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Research Article

DETERMINATION OF AMMONIA, PHOSPHATE, SULFIDE, IRON AND ZINC CONCENTRATION IN THE PRESENCE OF PLANTING MEDIA OF COCONUT FIBER AND CHARCOAL RICE HUSK IN KALE (IPOMOEA REPTANS POIR) CULTIVATION: THE HYDROPONICS SYSTEM

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ABSTRACT

Hydroponics technology is a system of agricultural cultivation without using soil but using water as a source of nutrients for plant growth. Hydroponics is used to optimize the function of water and space as a medium for cultivation of plants. Hydroponics system was analyzed using completely randomized design with 4 time variations and 5 variations of planting medium with three replications. On measurement of ammonia and phosphate concentration of sample solution dilution was done by using aquades, then measured using UV-Vis spectrophotometer. For the determination of sulfide concentration, iron and zinc samples were first detected using HNO_3 65% and then heated to 200°C until obtained by colorless solution, the sulfide concentration was measured using UV-Vis spectrophotometer and iron and zinc concentration using atomic absorption spectrophotometer flame (AAS). It has been done known that the sample of fish meal pellets solution experienced the process of maximum concentration reduction on day 30 of the hydroponics system performed. On this 30th day, hydroponic variations of the composition of the medium by using kale plants (*Ipomoea reptans* Poir) as plants that will help the process of reducing the concentration. In the result of measurement of ammonia, iron and zinc concentration, it was found that most variations of composition of the media with the greatest concentration reduction were medium with coconut fiber (CF) 100% and charcoal rice husk (CRH) 100% compositions, while on phosphate concentration measurement of composition variation CF: CRH=75%: 25% and CF: CRH=50%: 50%. The analysis of sulfide concentration, known that the sulfide content in the solution is below the threshold of <1 mg/L, where the lowest concentration is in media variation CRH: CF=75%: 25%, between (0.506-0.567) mg/L.

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 water mistakes to be made by humans. Water is widely used for human life support industries, one of the industries whose main ingredients in the production process is in the form of water in example fishery industry (Pattillo and Dan Kurt, 2013).

Hydroponics technology has been conducted in developed countries, especially countries with limited land (Nugroho, *et al*., 2012). Hydroponics axis system is a solution of agricultural systems that use fertilizer, with hydroponic axis system farmers no longer need to use fertilizer, power source and irrigation easy to control. Based on research results (Pradina, *et al*., 2015) hydroponics axis system with the type of wool Axis Is a good axis type to use because the water-drainage system with the wool axis has better capillarity power when compared to the axis of the cotton type.

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Kale includes plants that live on the ground with less-potent roots which is one of the requirements to be maintained in a hydroponic system using a simple filter system the number of clumps used is also made differently (Nugroho and Sutrisno, 2018). Kale can utilize nitrogen and phosphorus nutrients for plant growth (Effendi, *et al*., 2015) The two main sources of problems in the aquatic environment are the high concentrations of N and P in the water. The source of this N and P is 10% from natural processes in the water environment itself (background source), 7% from industry, 11% of detergent, 17% from agricultural fertilizer, 23% of human waste, and the largest 32% of livestock waste (Morse, *et al*., 1976). The pile of remaining fish feed can produce sulfide compounds that are harmful to aquatic life.

The hydroponic system reduces ammonia by absorbing cultivated wastewater or wastewater by using plant roots so that the absorbed ammonia undergoes oxidation with the help of oxygen and bacteria, ammonia is converted to nitrates. In aquaculture activities with a system without the water change, bacteria have an important role in removing ammonia particles through nitrification process (Rully, 2011). Decrease in water quality due to eutrophication will decrease the function of waters and disrupt the existing ecosystem. Human activity is the most influential factor in the improvement of organic matter. The organic material will decompose and increase the phosphorus and nitrogen elements in the water. Phosphorus and nitrogen elements entering the lake waters resulting from human activities include industrial activities derived from waste products, households derived from detergents, farms derived from fertilizers, and cultivation of floating net cages fisheries derived from residual excretion and residual Feed (Widyastuti, 2008).

Sulfides are sulfuric acid gases. Sulfide wastewater is the result of decomposition of an organic substance in the form of hydrogen sulfide (H_2S), which is toxic to algae and other microorganisms but can be used by photosynthetic bacteria as electron/hydrogen donors to reduce carbon dioxide. The decomposition of these organic substances causes an unpleasant odor in the surrounding environment (Mahinda, 1984).

Iron concentration in aerated waters (aerobic) is almost never more than 0.3 mg/L (Widyastuti, 2008). Iron content in natural waters ranges from 0.05-0.2 mg/L (Krist. and Rump, 1992). In deep ground water with low oxygen levels, iron content can reach 10-100 mg/L, whereas in marine waters around 0.01 mg/L. Rainy water contains an iron content of about 0.05 mg/L. Zinc is a very important element for human health. Zinc intake is too low to make a person lose appetite, decreased the sense of taste and smell, and wounds that will slowly heal. Zinc deficiency can even cause a fatal birth defect. However, intake of zinc is too high it causes various health problems, such as abdominal cramps, skin irritation, vomiting, nausea, and Anemia. Zinc-contaminated water can increase water acidity. Zinc levels in drinking water should be no more than 5 mg/L (Boyd, 1988).

EXPERIMENTAL DETAILS

Instruments and Materials Research

The tools used in this study include: glassware commonly used in laboratories, Spectrophotometer atomic absorption (AAS), Spectrophotometer UV-Vis, jars, plastic bottles, wicks stove, flower pots, tea strainer, bulb suction, aluminum foil, Vials.

The materials used in this study are coconut husks, rice husk, kale plant seeds, fish food pellets, Ammonium Molybdate, and H_2SO_4, 0.4; 10 N, Potassium Antimonitartarat, Ascorbic Acid, Sulfuric Amin, $FeCl_3$, Ammonium Phosphate, NH_4Cl, H_2PO_4, K-Na tartrate 50%, reagent Nestler, HNO_3 pa, $Na_2S.9H_2O$, Iron stock solution 1000 mg/L, and doubly distilled water.

Research Procedure

The study was conducted using method of completely randomized design with 4 variations of time (0, 15, 30, and 45 days) and 5 compositional variations P_0 as a control, the P_1 composition of rice husk (CRH) 100%, P_2 composition of coconut fiber (CF) 100%, P_3 CRH: CF=75%: 25%, P_4 CRH: CF=50%: 50%, and P_5 CRH: CF=25%: 75%. Where each variation is done 3 times the repeat.

The sample solution was prepared from a solution of fish food pellets with a ratio of 5%, of which 50 grams of the sample was dissolved in 1 liter of doubly distilled water. Fish food pellets contain protein, fat, essential minerals. Fish food pellets are first smoothed so that when the process of making the solution all the content in the pellet will dissolve into the water. The hydroponic system made by using a jar with a diameter of 8.5 cm, height 21 cm and a volume of 1.4 L. The pot plants on media with a diameter of 7.5 cm and 9 cm, filled with media CRF 100% and CF 100% With 3 replicates. Plant pots are linked to the axis system into fish sample fish samples. The analysis of pellet solvent content was done at the time variation of 0; 15; 30, and 45 days to see the optimum time of absorption process occurred. For the analysis of variation of planting media composition of CRF and

CF mixture was also done 3 replicates. Analysis of the solution of the sample solution was carried out at 30 days, can be seen in Table 1 and (Fig. 1a and b).

Pellet or sample solution was analyzed for ammonia, phosphate, iron and zinc content at 0; 15; 30; and 45 days. While samples for variations of media composition were analyzed against ammonia, phosphate, sulfide, iron and zinc content at 30 days.

RESULTS AND DISCUSSION

Making of Planting Media

Planting media used must meet the requirements such as: able to absorb and deliver water, not easily rot, does not affect the pH, sterile. Charcoal rice husk and coconut husk media are examples of planting media that meet these requirements. Planting media will be used as root handles and nutrient solution intermediaries, to meet the needs of macro nutrients and micro fertilizer substitutes (Syamsu, 2014). The container of the planting media or pot used is first washed before use. Pot paired axis system by using wool type axis. When the hydroponic process takes place part of the axis must be in the water of the pellet solution.

Planting on a Hydroponic System

Seeds used are seeds that have a purity of 90% seedlings with 70% seedling power of superior kale seedlings, Bika (Seed Pertiwi). Seeds are shown directly on the hydroponics medium without seeding first. Media at the variation of time is rice husk charcoal and coconut husk. While the media for variation of planting media is done mixing on each media. As the media is CF: CRH=75%: 25% both media are stirred in a container until homogenate and then freshly inserted into the potted plant. Planting seeds is done by: (1) planting media wetted first using water, (2) on each pot made 3 holes with 2 cm deep, (3) at each hole is inserted 5-10 seeds of superior kale plant (4) Each hole is closed again, (5) then the media is wetted back by using doubly distilled water. The process of wetting the media is done to keep the media used in a humid condition. Watering the media is done only when the media starts to look dry.

Table 1. Hydroponic system research model.

Replicates	CF : CRH			CF 100%	CRH 100%
	75%:25%	50%:50%	25%:75%		
1					
2					
3					
*l The sample solution was carried out at 30 days					

The Analysis Parameters

Analysis of the content of the sample on hydroponics conducted is an analysis on the concentration of ammonia, phosphate, sulfide, iron, and zinc. In the ammonia concentration analysis, the direct sample phosphate was dissolved in doubly distilled water in several dilution factors. As for the measurement of sulfide concentration, iron and zinc samples were deteriorated first using 65% nitric acid at 200^0C.

Analysis of Ammonia

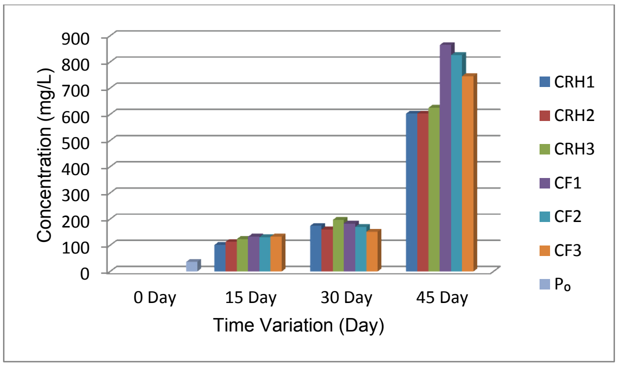
Ammonia is a major contamination of cultivation wastes and fish food pellets are a major source of contamination in cultivation systems (Pradina, *et al*., 2015). In water, ammonia is present in two forms, ie ammonia instead of ions NH_3 and ammonia in the form of NH_4^+ ions, the total number of these two forms of ammonia is used for the analysis of total ammonia or simple ammonia (Vandecasteele and Block, 1993). Ammonia measured using a

(a) (b)

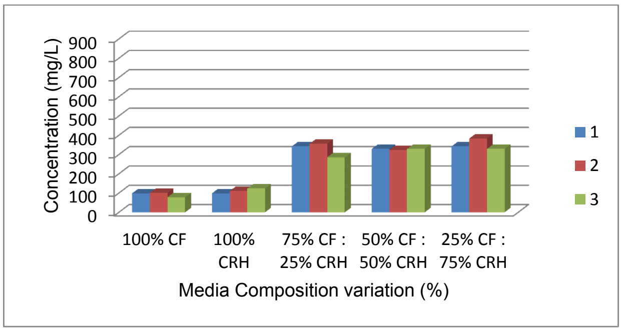
Fig. 1 (a) Hydroponic model for time variation (b) the hydroponic model of the variation in the composition of the media.

Nessler reagent and a seignatte salt to determine total ammonia nitrogen, reddish yellow color indicates that ammonia concentrations greater than 5 mg/L (Government Regulation No.82, 2001) (Fig. 2a and 2b).

The concentration of ammonia on the variation of planting media composition, it can be seen that on



(a)



(b)

Fig. 2 (a) Concentration of ammonia in time-varying varieties without plants (b) Ammonia concentration on media variations with kale plants.

the composition of 100% CF 100% and CRH 100% the resulting ammonia concentration is lower than in other variations, the concentration between (79.0974 – 101.8920) mg/L and (99.6125 – 124.6866) mg/L. And when compared with the hydroponic data of time variation it can be seen that in this media composition there is a considerable decrease in ammonia concentration that is ± 50% reduction of concentration. These data suggest that the composition of the media that is not mixed with other types of media can improve the ability to reduce ammonia (Table 2).

Phosphate Analysis

Phosphate is a second source of pollution in the environment of waters that can damage the environment in the form of eutrophication. A waters is called eutrophication if the total concentration of phosphate into water is in the range of 35-100 μg/L. The source of phosphorus causes 10% eutrophication derived from the natural process in the water environment itself (background source), 7% of industry, 11% of detergent, 17% of agricultural fertilizer, 23% of human waste, and the largest 32% (Pradina, *et al.*, 2015) (Fig 3a and 3b).

The limits of phosphate concentration are watered according to Government Regulation No.82, 2001 (Government Regulation No.82, 2001) in water quality control is 0.2 mg/L. It is known that the accumulation of fish feed contains phosphates in very high concentrations. Based on the data obtained it can be concluded that the most optimal phosphate reduction process at 30 day variation, where the data of phosphate concentration at 15 days and 30 days is not too much different, it can be assumed that within

Table 2. Comparison of ammonia concentration in planting medium (mg/L).

Variables	Without plants (day to) With plants (day to)				With plants (day to)	
S	0	15	30	45	S	30
CF 1		133.8044	183.9526	865.5117	CF 1	99.61249
CF 2		131.5250	170.2758	826.7609	CF 2	101.892
CF 3		133.8044	152.0401	746.9797	CF 3	79.09733
CRH 1		101.8920	174.8347	603.3736	CRH 1	99.61249
CRH 2		113.2893	161.1580	603.3736	CRH 2	111.0098
CRH 3		124.6866	197.6294	626.1682	CRH 3	124.6866
P_0	37,3148	--	--	--	75:25 1	343.5149
--	--	--	--	--	75:25 2	357.1917
--	--	--	--	--	75:25 3	286.5284
--	--	--	--	--	50:50 1	329.8382
--	--	--	--	--	50:50 2	325.2792
--	--	--	--	--	50:50 3	329.8382
--	--	--	--	--	25:75 1	343.5149
--	--	--	--	--	25:75 2	384.5452
--	--	--	--	--	25:75 3	329.8382

30 days of the best phosphate reducing process (Fig. 3a). From (Fig. 3b), it is known that the phosphate reducing process is best at CF: CRH=75%: 25% and CF: CRH=50%: 50% media variation, with a mean phosphate concentration of (108.0578 – 126.6884) mg/L and (126.6884 – 133.6749) mg/L. The ability of phosphate reduction increases with the presence of ground kale plants used (Table 3).

Sulfide Analysis

In the sulfide analysis, sample preparation by destruction should be done at the specified time, this is done because the sulfide sample is very easy to increase the change of concentration. Sulfide analysis was performed by total sulfide measurement using UV-Vis spectrophotometer at the wavelength of 665 nm.

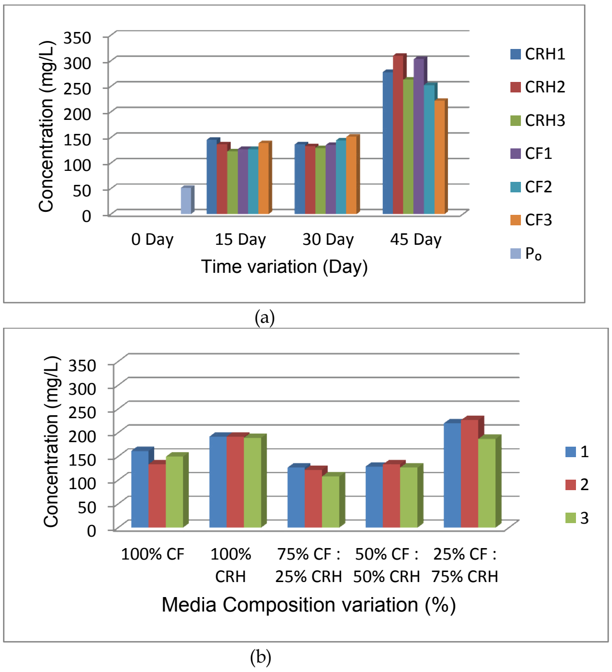


Fig. 3 (a) phosphate concentrations in time variations without kale plants (b) phosphate concentration on media variations with kale plants.

Based on (Fig. 4). it is known that the sulfide concentration in the sample solution that exceeds the threshold of the sulfide concentration in water is CRH 100% at the first repeat with a value of 1.012 mg/L. While the concentration value of sulfide in other varieties of planting medium is within the range of permissible sulfide concentration limits that is at the concentration of 0.506 mg/L - 0.951 mg/L, where the total sulfide limit in water and wastewater is in the range of 0.02 mg/L - 1.0 mg/L (Eugene, 2009). Based on the data obtained can be known sulfide content in the solution of fish food pellets including safe (Table 4).

Iron Analysis

The samples in the iron analysis were done destruction process first, destructed done using 65% nitric acid. 10 mL of the sample was dissolved in 5 mL of nitric acid at 200^{0}C until a colorless solution was obtained. The nitric acid will dissolve the iron contained in the sample solution, and the water contained in the sample will overflow leaving the iron in the nitric acid solution.

From (Fig. 5a and 5b) it can be seen that the iron reduction process with the hydroponics system has been successfully performed, wherein the lowest iron concentration is found in the 100% CRH media variation, followed by 100% CF medium.

Table 3. Comparison of concentration of phosphate on planting medium (mg/L).

	Without plants (day to) With plants (day to)				With plants (day to)	
S	0	15	30	45	S	30
CF 1	--	145.8142	136.6145	278.0589	CF 1	161.6209
CF 2	--	136.6145	133.1647	310.2576	CF 2	133.6749
CF 3	--	122.8151	129.7148	263.1095	CF 3	149.9767
CRH 1	--	127.4149	135.4646	303.3579	CRH 1	191.8957
CRH 2	--	127.4149	144.6642	252.7599	CRH 2	191.8957
CRH 3	--	138.9144	151.5639	221.7111	CRH 3	189.5668
P_0	51,5180	--	--	--	75:25 1	126.6884
--	--	--	--	--	75:25 2	122.0307
--	--	--	--	--	75:25 3	108.0578
--	--	--	--	--	50:50 1	129.0172
--	--	--	--	--	50:50 2	133.6749
--	--	--	--	--	50:50 3	126.6884
--	--	--	--	--	25:75 1	219.8416
--	--	--	--	--	25:75 2	226.8281
--	--	--	--	--	25:75 3	187.2380

Where the concentration is between (1.3747 - 1.8150) mg/L and (1.4348 - 1.9731) mg/L. This iron concentration is considerably reduced when compared to hydroponics without plants with a 30 day time variation. However, this concentration is still below the threshold for permitted irrigation iron concentration of (0.05-0.2) mg/L (Government Regulation No.82, 2001) (Table 5).

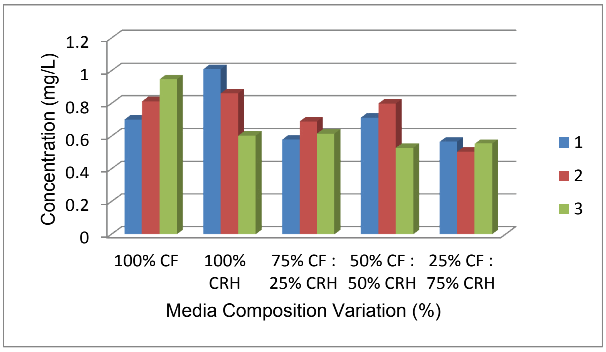


Fig. 4 Sulfide concentrations in media variations with kale plants.

Table 4. The mean concentration of sulfide in the variation of planting media composition (mg/L).

Media composition variation	Concentration (mg/L)
100% CF1	0.703
100% CF2	0.814
100% CF3	0.949
100% CRH1	1.011
100% CRH2	0.863
100% CRH3	0.604
75% CF: 25% CRH 1	0.580
75% CF: 25% CRH 2	0.691
75% CF: 25% CRH 3	0.617
50% CF: 50% CRH 1	0.715
50% CF: 50% CRH 2	0.801
50% CF: 50% CRH 3	0.530
25% CF: 75% CRH 1	0.567
25% CF: 75% CRH 2	0.506
25% CF: 75% CRH 3	0.555

Zinc Analysis

Samples in the zinc analysis were carried out the destruction process first, destruction performed using 65% nitric acid. 10 mL of the sample was

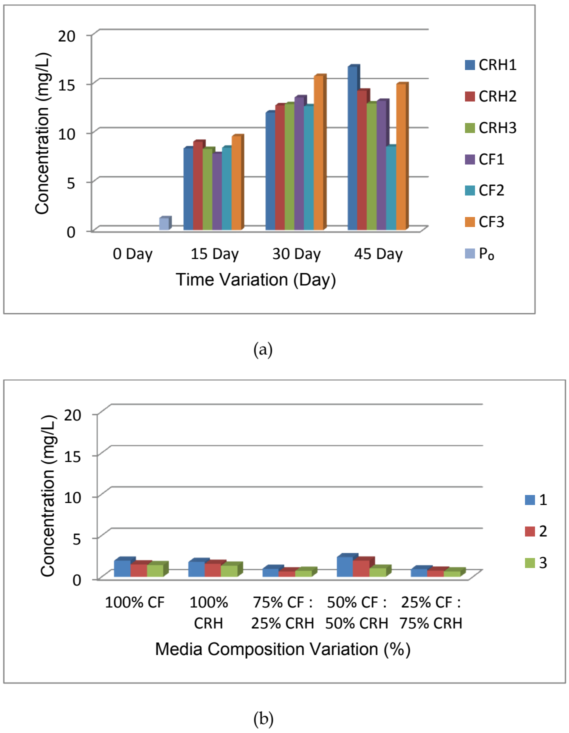


Fig. 5 (a) iron concentration on time variations without kale (B) iron concentrations in media variations with kale plants.

Table 5. Comparison of iron concentration in planting medium (mg/L).

	Without plants (day to) With plants (day to)				With plants (day to)	
S	**0**	**15**	**30**	**45**	**S**	**30**
CF 1	--	8.3284	11.9823	16.6582	CF 1	1.9731
CF 2	--	9.0104	12.7210	14.2133	CF 2	1.5254
CF 3	--	8.2827	12.8503	12.9200	CF 3	1.4389
CRH 1	--	7.7773	13.5268	13.1761	CRH 1	1.8150
CRH 2	--	8.4125	12.6140	8.50201	CRH 2	1.5956
CRH 3	--	9.5696	15.6957	14.8923	CRH 3	1.3747
P_0	1,2434	--	--	--	75:25 1	1.0031
--	--	--	--	--	75:25 2	0.6853
--	--	--	--	--	75:25 3	0.7450
--	--	--	--	--	50:50 1	2.4059
--	--	--	--	--	50:50 2	1.9866
--	--	--	--	--	50:50 3	1.0449
--	--	--	--	--	25:75 1	0.9494
--	--	--	--	--	25:75 2	0.7778
--	--	--	--	--	25:75 3	0.6868

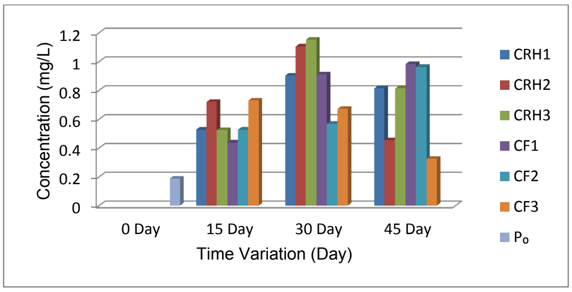
dissolved in 5 mL of nitric acid at 200^{0}C until a colorless solution was obtained. The nitric acid will dissolve the zinc present in the sample solution, and the water present in the sample will overflow leaving the zinc in the nitric acid solution.

The concentration of zinc in the remaining solution of fish food pellets used is still very high, for zinc between (0.9037 - 1.1545) mg/L on CF medium and (0.5694 - 0.9118) mg/L on CRH media at 30 days. Zinc concentrations are among the lowest when compared with other analysis parameters performed.

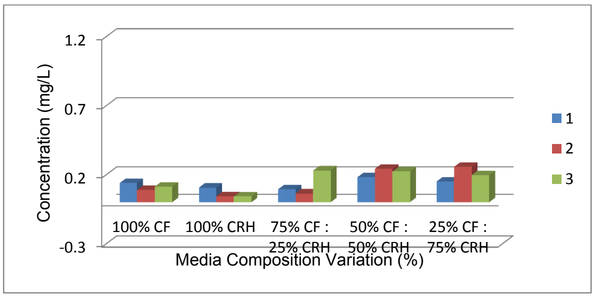
From (Fig. 6a and 6b), it can be seen that the zinc reduction process with the hydroponics system has been successfully performed, wherein the lowest concentration of zinc is present in CRH 100%, followed by CF 100%. Where the concentration is between (0.0900 - 0.1396) mg/L and (0.0430 - 0.1069) mg/L. The metal concentration of zinc is considerably reduced when compared to hydroponics without plants with a 30 day time variation. But in whole the zinc concentration is already included safe for aquaculture which limits the maximum concentration of zinc to water is 15mg/L (Government Regulation No.82, 2001). so the concentration of zinc contained in the solution does not harm the fish food pellets waters. However, it can be harmful if water is used for raw drinking water, where the maximum concentration of zinc for raw water according to (Eugene, 20009) is 0.05 mg/L (Table 6).

CONCLUSION

It can be concluded that the hydroponic axis system with the ground kale plant can be used to reduce the ammonia, phosphate, sulfide, iron and zinc content, in which the optimum time of the reduction process is obtained at a 30 day time variation of the hydroponics system . In the ammonia reduction and zinc process varieties of planting media CRH 100% and CF 100% are the media variations with the smallest ammonia concentrations when compared with other media variations. While in the phosphate reduction process, variation of planting medium is CF:CRH=75%: 25% and CF: CRH=50%: 50% is a media variation whose phosphate concentrations are the smallest when compared with other variations.



(a)



(b)

Fig. 6 (a) zinc concentration on time variations without kale (b) zinc concentration on media variations with kale plants.

Table 6. Comparison of zinc concentration on planting medium (mg / L).

	Wihout plants (day to) With plants (day to)				With plants (day to)	
S	**0**	**15**	**30**	**45**	**S**	**30**
CF 1	--	0.5279	0.9037	0.8143	CF 1	0.1396
CF 2	--	0.7206	1.1058	0.4557	CF 2	0.0900
CF 3	--	0.5253	1.1545	0.8141	CF 3	0.1147
CRH 1	--	0.4394	0.9118	0.9843	CRH 1	0.1069
CRH 2	--	0.5283	0.5694	0.9640	CRH 2	0.0450
CRH 3	--	0.7316	0.6728	0.3257	CRH 3	0.0430
P_0	0,1900	--	--	--	75:25 1	0.0955
--	--	--	--	--	75:25 2	0.0648
--	--	--	--	--	75:25 3	0.2320
--	--	--	--	--	50:50 1	0.1826
--	--	--	--	--	50:50 2	0.2435
--	--	--	--	--	50:50 3	0.2235
--	--	--	--	--	25:75 1	0.1517
--	--	--	--	--	25:75 2	0.2580
--	--	--	--	--	25:75 3	0.1979

For iron reduction process, variation of planting medium is CF: CRH=75%: 25% and CF: CRH=25%: 75% is a media variation whose phosphate concentrations are the smallest when compared with other variations. While in the analysis of sulfide concentration sulfide concentration is within the permissible limit range of concentration is (0.506 - 0.951) mg/L. In the analysis of ammonia, iron and phosphate concentrations are above the established threshold. While in the analysis of the concentration of sulfide and metal zinc is within the established threshold that is < 1 mg/L.

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