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Utilization of Planting Media of Charcoal Coconut Shell and Charcoal Rice Husk in Kale (Ipomea reptans Poir) Cultivation to Reduce Ammonia, Sulfide, Copper and Zinc Content in Hydroponics System

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ABSTRACT

Hydroponics studies with axis systems to reduce the ammonia, sulfide, copper and zinc content found in fish pellet solution has been performed. Data analysis was used Completely Randomized Design, with 5 treatments and 3 replications. The ammonia content of the sample solution was dilution by using doubly distilled water, while for the sulfide content test, the iron and zinc metal of the sample solution was destructed first using HNO_3 65% and then heated until a colorless solution was obtained. Ammonia content was analyzed using UV/Vis Spectrophotometer, while sulfide, copper and zinc metal content were analyzed using Atomic Absorption Spectrophotometer (AAS). The optimum time is the reduction process of ammonia, sulfide, copper and zinc content on time variation of 30 days hydroponic system. In this 30 day time variation, laboratory scale hydroponics is made using media varieties with kale (*Ipomea reptans* Poir) as a cultivation plant. The cultivation plants only grow on the medium of rice husk 100%. For the process of reducing ammonia, sulfide, copper and zinc metal, it is found that the best media variation for the reduction process is the media with coconut shell 100% composition and rice husk 100%.

KEY WORDS: Hydroponics, (Ammonia, Sulfide, Copper and Zinc), Charcoal Coconut Shell, Charcoal Rice Husk.

1. INTRODUCTION

Clean water is one of the most basic necessities for human beings and all living things because it needs constantly in their daily life to survive. Since water is the basic necessity of all living things, it is not uncommon for human error to manipulate water. Water is widely used for human life support industry, one of the industries whose main ingredients in the production process is in the form of water in example fishery industry (Pattilo and Kurt, 2013).

Water quality plays an important role in the field of fisheries, especially for cultivation activities as well as in the productivity of aquatic animals (Imam, 2010). Water is widely used for human life support industry, one of the industries whose main ingredients in the production process is in the form of water that is fishery industry (Pattilo, 2013). The influence of water quality on cultivation activities is very important, so the supervision of water quality parameters is absolutely done by the farmers (Imam, 2010).

Cultivation system without water change widely applied by the community because it is able to increase fish production on land and water are limited. 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, feces, inedible feed residues that will produce ammonia (NH_3), nitrites (NO_2), and CO_2 that can increase very quickly and are toxic to aquaculture organisms (Surawidjaja, 2006).

As the population of society increases, there will be new problems for the industrial world, in the form of limited land for the production process. Due to limited land, hence introduced the aquaponic system in the new industry. Not only as a fishery industry, aquaponics is also a vegetable farming industry. Aquaponics is a combination of aquaculture technology with hydroponic technology in one system to optimize water and space functions as a maintenance medium. The technology has been conducted in developed countries, especially those with limited land to optimize the productivity of aquatic biota. The basic principle that is beneficial for aquaculture is the residual feed and fish waste that potentially worsens the water quality will be used as fertilizer for aquatic plants (Nugroho, 2012).

In this research, the hydroponic model will be developed in laboratory scale. Hydroponics is chosen as the object of research because the hydroponic system can recycle the feed waste in the waters into nutrients for plants. Likewise, the waste of fish debris 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 it can be said that the waste generated from a biological system is used as a nutrient for the next biological system through direct filtration and biological filtration. The results of this metabolism are not in vain 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.

The objectives of this study are to: (a) study the combination of charcoal coconut shell and charcoal rice husk in the cultivation of watercress in reducing ammonia, sulfide, copper and zinc on hydroponic system, and (b) to analyze changes in water quality used before system implementation hydroponics compared with after application of the hydroponics system.

From the results of this study, it is expected to complete the information in the application and contribution of charcoal coconut shell and charcoal rice husk in the cultivation of kale plants to reduce ammonia, sulfide, copper, and zinc in the hydroponics system.

2. MATERIAL AND METHODS

Equipments and materials: The equipment used in this study is the Atomic Absorption spectrophotometer (AAS) (spectra AA-240 Variants), UV-Vis RHectrophotometer (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 charcoal coconut shell (CCS) and charcoal rice husk (CRH), plant seeds of kale, amine sulphate, ammonium phosphate, ammonium chloride (NH_4Cl) (Merck), K-Na tartarate 50%, reagent nessler, $Zn(NO_3)_2$ 1000 mg/L (Merck) stock solution, $Cu(NO_3)_2$ 1000 mg/L (Merck) stock 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 charcoal coconut shell (CCS), P_2 as charcoal rice husks (CRH), P_3 as CCS:CRH = 75%:25%, P_4 as CCS:CRH = 50%:50%, and P_5 as CCS: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, fat, and fiber. The fish feed used is smoothed so that all compositions in the fish feed are soluble in water.

A jar with a height of 18 cm, a width of 8 cm with a volume of 2 L filled with 5% pellet solution. Flower pots mounted axis with a length of 8 cm, filled with media crops such as CCS 100% and CRH 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 30 cm, filled with comparisons media crops such as CRH and CCS made as many as three replications, mounted flower pot with axis touch solution pellet, plant seeds RHinach sown on media Planting done analysis for 30 days with the variation of planting media can be seen at Table.1.

Table.1. Design experiment of hydroponics system

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

Note: CCS: charcoal coconut shell, CRH: charcoal rice husk, The water pellet analysis is conducted for 30 days

Figure.1. Design of hydroponics

Water quality analysis performed was analysis of phosphate, ammonia, sulfide, 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.

3. RESULTS AND DISCUSSION

Pellet solution, hydroponics model and planting medium: The pellets used are buoyancy pellets containing protein, fat, and fiber. The preparation of a 5% pellet solution is carried out by smoothing the pellets so that all compositions in the soluble pellets with water, further dissolving the pellets by 50 g in 1 L of water.

Laboratory hydroponic system with axis system with 100% plant charcoal coconut shell (CCS) planting treatment and 100% without plant and non-fish charcoal rice husk (CRH) were made to see the optimum absorption of the hydroponic system over a predetermined time range. Both of these planting media are used because rice husk has a high ability to absorb water, so the media is always wet (Dauhan and Riska, 2014).

Selection of planting media need to pay attention to 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. Planting media used in this study is organic media because the organic media has been able to provide nutrients needed by planting media, in addition to organic media also has a good pore for air recirculation.

Figure.2. Hidroponik 0-day (a) dan 15-day (b)

Figure.2, is a 0-day axis hydroponic laboratory system axis. At the beginning of the pellet solution, the color of the solution has shown a brownish yellow color which indicates high levels of protein, nitrogen content and other mineral content contained in the pellet. After 15 days of absorption, it can be seen that hydroponics is quite effective in the reduction process, which on the second day after laboratory scale hydroponics is done, in the jar in the presence of pellet solvent it appears that the bubbles indicate the reduction process has begun to occur. In order for the absorption process to take place all the jars used are stirring every day so that the soluble pellets do not settle.

Table.1. Ammonia concentration data on pellet solution (time variation)

Sampel	0 day (mg/L)	15 day (mg/L)	30 day (mg/L)	45 day (mg/L)
CCS1		109.3458	123.5924	299.9772
CCS2		86.0953	142.5120	231.5933
CCS3		41.7597	117.3239	213.3576
CRH 1		79.7128	135.5596	88.5571
CRH 2		62.9587	113.3349	93.6859
CRH 3		67.1757	96.5352	97.1051
Without Media	66,9934			

Laboratory hydroponic system is done with 4-time variations, ie 0; 15; 30; And 45 days. Based on the average data obtained, 30 days is the optimum time of ammonia reduction, because the data at 15 days is not different from 30 days. This condition indicates that after 15 days the hydroponics system is able to reduce the ammonia produced by the laboratory-scale hydroponics.

Analysis of Ammonia: Ammonia is a major contamination of cultivated wastes, pellets are a major source of contamination in the cultivation system (Wahyuningsih, 2016). From the tested samples obtained data of ammonia concentration relationship with planting medium used.

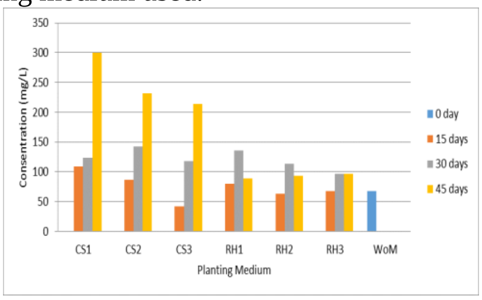

Figure.3. Concentration of ammonia at a time variation

Note : WoM : without medium

The ammonia concentration of the pellet solution performed with the hydroponics of the laboratory scale on the time variation obtained ammonia concentration at 0 days is 66.9934 mg/L. At 15 days the average concentration of ammonia (41.7597-109.3458) mg/L in pellet solution with 100% CCS planting medium and on 100% CRH plant medium, average ammonia concentration (62.9687-79.7128) mg/L . At 30 days, the average concentration of ammonia in a solution of pellet with 100% (100.3239-142.5120) mg/L and 100% CFH plant medium was added to the CRH medium 100% (96.5352-135.5596) mg/L. At 45 days, the average concentration of ammonia in the pellet solution with a 100% (100%) and 100% (100%) 100 mg/L CRH medium planting medium was 100% (88.5571-97.1051) mg/L. This concentration has exceeded the maximum threshold, since the tolerance level of NH_3 in fishery is only 0.05 mg/L (Government Regulation No. 82, 2001).

As a comparison of the effectiveness of planting media used, then tested on pellet solution with the variation on planting medium used with optimum time that has been set previously that is 30 days.

Table 2. Ammonia concentration data on pellet solution (media variation)

Sampel	CS (mg/L)	RH (mg/L)	CS:RH 75:25 (mg/L)	CS:RH 50:50 (mg/L)	CS:RH 25:75 (mg/L)
1	78.4591	113.9305	450.9916	321.6321	98.8147
2	97.9485	101.1397	327.3307	256.6674	457.8299
3	104.6729	134.5338	507.4082	307.3854	331.3198

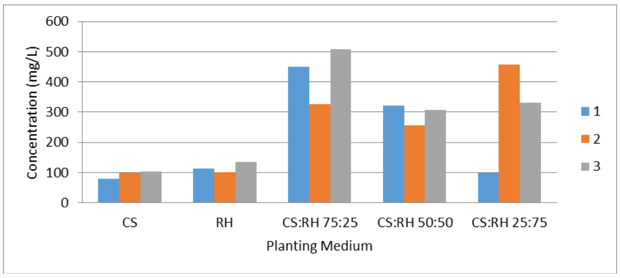

Figure.4. Ammonia concentration on variation of planting medium

Concentration of ammonia on the variation of planting media composition, it can be seen that on the composition of CCS 100% medium and CRH 100% showed the ammonia concentration produced is lower than the mixed media composition. And show that the unmixed media composition can improve the ability of ammonia to reduce in laboratory hydroponics. This condition is due to the use of mixed media can reduce the ability of the media in absorption of ammonia, so it can be concluded that the variation of media composition does not affect the laboratory scale hydroponics ability in reducing ammonia.

Analysis of Sulfide: Analysis of sulfide content was done by using Spectrophotometer at wavelength 665 nm. The organic sample of the pellet solution is pre-disposed in order to remove other organic compounds such as ammonia. Sulfide source in this study comes from the process of protein breakdown found in fish feeds used (crude protein 35%). For analysis of sulfide content with spectrophotometer, the data obtained as in Table.3.

Table.3. Sulfide concentration data on pellet solution.

	CS 100% (mg/L)	RH 100% (mg/L)	CS:RH 75:25 (mg/L)	CS:RH 50:50 (mg/L)	CS:RH 25:75 (mg/L)
1	0.5190	0.7410	0.7160	0.5430	0.9510
2	0.5680	0.3580	0.4810	0.5800	0.8150
3	0.5930	0.6050	0.7040	0.6790	0.6050

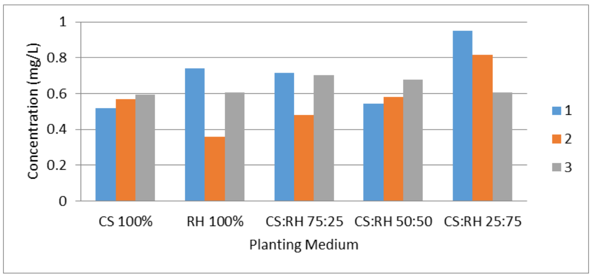

Figure.5. Sulfide concentration on variation of planting medium

From the data obtained, the concentration of sulfide in pellet solution with the variation of medium CCS 100%, CRH 100%, CCS: CRH = 75: 25, CCS: CRH 50:50 and CCS: CRH = 25: 75, reRHectively (0, 5190-0,5930) mg/L, (0,3580-0,7410) mg/L, (0.4810-0,7160) mg/L, (0,5430-0,6790) mg/L and (0.6050-0.9510) mg/L. With the lowest concentration was in pellet solution with variation of CRH medium 100% with value 0,3580 mg/L and highest concentration with variation of CCS media : CRH = 25: 75 with value 0,9510 mg/L. This condition is due to absorption of 100% CRH medium having pores capable of accommodating more sulfide content than other media. In mixed media CCS: CRH, the absorption capacity of CRH media is reduced due to the presence of CCS media. Furthermore, CCS media come to fill the pores on the media CRH and vice versa so that its absorption ability to be reduced.

Analysis of Copper and Zinc Metals: Copper and Zinc is a heavy metal commonly found in natural waters and is an essential mineral for plants and animals. Copper and zinc metal can be sourced from household waste, pesticides, fertilizers, and dust particles from surrounding activities. If the accumulation of copper and zinc is above the threshold will cause pollution and problems for the surrounding environment, which will affect the plants, water biota, and sediments in the surrounding area.

The analysis of the copper content was carried out 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 in the wet destruction it can break down the sample into a biodegradable compound and the solvent nitric acid itself is volatile, the samples are destructed and then heated at (200 - 300)°C.

In the process of destruction emerged gas bubbles. This gas is NO_2 (the by product 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.

Analysis of Copper and Zinc metals by treatment of time variation (without plant application): The first analysis is the concentration of copper and zinc metal with the treatment of time variation. Copper metal analysis results can be seen Table.4.

Tabel 4. Data konsentrasi logam Copper pada larutan pelet (variasi waktu)

Sampel	0 day (mg/L)	15 day (mg/L)	30 day (mg/L)	45 day (mg/L)
CCS1		0.0828	**0.0871**	**0.0850**
CCS2		0.0643	0.0934	0.1298
CCS3		**0.0510**	0.0939	0.0956
CRH 1		0.0493	**0.0710**	**0.0821**
CRH 2		**0.0349**	0.0915	0.0982
CRH 3		0.0452	0.0884	0.1247
Without Media	0.1351			

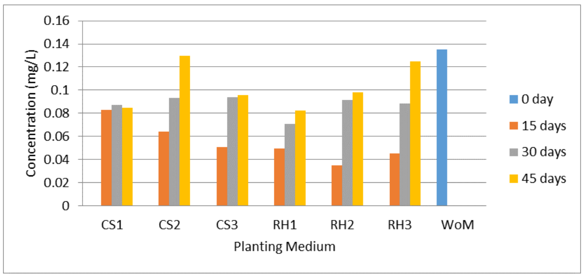

Figure.6. Copper metal concentration (time variation)

From the data obtained, the effective absorption of copper metal occurs on 100% CCS medium and CRH media 100% at the time variation. In the first 15 days, the copper metal absorption was initially 0.1351 mg/L (0.0828-0.0510) mg/L for CCS media and (0.0493-0.0349) mg/L for CRH media. At day 30, the copper concentration in pellet solution with CCS and CRH media was 0.0939-0.0871 mg/L and (0.0915-0.071) mg/L, respectively. At day 45, the copper concentration in the pellet solution with CCS and CRH medium was (0.0850-0.1298) mg/L and (0.1247-0.0821) mg/L. For the next 15 days the copper concentration increased both on CCS media and CRH media, but did not exceed the copper concentration in 0 days. This condition is because at 0 days the copper metal contained in the pellet is not completely soluble in the pellet solution.

From the data obtained (Table 5), the zinc concentration of metal at 0 days was 0.1901 mg/L. At day 15 with CCS and CRH media, Zinc concentrations in successive pellet solution (1,3055-0,4875) mg/L and (1,1050-0,9460) mg/L. At day 30 with CCS and CRH media, Zinc concentration in consecutive pellet solution (1.0443-0.7308) mg/L and (1,3802-0,7173) mg/L. On the 45th day with CCS and CRH media, Zinc concentration in successive pellet solution (0.8185-0.6344) mg/L and (0.7022-0.3941) mg/L. For > 15 days, the concentration of Zinc metal in pellet solution is increasing. This is because at 0 days the zinc metal contained in the pellets has not dissolved entirely in the pellet solution. However, after the first 15 days, the concentration of Zinc metal in the solution decreased. This condition indicates that the medium used can absorb Zinc metal in pellet solution.

Table.5. Data of Zinc metal concentration on pellet solution (variation of time)

Sampel	0 day (mg/L)	15 day (mg/L)	30 day (mg/L)	45 day (mg/L)
CCS 1		1.3055	0.8031	**0.6344**
CCS 2		0.8352	**0.7308**	0.8045
CCS 3		**0.4875**	1.0443	0.8185
CRH 1		1.0102	1.3862	0.4802
CRH 2		1.1050	**0.7173**	**0.3941**
CRH 3		**0.9460**	0.8111	0.7022
Without Media	0.1901			

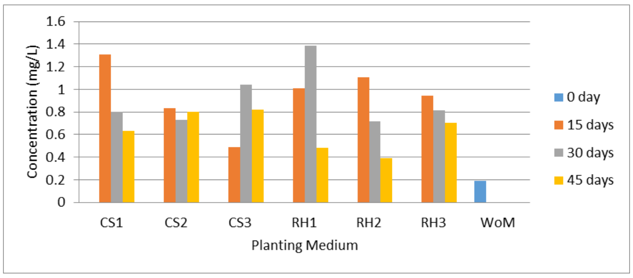

Figure.7. Concentration of Zinc Metal (time variation)

From the data seen Copper metal concentration is smaller than the metal Zinc. As is known, Copper and Zinc metals are the essential metals required by living creatures in small concentrations of 1-5 mg/kg for Copper and 10-50 mg/Kg for Zinc in food (Boyd, 1988). This condition causes absorption by planting medium to be effective. Copper and Zinc metal concentrations in the analyzed pellet solution are still below the threshold. Where, the threshold for Copper metal is 0.05-0.2 mg/L, while for Zn metal is < 5 mg / L (McNeely, 1979).

Analysis of Copper and Zinc metals by treatment of variation of planting medium (with plant application): From the data obtained (Table.6), Copper metal absorption is more effective in CCS medium with concentration 0.0915 mg/L. Copper concentration of pellet solution on CCS medium: CRH = 75:25, CCS: CRH = 50: 50 and CCS: CRH 25:75 consecutive (0.1227; 0.1196; and 0.1090) mg/L. For media variations, CCS media: CRH = 25: 75 is a medium with better Copper metal absorption. This condition is due to lack of absorption ability of CCS media.

Tabel.6. Data konsentrasi logam Cu pada larutan pelet (variasi media tanam)

Sampel	CS (mg/L)	RH (mg/L)	CS:RH 75:25 (mg/L)	CS:RH 50:50 (mg/L)	CS:RH 25:75 (mg/L)
1	0.0872	0.1355	0.0546	0.1312	0.1437
2	0.0934	0.1473	0.1312	0.1136	0.0741
3	0.0939	0.1789	0.1823	0.1141	0.1091

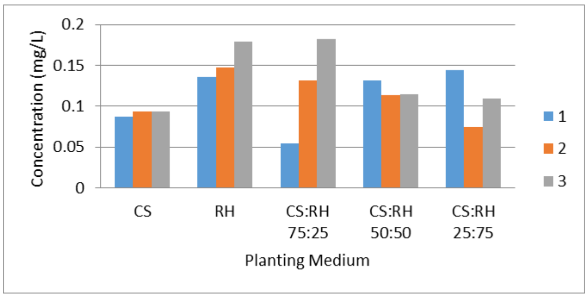

Figure.8. Copper metal concentration (variation of planting medium)

From the data obtained (Table 7), the more effective absorption of Zinc metals occurs on varied media compared to the CCS and CRH medium 100%. Concentration of pellet solution on medium CCS : CRH = 75:25, CCS: CRH = 50: 50 and CCS: CRH = 25:75 subsequently (3.8067; 1.6418 and 1.4911) mg/L. Media CCS: CRH = 25:75 is a medium with good absorption of Zinc metal.

Table 7 Data of Zinc metal concentration in pellet solution (variation of planting medium)

Sampel	CS (mg/L)	RH (mg/L)	CS:RH 75:25 (mg/L)	CS:RH 50:50 (mg/L)	CS:RH 25:75 (mg/L)
1	4.0161	2.8199	3.0625	1.7760	2.0527
2	3.6543	4.6896	5.1553	1.6765	0.9011
3	5.2221	2.1079	3.2022	1.4728	1.5195

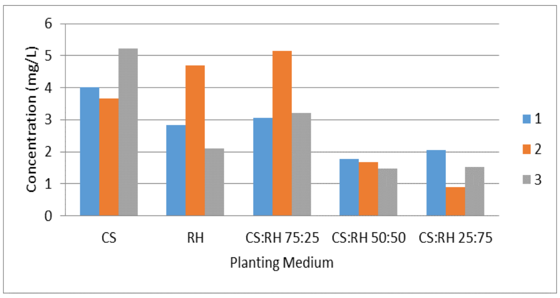

Figure.9. Zinc metal concentration (variation of planting medium)

Dari data yang diperoleh, penyerapan logam Zn lebih efektif terjadi pada media yang divariasikan dibandingkan dengan media 100% BK dan SP. Konsentrasi larutan pelet pada media BK:SP 75:25, BK:SP 50:50

dan BK:SP 25:75 adalah sebesar 3.8067 mg/L, 1.6418 mg/L dan 1.4911 mg/L. Media BK:SP 25:75 merupakan media dengan penyerapan logam Zn yang lebih baik.

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5. CONCLUSION

Hydroponics can reduce the content of ammonia, sulfide, copper and zinc metals in the pellet solution. The optimum time of the absorption process was obtained at a time-varying 30- day hydroponics laboratory scale. In the ammonia absorption process, the variation of 100% CCS planting medium and CRR 100% is an effective media variation in reducing ammonia compared to other variations of media. In the sulfide absorption process, the medium which absorbs the optimum in reducing the sulfide content is a 100% CRR medium. In the process of absorption of copper and zinc metals, 100% CCS planting medium and 100% CRR with time variation is an effective medium in the process of reducing copper and zinc metal content in the hydroponic system pellet solution. For varied planting, mediums showed ineffective copper and zinc metal reduction results, since the absorption capacity of the CCS media composition mixed with CRR media was reduced. Reduced ability of CCS and CRR on mixed media, because each media to fill each other pore so that to make the absorption ability becomes less. For the application of plants, the medium that can be overgrown with crops only medium with 100% CRR composition.

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