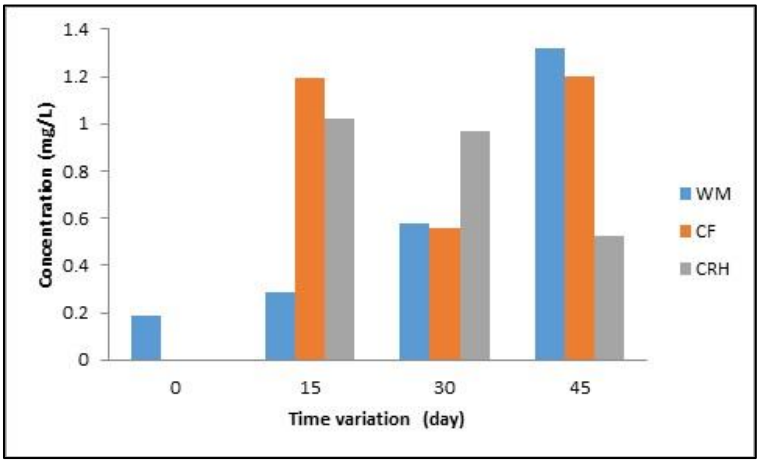

Figure 7: Zn metal concentration relationship with time variation

From Figure 7 shows that at 30 days the CF media has decreased indicating that the medium is able to reduce the concentration of metal Zn well. However, CRH media only experienced a slight reduction in concentration, different from 45 days with a drastic decrease in concentration.

Based on Figure 8, a good medium in the absorption of Zn metal is a 100% CF medium. With remaining concentrations lower than in comparison with other media comparisons, which means that higher absorbed concentrations in CF medium. But on the growth of lettuce plants do not grow well, from the function of micro nutrients that should help the metabolism and growth and production of lettuce plants well.

Analysis of Fe Metal Content

Analysis on variations of time 0, 15, 30, 45 Days without the use of plants:

Iron (Fe) is a heavy metal commonly found in natural waters and is an essential mineral for plants and animals. Fe metals can be sourced from household waste, pesticides, fertilizers, and dust particles from surrounding activities. If the accumulation of Fe is above the permissible limit will cause pollution and problems for the surrounding environment, so that will also affect the surrounding creatures.

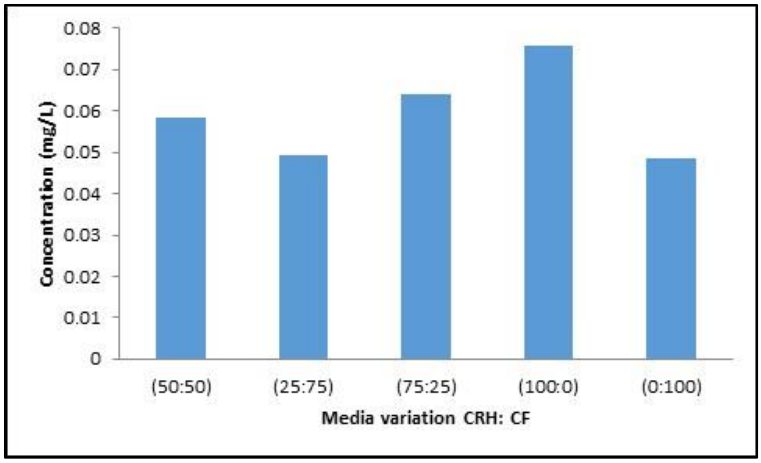

Figure 8: Relation of zinc metal concentration to media variation (CRH: CF) within 30 days

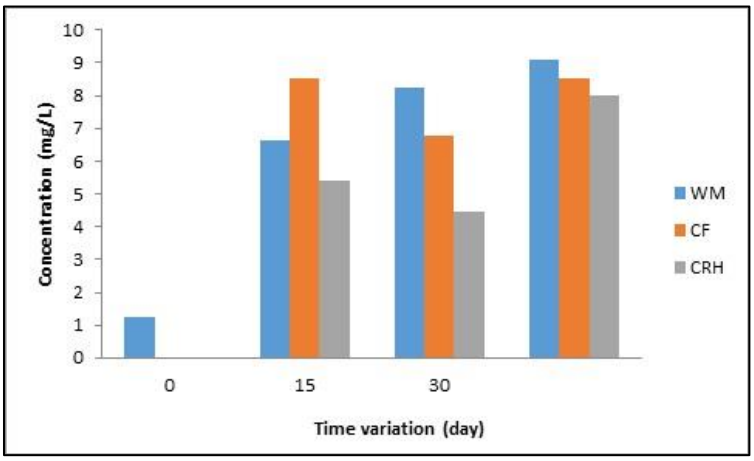

Figure 9: Fe metal concentration relationship with time variation

Based on Figure 9, the optimum absorption time of the media used is at 30 days. Because of both media at 30 days decreased from 15 days and increased during 45 days. This happens because of the optimum absorption of the media at 30 days. Therefore the concentration of Fe metals in 45 days increased due to the reduced absorption of the media used.

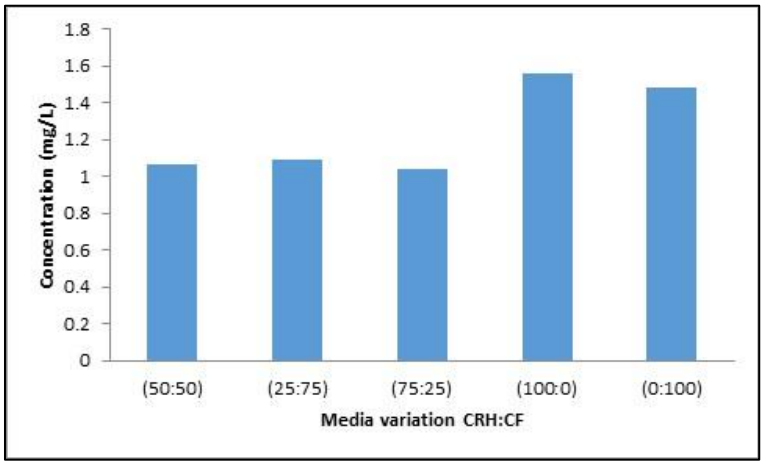

Figure 10: Relation of Fe metal concentration with media variation (CRH: CF) within 30 days

For concentrations of Fe metals with variations of media using lettuce plants, the lowest average concentration values of CRH : CF=75% : 25% variation with 1.04 mg/L concentration indicated that the medium was good enough to reduce Fe metal in pellet solution. On the growth of lettuce plants micro nutrients (Fe) function in the metabolism of lettuce, growth, and production of lettuce (Figure 10).
From the data obtained it is known that better absorption by using more CRH planting media to reduce levels of ammonia, phosphate, sulfide, and Fe metals. Except for the Zn metal which is better absorbed by CF planting medium.

CONCLUSION

It can be concluded that the composition of CF and CRH is able to reduce the concentration of phosphate, ammonia, sulfide, Zn and Fe metal in the hydroponics system. The maximum absorption composition for each analysis is different. The ammonia analysis showed a good combination of plant medium on a CRH : CF=50 : 50 ratio with 79.14 mg/L concentration and optimum absorption at 30 days. While the analysis of phosphate and sulfide planting media is good at 100% CRH with a concentration of 74.05 mg/L and 0.86 mg/L. Zn analysis on 100% CRH planting medium with the concentration of 0.04 mg/L and Fe in the combination of CRH: CF with 1.04 mg/L concentration. From the absorption can improve water quality and help the growth of lettuce plants.

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