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by Refilda Refilda

Asian Jr. of Microbiol. Biotech. Env. Sc. Vol. 20 (Feb. Suppl.) : 2018 : S9-S16
ISSN-0972-3005

THE EFFECTS OF PLANTING MEDIA OF COCONUT FIBRE AND CHARCOAL RICE HUSK ON AMMONIA, PHOSPHATE, SULFIDE, COPPER AND ZINC IN HYDROPONIC SYSTEM OF SPINACH (*AMARANTHUS TRICOLOR* L.)

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(Received 30 September, 2017; accepted 17 November, 2017)

Key words : *Hydrophonics, (Phosphate, Ammonia, Sulfide, Copper, Zinc), Spinach, Charcoal rice husk, Coconut fibre*

Abstract–Hydroponics research with the axis of the system is expected to reduce ammonia, phosphate, sulfide, copper and zinc contained in the solution of fish pellets. For testing the concentration of ammonia and phosphate dilution of the sample solution by using doubly distilled water, while to test the concentration of sulfides, copper and zinc sample by pretreatment with wet digestion process using HNO_3 65% and then heated until a solution are colorless (clear). The content of ammonia and phosphate in the analysis using UV/Vis, while the content of sulfide, copper and zinc were analyzed using flame atomic absorption spectrophotometry (AAS). It has been made known that the samples of fish pellets undergo a process of reduction of the maximum on the 30th day of hydroponic systems. On the 30th day, hydroponics were made using a variety of medium using spinach (*Amaranthus tricolor* L.) as a plant that will assist the process of reducing toxic substances. For the ammonia reduction process, copper and zinc metals obtained data that the best medium variation for the reduction process is a medium with composition CRH (charcoal rice husk) 100% and CCF (coconut fibre) 100%, whereas for phosphate reduction in medium with composition CCF: CRH = 75%:25% and composition CCF: CRH = 50% : 50%

INTRODUCTION

The condition of agriculture in Indonesia is currently undergoing a change, namely the narrowing of agricultural land due to the conversion of land into residential areas, thus affecting several factors such as reduced production of crops. However, with the technological advances in agriculture already developed, the application of technological advances is done to overcome problems such as the willingness of fertilizer, water, and fertilizer, dependence on pesticides that affect the yield of vegetables obtained, soil processing, planting, maintenance and availability of land for the area Urban areas. Application of technology makes cultivating activities can still be done in a way that is easier and has a greater advantage. Even narrow land with limited water sources such as yard can be managed for cultivation activities (Rochintaniawati, 2013).

Hydroponics is the fastest growing sector of agriculture, and it can very well dominate food production in the future. As population increases and arable land declines due to poor land management, people will turn to new technologies like hydroponics and vertical farming to create additional channels of crop production. Currently, arable land comprises only about 3 percent of Earth's surface, and the world population is around 6 billion people. By 2050, scientists estimate that the Earth's population will increase to 9.2 billion, while land available for crop and food production will decline. To feed the population, hydroponics will begin replacing traditional agriculture

Hydroponics is one of the today's agricultural technologies that grow crops by utilizing water-filled sites or growing methods with growing medium (internediaries) instead of soil, such as gravel, tile fractions, foam, and sand. Where the state of planting Medium should be sterile, so pests and diseases of plants coming from the ground will die. This hydroponic specialty, in addition to

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containing all the nutrients needed by plants, also uses materials that are 100% water soluble, by means of its use is very practical and can be stored for a long time.

There are many advantages and disadvantages of hydroponics. Advantages of Hydroponics: Absence of soil-borne diseases, weeding is not necessary, off-season production is possible, minimum water wastage, less labor, and high yield. Limitations of hydroponics: Higher initial capital expenditure, need the high degree of management spills, and disease can spread easy (Jones, 2005).

Although initial capital investment is high, hydroponics systems have several advantages over conventional cultivation in a soil. Firstly, inert Medium, mechanically supporting the plants, provide more consistent rooting conditions for the crop (Zinnen, 1988). Secondly, nutrient regimes and watering are tailored to fit the physiological agents of the crop and prevailing environmental conditions. Plant nutrition and the physical environment can be tightly controlled by the grower, resulting in higher yields, better quality, and control of crop scheduling. All the elements in plant nutrients can be reduced and plant densities can be used (Paulitz, 1997). The third advantage is the avoidance, theoretically at least, of certain root diseases (Zinnen, 1988), Bates and Stanghellini, 1984; Golberg and Stanghelini, 1990).

Based on several hydroponic studies that have been done, the result shows that solid Medium type has an effect on growth and crop yield. Furthermore, the utilization of different nutrients and planting Medium gave different results to the growth of lettuce plants. Nutrition needed by plants include macro and micro nutrients. Each type of hydroponic nutrition has a different composition.

The results of this study are expected to complement the information in the application and contribution of CCS and CRH on spinach cultivation to reduce phosphate, nitrite, sulfide, copper, and zinc in the hydroponic system so that later can be the basis for the system of aquaponic in Maninjau Lake.

MATERIALS AND METHODS

Equipments and materials

The equipment used in this study is the Atomic Absorption spectrophotometer (AAS) (spectraAA-240 Variants), UV-Vis spectrophotometer (PDA-303S), analytical balance, jars, flower pots, and glassware are commonly used in laboratories.

Materials used in this study are forage fish, the planting medium coconut fibre (CCF) and charcoal rice husk (CRH), plant seeds of spinach, potassium hydrogen phosphate (KH_2PO_4) (Merck), sulfuric acid concentrated (H_2SO_4) (Merck), ammonium molybdate (Merck), potassium antimonitartarat ($K_2Sb_2 . 4H_2O$) (Merck), ascorbic acid ($C_6H_8O_6$) (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, Cu$(NO_3)_2$ 1000 mg/L (Merck) parent solution, doubly distilled water.

Research procedure

The study was conducted using a completely randomized design with 5 treatments (planting medium) 3 replications, where P_0 as Control, P_1 as coconut fibre (CCF), P_2 as charcoal rice husk (CRH), P_3 as CCF : CRH = 75% : 25%, P_4 as CCF: CRH = 50% : 50%, and P5 as CCF: CRH= 25% : 75%.

Preparation of 5% fish feed solution is done by dissolving fish feed as much as 50 gram in 1 L of water, fish feed used is dried fish feed containing protein, and fat The fish feed used is smoothed so that all compositions in the fish feed are soluble in water.

A jar with a height of 50 cm, a width of 20 cm with a volume of 1.5 L filled with 5% pellet solution. Flower pots mounted axis with a length of 60 cm, filled with Medium crops such as CRH 100% and CCF 100% made as many as three replications, mounted flower pot with the axis touches the solution of the pellet, an analysis of the water content of the pellets for 0; 15; 30 and 45 days ago is determined the maximum day of absorption.

Jar filled with a solution of pellets 5%, then a flower pot mounted axis with shelf 60 cm, filled with comparisons Medium crops such as CRH and CCF made as many as three replications, mounted flower pot with axis touch solution pellet, plant

Gambar 1. Design of hydroponics

seeds spinach sown on Medium Planting done analysis for 30 days with the variation of planting Medium can be seen at Table 1.

Water quality analysis performed was analysis of phosphate, ammonia, sulphide, copper and zinc content at 0; 15; 30, and 45 days. The process of analysis is carried out on the fish feed water that was previously separated from the sediment.

RESULTS AND DISCUSSION

Planting Medium

Planting medium used in this research is charcoal husk rice (CHR) and coconut fibre (CCH). Both of these planting Medium are used becausemedium is always wet (Amriani, 2011). Selection of planting Medium need to pay attention reported that CHR has a high ability to absorb water, so that the planting phase, the selection of planting medium needs to consider the types of plants to be planted.

The planting medium used in the hydroponics system must have pores or pivot so as to simplify the absorption process, have a good structure for the storage of water absorption so that it can be used for planting growth, containing mineral materials that can be utilized for plant growth nutrition and can support plant roots. Type of planting Medium used in this study is organic Medium because the organic Medium has been able to provide nutrients needed by planting Medium, in addition to organic Medium also has a good pore for air recirculation (Rambitan, 2014).

This study uses planting Medium placed in potted plants, which have been connected with the axis that touches the fish feed solution. The use of axes is carried out by utilizing the principle of capillarity, in which a solution containing nutrients is absorbed by the plant through the axis. In this system, there is no recirculation of the solution due to the capillarization process occurs from the solution to the planting medium alone (Amriani, 2011). Fish feed water associated with planting medium is analyzed on days 0; 15; 30; and 45 days in order to know maximum absorption of planting medium.

Hydroponics Model

Hydroponic modeling is done by spreading the seeds of spinach plants on planting medium. The number of seeds in the spread on the planting medium amounted to 10-15 seeds (Gardner, 1991), the distribution is done with the number of seeds that are not too much because the number of seeds that many will lead to slow growth and even cause the seed does not grow into plants. The seed planting technique is carried out by direct propagation without removal. Types of plants used in the hydroponics system is a group of vegetables and fruits that have a short harvest age, in this study used spinach plants whose harvest age is 20-30 days.

Hydroponics system analysis

Water quality analysis performed on this hydroponics system is phosphate, ammonia, sulfide, copper and zinc analysis conducted at 0; 15; 30; and 45 days. The time of analysis of 0 days was the control of this study, which in 0 days analyzed was water pellet without plant Medium. The analytical process was carried out on fish feed water that had previously been separated from the sediment. The color difference is obtained from the feed water of the fish, whereas the longer the hydroponic plant day, the denser the color of the water of the pellet, indicating that more and more chemical compounds dissolved in the water pellets.

Analysis of phosphate

Analysis of phosphate content in fish feed water

Table 1. Design experiment of hydroponics system

Replicates	CCF : CRH			CCF 100%	CRH 100%
	75%:25%	50%:50%	25%:75%		
1	▬	▲	◆	●	◣
2	▬	▲	◆	●	◣
3	▬	▲	◆	●	◣

Note :
CCF : coconut fibre
CRH : charcoal rice husk
The water pellet analysis is conducted for 30 days

samples was done to determine the ability to plant Medium in reducing phosphate in the fish feed water. In this study, we studied the ability to plant Medium in reducing ammonia, phosphate, sulfide, copper, and zinc as well as determining the maximum time.

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 from the waste water of the population (feces) and food waste, but it also exists in dissolved orthophosphates through biological processes because both plants and bacteria absorb phosphate for their growth (Kipngetich, 2013).

The results showed that the content of phosphate 0 days very high that is 95.3315 mg/L. The 0 day time was the control of this study, which in 0 days did not use the planting Medium as reducing of phosphate, then on the 15th day the phosphate concentration decreased both on coconut fibre medium and charcoal rice husk but on the 30th day the phosphate concentration in the sample increased and subsequently on the 45th day decreased. It shows that on the 30th day is the maximum time for phosphate absorption. Based on this optimum condition is done the analysis of phosphate content on hydroponics by using spinach plants at 30 days. The results are shown in Fig. 2.

The results of phosphate content analysis were also performed on hydroponics using spinach plants. Based on the results of research known that spinach plants can reduce the concentration of phosphate content in the fish feed water, characterized by reduced concentration phosphate in the presence of plants. The lowest concentration of phosphate on the 30th day was 70.000 mg/L contained in CRH planting medium, while the phosphate concentration with spinach plant was also on CRH planting medium with concentration 34.5959 mg/L. Medium planting CRH can reduce 50% phosphate content in water pellets, and the results are shown in Table 2.

Analysis of Ammonia

In the cultivation system with a system without water change, bacteria have an important role in eliminating ammonia through nitrification process. Absorption of ammonia varies from each plant, in this study used analysis of ammonia compounds with spinach plants. Ammonia and nitrite compounds are toxic to aquatic, ammonia is one of the metabolism process of food overhaul, the especially protein derived from the fish feed, the fish feed can accelerate the formation of ammonia and nitrite in the waters. Ammonia content is also a source for microorganisms to ammonia reshuffle process to nitrate (Henggar, 2009).

The hydroponics system is capable of reducing ammonia concentration 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 nitrification process.

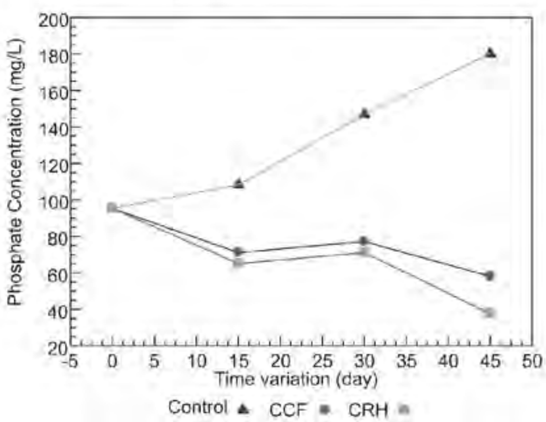

Fig. 2. Phosphate concentration in fish feed water

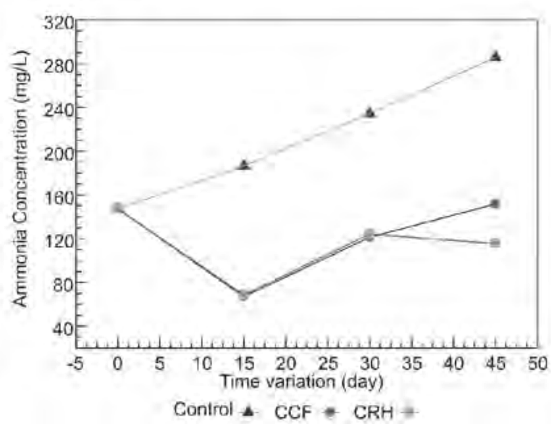

Fig. 3. Ammonia concentration in fish feed water

The results showed that ammonia concentration in fish feed samples in the presence of plants analyzed on the 30th day was able to make ammonia concentration in water shown in Table 3, and Fig. 6. The highest ammonia concentration was in planting medium ratio (CCF: CRH = 75 : 25) with ammonia concentration of 227.81-285.71 mg/L. As for the lowest ammonia concentration obtained on CRH planting medium 100%, where the results obtained the same as for phosphate analysis.

Sulfide analysis

The sulfide content analysis was done only on the sample with planting medium, whereas in the determination of the maximum day was not performed the analysis because the distance of filtration time with filtrate is too long so that the sulfide concentration in the water pellet. The result showed that the highest concentration of sulphide in CCF medium was 100% with concentration (1.148 - 1.321) mg/L while for the lowest sulfide concentration was on planting medium with comparisonCCF: CRH = 75% : 25% with concentration (0.741 - 1.037) mg/L. This shows that CCFis good for reducing sulfide, the same result is also shown in the analysis of sulfide with more CCF composition which is 75% :25%.

Copper analysis

Copper content analysis was performed using AAS

Table 2. Comparison of phosphate concentrations in planting medium (mg/L)

	Wihout plants (day to)				With plants (day to)	
S	0	15	30	45	S	30
CCF 1	93,3317	77.2950	77.1773	58.6610	CCF 1	73.8700
CCF 2		74.5838	77.2979	56.9119	CCF 2	71.2666
CCF 3		76.6345	77.2376	58.6800	CCF 3	69.9397
CRH 1		66.9843	71.9903	34.5959	ACRH 1	68.4318
CRH 2		64.3305	71.2666	37.3703	ACRH 2	66.7431
CRH 3		63.9686	70.0000	41.1701	ACRH 3	66.0193
					75:25	73.6067
					50:50	70.6031
					25:75	56.0072
					75:25	60.8926
					50:50	60.7720
					25:75	53.9566
					75:25	57.0929
					50:50	70.6031
					25:75	55.5257

Table 3. Comparison of ammonia concentrations in planting medium (mg/L)

	Wihout plants (day to)				With plants (day to)	
S	0	15	30	45	S	30
CCF 1		491.5204	640.5744	1459.3572	CCF 1	100.0000
CCF 2		484.9783	663.6426	1338.8648	CCF 2	127.1256
CCF 3		545.2245	546.5922	1218.3953	CCF 3	116.6401
CRH 1		337.3148	564.1169	1371.3699	CRH 1	111.5113
CRH 2		368.1103	568.9765	984.31730	CRH 2	137.6110
CRH 3		460.8844	679.8268	1037.6795	CRH 3	126.6697
	64.0531				75:25	227.8094
					50:50	188.6027
					25:75	205.2428
					75:25	285.7078
					50:50	208.2061
					25:75	195.4411
					75:25	223.7064
					50:50	219.8313
					25:75	206.2931

(Atomic Absorption Spectroscopy), the samples analyzed should be destructed by adding 5 mL concentrated nitric acid. The most frequent and effective acid solution is used because in wet destruction because it can break down the sample into a biodegradable compound and the solvent nitric acid itself is volatile, the destructed sample is then heated at a temperature of (200 – 300) °C.

In the process of destruction emerged gas bubbles. This gas is NO_2 (the byproduct of destruction process using nitric acid). This gas indicates that the organic material is completely oxidized by nitric acid. The use of nitric acid promotes a brownish gas during heating. Copper metallic analysis is carried out because copper metal is an essential metal naturally present in the fish feed, esensial metal is a metal that may be in a water environment in the permissible concentration. The allowed concentration in the aqueous environment is 2.5-3.0 mg/L (Syandri *et al.*, 2015).

Based on Fig. 4, the maximum concentration of copper is fish feed water sample that is on the 45th day, copper concentration at 0 days is 0.1293 mg /L where copper concentration at 0 days exceeds the allowable threshold and on the 15th day of concentration copper decreased to (0.039 - 0.091)mg/L however, indicating that planting medium used in this research is very effective in reducing copper metal. Copper concentrations increased on the 30th day and increased dramatically on the 45th day. Copper concentrations increased on the 30th and 45th days which is the maximum day of metal absorption in fish feed water samples. Copper metals are

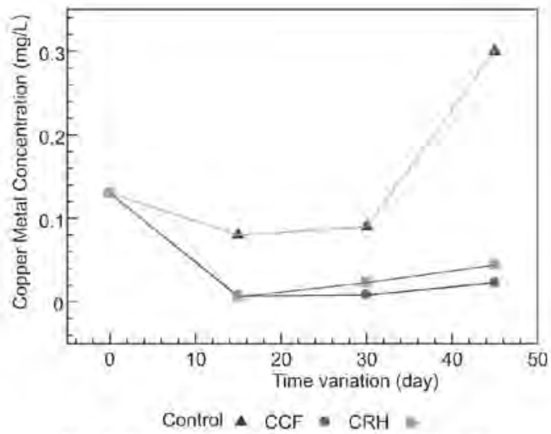

Fig. 4. Copper concentration in fish feed water

completely dissolved on the 45th day and have passed the safe boundary copper in the water environment, so has been done analysis by using plants.

Zinc analysis

The Zinccontent was analyzed using AAS as well as the Copper content analysis, the analyzed sample had to be destructed by adding 5 mL of concentrated nitric acid. The most frequent and effective acid solution is used because in wet destruction as it can break down the sample into a biodegradable compound and the solvent nitric acid itself is volatile, the samples are then heated and then heated at a temperature of (200-300) °C.

Table 4. Comparison of copper concentrations in planting Medium (mg/L)

	Wihout plants (day to)				With plants	
S	0	15	30	45	S	30
CCF 1		0.0405	0.0504	0.0903	CCF 1	0.0361
CCF 2		0.0405	0.0455	0.1385	CCF 2	0.0571
CCF 3		0.0643	0.0556	0.0556	CCF 3	0.0499
CRH 1		0.0390	0.0708	0.0708	CRH 1	0.0592
CRH 2		0.0426	0.0491	0.1337	CRH 2	0.0571
CRH 3		0.0469	0.0636	0.5390	CRH 3	0.0520
	0.1293				75:25	0.0694
					50:50	0.0686
					25:75	0.0686
					75:25	0.0665
					50:50	0.0599
					25:75	0.0715
					75:25	0.0592
					50:50	0.0672
					25:75	0.0708

Fig. 5 shows the Zn concentration increased from day 0 to day 45, Zn metal is an essential metal naturally present in the fish feed. Zn concentration in the CCF medium decreased on the 45th day indicating that CCF is a good planting medium in reducing Zn metal in different water samples with CRH growing Medium which increased from day 0 -45.

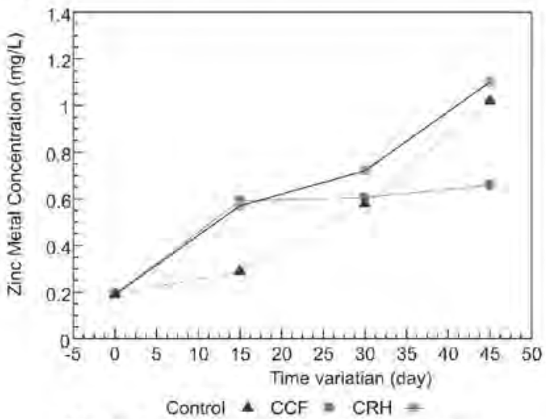

Fig. 5. Zinc concentration in fish feed water

Phosphate ammonia, Cu, Zn dan sulfide in different planting media

Based on Fig. 6, the result of phosphate content analysis in fish feed water samples, the highest concentration of phosphate is in CCF 100%, and the lowest is sample comparison between CCF and CRF= 25% : 75%. There are several factors causing the high concentration of phosphate concentration in CCF 100%, that is because the CCF does not support the growth of plant roots which causes in

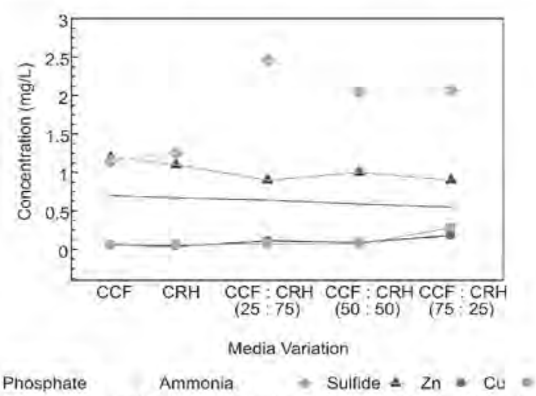

Fig. 6. Phosphate, ammonia, Cu, Zn dan sulfide in different planting media

some studies the same dead plants because the CCF Medium is not so good in sustaining root growth.

Based on Fig. 6, CRH has a good water absorbing ability, the absorption will be better by using two types of planting Medium. Because of differences in the ability of each planting Medium absorption is able to absorb phosphate better, one important factor in cultivation is the physical properties of planting Medium, particle size, and volume of plants that also affect the phosphate concentration.

Physical observation is also done on plants that grow on planting medium. spinach plant growth on CRH Medium grow more fertile than CCF planting medium 3 states that Medium and nutrition are factors that can affect the growth and yield of plants hydroponically.

Seeds planted in the seeded water with a little water in the morning and afternoon, other than that plant seeds are also in wear sunlight for photosynthesis so that the process of plant growth can take place with the help of the sun.

It is known that the highest concentration of Copper is on planting medium (CR : CRH = 25% : 75%) with concentration 0,0694 mg/L shown in Table 4. The results showed that CCF medium was able to reduce the concentration of copper metal in plants, and the lowest copper concentration was 0.0361 mg/L on the CCF medium. The results showed that to reduce the copper metal suitable Medium is CCF planting medium.

The analysis of zinc content in hydroponics using crops showed that the lowest concentration of zinc in coconut planting medium was shown on planting Medium composition CCF: CRH = 75% : 25% obtained by lower concentration.

CONCLUSION

It can be concluded that the composition of CCF and CRH can reduce the concentration of phosphate, ammonia, sulfide, copper, and zinc on hydroponic system. The maximum absorption composition for each analyst is different. Phosphate analysis showed a good combination of plant medium on CCF : CRH = 25% :75% with the phosphate concentration of 53.9566 mg/L and optimum absorption at 30 days. While the ammonia analysis showed a combination of good planting medium in CCF 100% with the concentration of 100 mg/L and optimum absorption at 45 days. Sulfide analyzes also showed results with the lowest concentrations in the sample with CCF : CRH = 75% : 25% composition with concentrations

Table 5. Comparison of zinc concentrations in planting Medium (mg/L)

		Without plants (day to)			With plants (day to)	
S	0	15	30	45	S	30
CCF 1		0.5293	0.9038	0.8148	CCF 1	0.0393
CCF 2		0.7215	1.1053	0.4572	CCF 2	0.0868
CCF 3		0.5269	1.1540	0.8145	CCF 3	0.0448
CRH 1		0.4411	0.9120	0.9843	CRH 1	0.0646
CRH 2		0.5297	0.5707	0.9639	CRH 2	0.0350
CRH 3		0.7325	0.6736	1.3425	CRH 3	0.1508
	0.1925				75:25	0.0548
					50:50	0.1724
					25:75	0.2042
					75:25	0.1233
					50:50	0.0314
					25:75	0.1461
					75:25	0.0314
					50:50	0.0678
					25:75	0.1823

(0.741-1.037) mg/L. Copper and zinc analysis showed that a good combination of planting medium was a variation of CCF : CRH = 75% : 25% with a concentration of 0.0592 and 0.0314 mg/L, respectively, indicating that the hydroponics system was able to reduce phosphate, ammonia, sulfide, copper, and zinc concentrations.

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