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Potential Utilization of Catfish Wastewater, Livestock Manure and Waste of Fish as Media and Nutrition for Organic Hydroponic

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ABSTRACT: This study aimed to determine the plant nutrient content in catfish culture wastewater added with cow dung, chicken manure, trash fish waste, and catfish waste; and to determine the growth of mustard greens and lettuce which were cultivated hydroponically in a growing medium of catfish wastewater added with cow dung, chicken manure, trash fish waste, and catfish waste. The results showed that the solution of catfish culture wastewater added with catfish waste contained nutrients N 220.0 ppm, P 166.3 ppm K 154.4 ppm Ca 65.9 ppm Fe 4.4 ppm; catfish culture wastewater added with trash fish waste contains 50.0 ppm N; P 10.8 ppm; K 173.4 ppm; Ca 219.4 ppm and Fe 3.2 ppm; catfish culture wastewater added with cow dung contained nutrients N 300.0 ppm, P 293.4ppm K 1026.8 ppm Ca 413.6 ppm Fe 64.9 ppm, while those given chicken manure included N 100.0 ppm; P 76.1 ppm; K 471.1ppm; Ca 299.9ppm and Fe 27.3ppm. While catfish culture wastewater contains 55.2 ppm of N nutrients; P 6.4 ppm; K 7.0 ppm; Ca 14.2 ppm; Fe 0.4 ppm. The growth of lettuce in the growing media of catfish culture wastewater given trash fish and catfish was relatively the same, namely 37.7% and 37.9%, respectively. Meanwhile, the growth of mustard pakcoy grown on planting media given chicken manure (47.6%) was higher than the growth of mustard pakcoy grown on cow dung (33.3%). The addition of 50% ABmix nutrients increased the growth of mustard pakcoy on media that was given chicken manure by 81.7%; pakcoy on media that was given cow dung waste by 74.8%; Meanwhile, the addition of ABmix 50% nutrients increased the growth of lettuce on media that was given catfish meal by 64.4%, and on media that was given trash fish meal by 61.9%. Research shows a high potential for using organic waste as a medium and source of organic hydroponic cultivation fertilizer.

Keywords: bioponic, livestock manure, nutrient

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INTRODUCTION

Organic Hydroponics combines hydroponic methods with organic farming, which is an effort to meet the needs of healthy food from organic farming systems but produced using a hydroponic system (Gioia and Rosskopf, 2021). In organic hydroponic farming, planting media given organic fertilizer are usually incubated before the media is used. Direct application of organic fertilizers into the planting media in an organic hydroponic system will damage plants (Shinohara et al., 2011). It is because organic fertilizers are phytotoxic due to the high organic matter content and the presence of NH_3 (Shinohara et al., 2011; Uchimura et al., 2014). To overcome this problem, planting media containing organic matter must first be processed in a particular biodigester installation as a place for culturing microorganisms to degrade organic matter, releasing nutrients, and then using the biodegraded solution as an organic hydroponic growing medium (Atkin & Nichols, 2004; Mackowiak et al., 1996).

Organic materials are good sources of organic nutrients, which contain complete and balanced essential minerals (Unnisa, 2015). Organic materials derived from plant and animal waste have been proven to be used as organic hydroponic nutrients and have a significant effect on plants (Nurrohman et al., 2014; Phibunwatthanawong & Riddech, 2019). Wastewater from catfish farming can be used as an alternative hydroponic growing medium (Handayani et al., 2020); Syam, et al. (2019). Liquid waste from catfish farming is organic waste from catfish cultivation in tarpaulin ponds, cement ponds, ponds, etc., fiber, and other cultivation activities. In 2014 catfish production reached around 900,000 tons, accompanied by an increase in waste generated (Andriyeni et al., 2017).

Animal waste and fish waste are widely used as a source of N nutrients in organic agriculture (Kuswoyo & Zein, 2018; (Fitriani et al., 2019); (Oviyanti et al., 2016). Cow dung contains nutrients N 2.33%, P_2O_5 0.61%, K2O 1.58%, Ca 1.04%, while chicken manure contains nutrients N 3.21%, P_2O_5 3.21%, K2O 1 ,57 %, Ca 1,57% (Andayani and La 2013). Fish meal bokashi is a source of phosphorus and calcium (Sundari et al., 2014). It contains 9.63% N and 3.26% P (Syukron, 2018). According to (Yolanda Septi et al., 2013), the organic matter of trash fish waste contains 7% nitrogen, while catfish waste has an N content of 11%.6 (Pangestika et al., 2021).

To increase the concentration and composition of nutrients in catfish farming wastewater, which will be used as an organic hydroponic growing medium. A study was conducted with the objectives: to determine the nutrient content in the media of catfish wastewater given cow dung, chicken manure, trash fish waste, and catfish waste; and to know the growth of pakcoy and lettuce plants that were cultivated hydroponically on catfish wastewater growing media which was given cow dung, chicken manure, trash fish waste, and catfish waste.

MATERIALS AND METHODS

The research was carried out at the hydroponic laboratory, Faculty of Agriculture, Sriwijaya University, Indralaya, Ogan Ilir, South Sumatra, from December 2020 to February 2021. The study consisted of two stages, namely the first stage of research was the experiment of adding organic matter to catfish cultivation wastewater to be used as a hydroponic growing medium, and the second stage of research was the experiment of using hydroponic growing media from catfish cultivation wastewater which had been enriched with organic matter in vegetable crops.

The organic materials used in the first research stage were trash fish, catfish waste, cow manure and chicken manure. The weight of the waste used is based on the need for N nutrient concentrations for standard hydroponic growing media, which is 200 mg/liter (Van patten, 2008), and the percentage of N nutrient content in each waste material, assuming that all N in the material will be mineralized during the incubation process. Based on these calculations, 2 kg of trash fish, 1 kg of catfish, 3.13 kg of cow dung, and 1.67 kg of chicken manure were used. Each ingredient is put into a bucket containing 50 liters of catfish culture wastewater. Then add 200 mL of biodecomposer EM4 and 200 g of granulated sugar, then stir until all ingredients are evenly mixed. The bucket containing the organic matter solution was incubated for four weeks by flowing air into the bucket through a hose connected to the aerator pump. The solution is ready to be used as a hydroponic growing medium, characterized by a brownish color and odorless. Furthermore, the nutrient content in the solution, Nutrient N, was analyzed by the Kjeldahl-Titrimetry method, P by the Spectrophotometry method, K by the Flamephotometry method, and Ca and Fe by the AAS method.

The second stage of the research consisted of two experiments. The first experiment tested a solution of catfish wastewater given trash fish waste and catfish as hydroponic growing media of lettuce (Lactuca sativa L.). The experiment consisted of 7 treatments of growing media types: A1: catfish wastewater; A2: catfish wastewater + trash fish; A3: catfish wastewater +catfish; A4 : catfish wastewater + ABmix 50%: A5 : catfish wastewater + trash fish + ABmix 50%; A6 : catfish wastewater + catfish + ABmix 50%; A7 : 100% ABmix solution.

The second experiment tested a solution of catfish wastewater given cow dung and chicken as hydroponic growing media for mustard pakcoy (Brassica rapa. L). The experiment consisted of 7 treatments of growing media: P1: catfish wastewater; P2: catfish wastewater + cow dung; P3: catfish wastewater + chicken manure; P4: catfish wastewater+ABmix 50%; P5: catfish wastewater + cow dung + ABmix 50%; P6: catfish wastewater + chicken manure + ABmix 50%; P7: 100% ABmixed solution.

The second stage of the experiment used the Completely Randomized Design (CRD) method, which was repeated three times, so there were 21 treatment units; each treatment unit was a 35 x 40 cm container containing 7 liters of planting media planted with nine vegetable crops. Seeds were sown using moistened rock wool, placed on trays, and maintained for seven days before being transferred. Seedlings were transferred to a Net Pot set on a Styrofoam panel with a spacing of 13 x 11 cm, which floated on a container containing planting media. The nutrient composition of the growing media solution was adjusted to the treatment. The solution was first diluted two times before being used as an organic hydroponic growing medium. The nutrient dose of ABmix 100% is 5 ml/liter, and ABmix 50% is 2.5 ml/liter of increasing media volume. The planting media is aerated by installing a hose connected to the aerator pump to circulate oxygen. Parameters observed were plant height, number of leaves per plant, root length, SPAD leaf chlorophyll (Soil Plant Analysis Development), fresh weight, and dry weight of plants. Data were analyzed using Analysis of Variance.

RESULTS AND DISCUSSION

Nutrient Content of Planting Media Incubated Solution

The nutrient content of the incubation solution is shown in table 1. The solution of catfish wastewater added with catfish waste contains nutrients N 220 ppm, P 166.3 ppm K 154.4 ppm Ca 65.9 ppm Fe 4.4 ppm on average about 93.6% of that required for standard hydroponic nutrients; while those given trash fish waste were N 50.0 ppm; P 10.8 ppm; K 173.4 ppm; Ca 219.4 ppm and Fe3.2 ppm, an average of about 53.2% of that required for standard hydroponic nutrients. The solution catfish culture wastewater added with cow dung contains nutrients N 300.0 ppm, P 293.4 ppm K 1026.8 ppm, Ca 413.6ppm Fe 64.9 ppm, about an average of 466.8% of those required for standard hydroponic nutrients; while those given the chicken manure contained N 100 ppm; P 76.1 ppm; K 471.1 ppm; Ca 299.9 ppm and Fe 27.3ppm, averaging about 197.6% of what is required for standard hydroponic nutrients. Wastewater from catfish cultivation contains 55.2 ppm of N nutrients; P 6.4 ppm; K 7.0 ppm; Ca 14.2 ppm; Fe 0.4 ppm or about 9.5% of standard hydroponic nutrients. Analysis of nutrient content in the solution of planting media is based on the relative value of nutrient content in each medium solution with nutrient content in 100% ABmix hydroponic standard media, commonly used in hydroponic cultivation systems. The analysis also showed that the order of the N and P nutrient content was indicated in cow dung media, followed by catfish waste and chicken manure. Trash fish waste and the lowest in catfish wastewater solution. Nutrient K was highest in catfish wastewater added with cow dung, chicken manure, trash fish, and catfish waste and was lowest in catfish wastewater. The highest Ca nutrient was in catfish wastewater given cow dung and chicken manure, while the highest Fe was in catfish wastewater given cow dung and chicken manure, trash fish and catfish waste, and catfish wastewater solution.

Table 1. Nutrient Content of Media Given Catfish wastewater, Trash fish, Cow dung, and Chicken Manure

Treatment	ABmix*		Catfish wastewater		+ Trash fish		+ Patin fish waste		+ Cow dung		+ Chicken manure	
Nutrient	(ppm)	%	(ppm)	%**	(ppm)	%**	(ppm)	%**	(ppm)	%**	(ppm)	%**
N	250	100	55.2	22.1	50.0	20.0	220.0	88.0	300.0	120.0	100.0	40.0
P	80	100	6.4	8.0	10.8	13.5	166.3	207.9	293.4	366.8	76.1	95.1
K	300	100	7.0	2.3	173.4	57.8	154.4	51.5	1026.8	342.3	471.1	157.0
Ca	200	100	14.2	7.1	219.4	109.7	65.9	33.0	413.6	206.8	299.9	150.0
Fe	5	100	0.4	7.8	3.2	64.8	4.4	87.8	64.9	1298.0	27.3	545.8
		100		9.5		53.2		93.6		466.8		197.6

* Van Patten, G.F. 2008. Gardening Indoor with soil and Hydroponics. Van Patten Publishing the Fifth Edition. ISBN-13:978-1-878823-32-8. New York.

** Percentage of nutrient content ABmix

The planting medium used in the plant experiment was the incubation solution which had been diluted two times so that the concentration was only 50% of the nutrient concentration in the incubation solution. Based on the calculation results, the concentration of each nutrient in the planting media for the experiment is shown in Tables 2 and 3. When compared with those required for hydroponic standards, the average concentration of nutrient availability in the growing media for catfish wastewater without organic matter is 9.5 %; media that was given trash fish waste was 26.6%; catfish 46.8%, chicken manure 98.8%; and 233.4% cow dung waste. The concentration of the media given ABmix 50% nutrients was the nutrient in the catfish water planting medium was 59.5%; those given trash fish waste were 76.6%, catfish 96.8%, chicken manure waste 148.8 %; and 283.4% cow dung waste.

Table 2. Concentration of nutrients in lettuce experimental media

Treatment	ABmix*		Catfish wastewater		Trash fish		Patin fish waste		Abmix 50%		Trash fish + ABmix50%		Patin fish waste + ABmix50%	
Nutrient	(ppm)	%	(ppm)	%	(ppm)	%	(ppm)	%	(ppm)	%**	(ppm)	%**	(ppm)	%**
N	250	100	55.2	22.1	25.0	10.0	110.0	44.0	180.2	72.1	150.0	60.0	235.0	94.0
P	80	100	6.4	8.0	5.4	6.8	83.1	103.9	46.4	58.0	45.4	56.8	123.1	153.9
K	300	100	7.0	2.3	86.7	28.9	77.2	25.7	157.0	52.3	236.7	78.9	227.2	75.7
Ca	200	100	14.2	7.1	109.7	54.8	33.0	16.5	114.2	57.1	209.7	104.8	133.0	66.5
Fe	5	100	0.4	7.8	1.6	32.4	2.2	43.9	2.9	57.8	4.1	82.4	4.7	93.9
Average %		100		9.5		26.6		46.8		59.5		76.6		96.8

*Van Patten, G.F. 2008. Gardening Indoor with soil and Hydroponics. Van Patten Publishing. The Fifth Edition. ISBN-13:978-1-878823-32-8. New York.

Table 3. The concentration of nutrients in pakcoy experimental media

Treatment	ABmix*		Catfish wastewater		Cow dung		Chicken manure		Catfish wastewater + ABmix50%		Cow dung + ABmix50%		Chicken manure + ABmix500%	
Nutrient	(ppm)	%	(ppm)	%	(ppm)	%	(ppm)	%	(ppm)	%	(ppm)	%	(ppm)	%
N	250.0	100.0	55.2	22.1	150.0	60.0	50.0	20.0	180.2	72.1	275.0	110.0	175.0	70.0
P	80.0	100.0	6.4	8.0	146.7	183.4	38.0	47.5	46.4	58.0	186.7	233.4	78.0	97.5
K	300.0	100.0	7.0	2.3	513.4	171.1	235.5	78.5	157.0	52.3	663.4	221.1	385.5	128.5
Ca	200.0	100.0	14.2	7.1	206.8	103.4	150.0	75.0	114.2	57.1	306.8	153.4	250.0	125.0
Fe	5.0	100.0	0.4	7.8	32.5	649.0	13.6	272.9	2.9	57.8	35.0	699.0	16.1	322.9
Average %		100.0		9.5		233.4		98.8		59.5		283.4		148.8

*Van Patten, G.F. 2008. Gardening Indoor with soil and Hydroponics. Van Patten Publishing. The Fifth Edition. ISBN-13:978-1-878823-32-8. New York.

Pakcoy plant growth on catfish wastewater media given a cow and chicken manure

The development of height and number of leaves from 1 week of age to the age of 4 weeks of pakcoy plants grown on planting media that was given a cow and chicken dung is shown in Figure 1.

Plant height: Pakcoy's size increased linearly to the 3rd week in all treatments, then sloped until the 4th week. The height of pakcoy at the last observation, the 4th week, was significantly different between treatments (table 4). The average plant height of pakcoy ranged from 9.26 cm in the cow waste treatment to 23.8 cm in the 100% ABmix treatment and an average of 17.4 cm.

The number of leaves: pakcoy leaves increased linearly up to week four on ABmix100% treatment (P7), catfish water waste media with cow and chicken dung, and ABmix 50% (P4, P5, and P6). In the media with cow dung (P2), leaves only increased until the 2nd week, while on catfish water media and chicken manure media, leaves were raised until the 3rd week. The number of pakcoy leaves in the last week ranged from 6.54 - 14.63 leaves, with an average value of 11.5 leaves (table 4)

Leaf Greenness Level SPAD: The mean SPAD value was 31.8, ranging from 23.34 on cow waste media to 41.1 on 100% ABmix media. There was no significant difference between treatments of catfish water, cow waste, and chicken waste. Between treatments of catfish water, cow waste, and chicken waste given ABmix 50%, ABmix 100% did not differ from cow waste and chicken waste given ABmix 50%.

Root Length: The average root length of pakcoy ranged from 15.67 cm in cow waste media to 37.56 cm in ABmix100% media, with an average value of 17.4 cm. The root length of plants growing on media with cow manure and chicken manure, without or after adding 50% ABmix, was not significantly different. The 100% ABmix treatment was not very different from the catfish water treatment, chicken waste, and chicken that were given 50% ABmix,

Fresh weight: Fresh weight of pakcoy plants ranged from 3.33-70.42 g, with a mean value of 31.6 g. The 100% ABmix treatment was different from all other treatments. The treatment of catfish water waste and cow and chicken waste was not further. Between treatments given, ABmix50% was not significantly different but distinct from other treatments. The treatment of catfish wastewater and chicken waste is given ABmix50% was not very different, but different from the treatment of cow waste.

Dry Weight: The average dry weight of pakcoy plants is 2.5 g, ranging between 0.43 g in cow waste media and 4.39 g in 100% ABmix. There was no significant difference between the dry weight of plants with media given cow waste and chicken waste; between catfish wastewater treatments, cow waste and chicken waste given ABmix 50% also did not differ. The 100% ABmix treatment was no different from the chicken waste media treatment that was given 50% ABmix. The dry weight of plants grown on media with cow manure and chicken manure, without or with the addition of 50% ABmix, was relatively not significantly different.

As a summary of the results, the various growth parameters of mustard pakcoy plants grown on catfish wastewater growing media that were given chicken manure was higher than that of pakcoy fed with cow waste. However, the nutrient content in media with cow dung was higher than in media with chicken manure. The number of pakcoy leaves increased linearly up to week four on plants growing on optimal nutrient media (ABmix 100%), increasing linearly up to week two on nutrient-deficient media such as media with cow dung. The plant height and the number of leaves of pakcoy grown on media that was given cow dung without (P2) or with the addition of 50% ABmix (P5) were lower than the plant height and number of pakcoy leaves that grew on chicken manure without (P3). Or with the addition of 50% ABmix (P6). The growth rates of pakcoy in the media that were given chicken and beef waste without adding 50% ABmix were 47.6% and 33.3%, respectively; and in the conditions, given the addition of ABmix, 50% were 81.7 and 74.8%. Statistically, the two treatments were significantly different in the parameters of plant height and number of leaves.

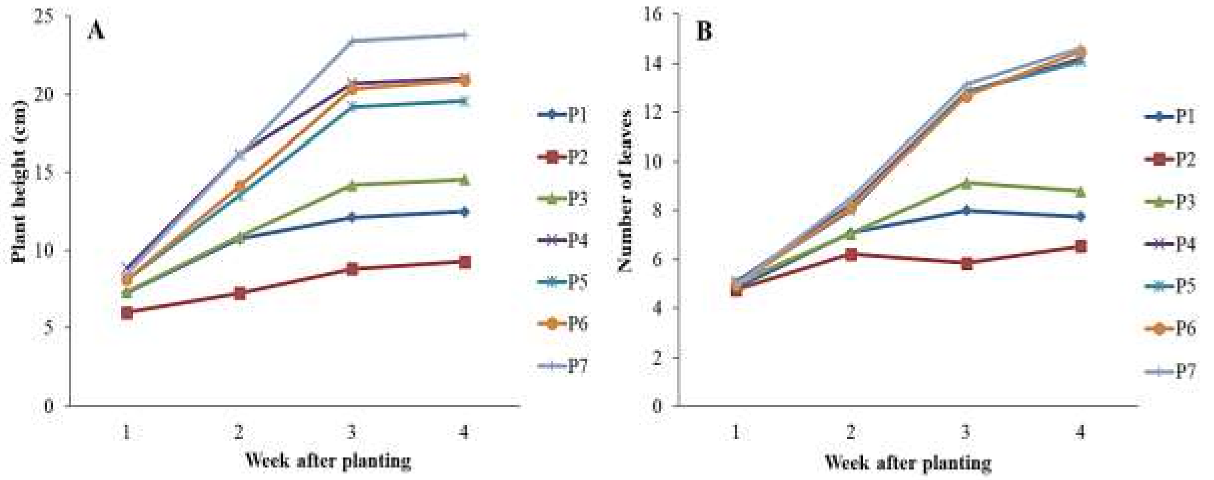

Figure 1. Plant height (A) and the number of leaves (B) of pakcoy grown in a solution of catfish culture waste given cow dung and chicken manure.

Table 4. Effect of Hydroponic Media on Growth Pakcoy

Source of nutrition hydroponic media	Growth Parameters					
	Plant height (cm)	Number of leafs	SPAD	Length of roots (cm)	Fresh of wight (g)	Dry of wight (g)
Catfish wastewater	12.49b	7.75ab	24.96a	21.22a	6.42a	1.0a
Trash fish	9.26a	6.54a	24.76a	15.67a	3.33a	0.43a
Patin fish waste	14.56bc	8.79b	23.34a	26.33ab	7.29a	1.19a
Catfish wastewater +ABmix50%	21.04d	14.21c	35.01b	27.33ab	49.58c	3.3b
Trash fish +ABmix50%	19.55d	14.09c	36.68bc	19.44a	39.13b	3.24b
Patin fish waste + ABmix50%	20.88d	14.5c	37.07bc	24.33ab	45.21b	3.69bc
ABmix 100%	23.8e	14.63c	41.11c	37.56b	70.42d	4.39c
LSD 5%						

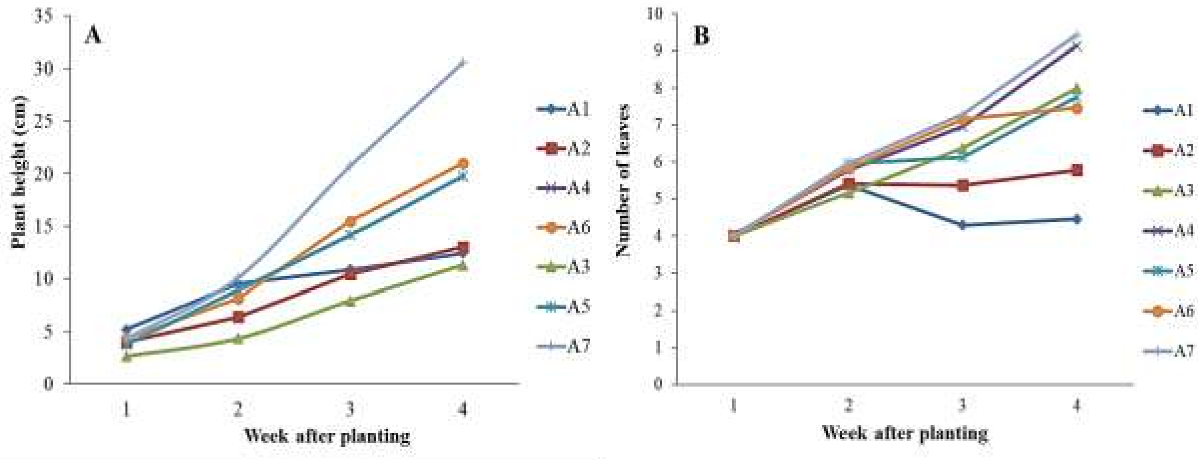

Figure 2. Plant height (A) and the number of leaves (B) of lettuce in a solution of catfish wastewater trash fish and catfish waste.

Table 5. Effect of Hydroponic Media on Growth lettuce

source of nutrition hydroponic media	Growth Parameters					
	Plant height (cm)	Number of leafs	SPAD	Length of roots	Fresh of wight	Dry of wight
Catfish wastewater	12.44ab	4.46a	13.91a	8.11a	2.75a	0.26a
Trash fish	13.03ab	5.79ab	12.37a	15.89bc	4.04a	0.3a
Patin fish waste	11.30a	8.00cd	16.43ab	7.67a	4.59a	0.28a
Catfish wastewater +ABmix50%	27.37cd	9.13cd	23.23bc	20.55cd	39.25c	1.88bc
Trash fish +ABmix50%	19.76bc	7.75cd	23.30bc	13.33ab	26.38b	1.19ab
Patin fish waste + ABmix50%	20.99c	7.46bc	24.20bc	12.33ab	29.46bc	1.41bc
ABmix 100%	30.61d	9.42d	28.73c	26.67d	60.54d	2.38c
LSD 5%						

Lettuce Plant Growth in Hydroponic Media added Trash fish and Patin fish waste

The development of height and number of lettuce leaves from 1 week of age to the age of 4 weeks planting on media that was given trash fish and catfish waste is shown in Figure 2.

Plant Height: The growth of lettuce plant height in all treatments increased linearly until 4 weeks; the highest plant height rate was in ABmix100% (P7) and the media of given catfish trash with ABmix 50%. At four weeks of observation, the mean lettuce plant height reached 19.36 cm, with a range of 12.44 cm in catfish water media to 30.61 cm in 100% ABmix media. Based on statistical tests, the ABmix 100% treatment was different from all other treatments except for the catfish water waste media, which was given ABmix 50%

The number of leaves: The number of lettuce leaves increased linearly until the 4th week on 100% ABmix media, and catfish water media gave 50% ABmix. Until week three, the number of leaves on catfish waste media, which was given to 50% ABmix was relatively high. Still, at week four, it was no different from that grown on trash fish media given 50% ABmix and catfish waste media. In the last observation (Table 5), the number of lettuce leaves ranged from 4.46 to 9.42, with an average value of 7.43. Based on statistical tests, the relative treatments of ABmix were not significantly different.

Leaf Greenness Level (SPAD): The greenish level of lettuce leaves ranged from

12.37 on media treated with trash fish to 28.73 on ABmix100% media with an average value of 20.31. Based on statistical tests, all treatments were not significantly different.

Root length: The mean lettuce root length was 14.94 cm., with a range of 7.67 cm on catfish media to 26.67 cm on ABmix100. There was no significant difference between treatments.

Fresh weight: Fresh weight ranged from 2.75-60.54 g, with a mean value of 23.86 g. Statistical tests show that the ABmix 100% treatment differed from all other treatments. The treatment of catfish wastewater, media with trash, and catfish was not significantly different. Between catfish wastewater treatments and media with catfish given ABmix50% were not very other, between media with catfish waste and trash fish waste shown with ABmix50% were also not significantly different.

Dry Weight: The average dry weight of lettuce was 1.1 g, ranging from 0.26 g on catfish water media to 2.38 g on 100% ABmix media. Furthermore, statistical tests show no significant difference between treating catfish wastewater and media with trash and catfish waste. Between catfish wastewater, media with trash, and catfish waste added with ABmix 50%. Treatment of ABmix 100% did not differ from media with catfish waste and catfish wastewater given with ABmix 50%.

As a summary of the results, the number of leaves and root length of lettuce plants grown in the media given trash fish and catfish were significantly different. At the same time, it was not significantly different among other growth parameters. Lettuce growth in media with catfish was higher than in media with trash fish. The treatments of media with trash fish and media with catfish were only significantly different in the parameters of the number of leaves and root length, for other growth parameters were not very different. The growth rate of lettuce in the media given catfish and trash fish waste without adding 50% ABmix was 37.9% and 37.7%, respectively; when they were given ABmix50%, it increased to 64.4% and 61.4%, respectively.

DISCUSSION

There is potential for using catfish wastewater as an organic hydroponic growing medium. Still, because the nutrient content is shallow, to increase the nutrient content of catfish wastewater, the use of catfish wastewater as a hydroponic planting medium requires the addition of fertilizer. This study shows the potential for organic waste from animal and fish waste to be used as a source of fertilizer to increase the nutrient content of organic hydroponic growing media. Organic waste in catfish culture water comes from feces, urine, and leftover feed not eaten by fish suspended in pond water (Syam et al., 2019). The liquid waste contains a variety of nutrients that come from the remains of feed and catfish manure. In this study, the nutrient content of catfish wastewater contained 55.2 ppm N; P 6.4 ppm; K 7.0 ppm; Ca 14.2 ppm; Fe 0.4 ppm. The nutrient content is shallow compared to previous studies containing 600 ppm nitrogen, 2.115 ppm phosphorus, 22.21 ppm potassium, and 32.25 ppm calcium (Gustiar et al., 2020). Research by Andriyeni et al. (2017) reported that catfish wastewater contained 0.98-1.67% nitrogen, 1.89-3.40% phosphorus, 0.01-1.03% potassium, and 32.25 ppm calcium. Based on the research of Kuswoyo and Zein (2018), hydroponic media of catfish wastewater given goat urine in a ratio of 10: 1 resulted in the growth of height and weight of Mustard Pakcoy (*Brassica rapa* L.) plants were no different from those that were growing in the media for catfish wastewater given ABmix 100%, even though the yield of the plant has not matched the product of 100% ABmix nutrition.

Organic waste material from livestock and fish waste can potentially be a source of macro and micronutrients needed for organic Hydroponics. The results showed that the N and P content in the growing media was the highest in media given cow dung, followed by media given catfish and chicken manure, and the lowest was in media given trash fish. This media-given catfish waste contained nutrient P quitely high, two times the nutrient P required. Media given cow dung produces macronutrients N, P, and Ca 2-3 times that plants need and contains micronutrients Fe 13 times that plants require. The incubated solution given animal dung had higher K, Ca, and Fe nutrients than the one given fish waste. The wastewater from catfish farming I added with cow manure, chicken manure, catfish waste, and trash fish waste, each containing an average of 466.8% nutrients; 197.6%, 93.6%, and 53.2% of the nutrients needed for hydroponic plant growth; while the water from catfish farming contains 9.5% of the required standard nutrients.

The content and composition of inorganic nutrients resulting from the mineralization of organic matter by microorganisms during aerobic incubation differ, depending on the type of organic matter used. The efficiency of the mineralization process of organic nitrogen, which is the ratio between the amount of N in organic matter and N in solution after incubation, is an indicator of the ability of microorganisms to break down organic N into simpler inorganic N nutrients (N-NH4 or N-Nitrate) in a solution that plants can absorb. (Khronis, Marie. 2020).

It is reported that nutrients contained in cow manure are N 2.33%, P2O5 0.61%, K2O 1.58%, Ca 1.04%, while in chicken manure are N 3,21 %,, P2O5 3.21%, K2O 1.57%, Ca 1.57% (Andayani; & La, 2013). According to (Yolanda Septi et al., 2013), trash fish waste contains 7% nitrogen, while catfish waste contains 11% nitrogen (Pangestika et al., 2021).

Based on the study's results, it was found that the highest efficiency of the mineralization was in cow dung waste at almost 100%, catfish at 87%, and chicken manure and trash fish waste at around 40%. According to (Shinohara et al., 2011), mineralization into nitrate from fish-based organic matter is different from plant-based biomass, organic nitrogen in fish-based biomass cannot directly decompose into nitrate, so the efficiency of mineralization of fish waste is lower than that of livestock and plant waste.

The addition of 50% ABmix nutrients increased the availability of nutrients in the media to 76.6% in media-added trash fish, 96.8% in media-added catfish, 148.8% in media-added chicken manure, and 283.4% in media-added cow dung relative to the standard nutrient concentration of 100% ABmix. This experiment showed that adding inorganic nutrients 50% ABmix to organic growing media resulted in leaf number, SPAD value, and plant dry weight were not significantly different from the number of leaves, SPAD value, and dry weight of plants grown on 100% ABmix standard media.

This experiment showed that adding 50% ABmix inorganic nutrients to organic growing media resulted in leaf number, SPAD value, and plant dry weight, which were not significantly different from the number of leaves, SPAD value, and dry weight of plants grown on 100% ABmix standard media. This fact shows that the nutrient needs of organic hydroponic plants cannot be fully met from organic fertilizers because they must add 50% abmix; the results of this study imply that the use of ABmix inorganic fertilizers in Hydroponics can be reduced by adding organic fertilizers which are incubated first in the growing media. The results of this study are in line with various studies that confirm that organic fertilizers can substitute ABmix between 15-50% as reported on shallots by (Anshar & Yusuf, 2021) on green spinach (*Amaranthus* sp.) and red spinach (*Alternanthera ficoides*) (Ayuana, 2020); on lettuce (*Lactuca sativa* L.) (Tomenes et al. 2017, Shodik, 2020); on Caisim plants (*Brassica juncea* L.) and (Marginingsih et al., 2018)

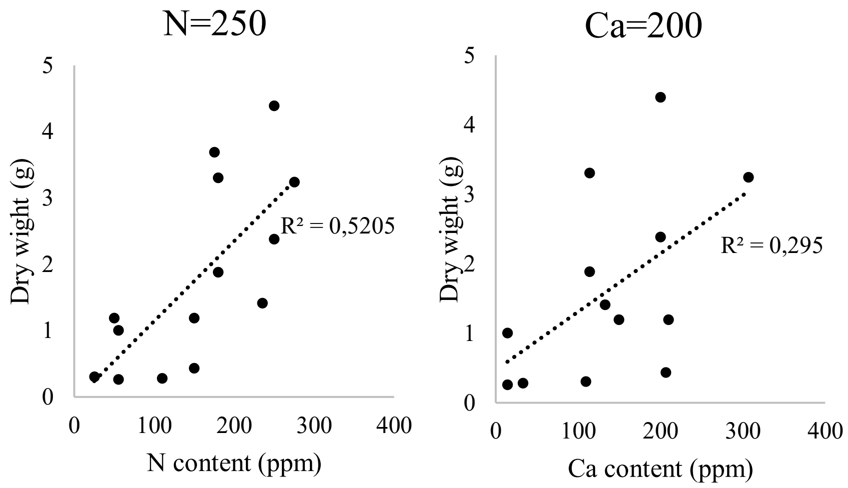

Figure 3. N and Ca nutrient concentrations correlate in hydroponic growing media with pakcoy and lettuce dry weight.

The application of organic fertilizers directly into organic hydroponic growing media is reported to have a phytotoxic effect due to too high concentrations of organic matter and the presence of toxic compounds such as NH3 and certain nutrients (Uchimura et al., 2014). In this experiment, the indirect application of cow dung into growing media produced enough P, K, and Fe nutrients, inhibiting plant growth. At the same time, the mineralization of trash fish and chicken manure provided a low ratio of nutrients to meet the essential minerals needed by plants. Based on the data of nutrient content in media and dry weight growth, a response curve of the relationship between nutrient concentrations of N, Ca, P, K, and Fe in hydroponic growing media with a dry weight of mustard pakcoy and lettuce can be made as shown in Figure 4 and Figure 5. According to Marschner (1990). There are three response ranges for the relationship between nutrient availability in the planting medium and dry weight, namely the deficient range, where the plant growth rate increases with increasing nutrient supply; the adequate range, where the growth rate reaches its maximum point; and after that, it relatively remains unaffected by nutrient supply, and the third range is the toxic range, where growth rate decreases with increasing nutrient supply

The graph of the relationship between N and Ca nutrient concentrations in media with plant dry weight shows that up to 300 ppm, plant dry weight is still in the short-range where dry weight growth increases linearly and has not reached saturation point. According to (Van patten, 2008), the average nutrient concentration requirements of N and Ca in standard Hydroponics are 250.0 ppm: 200.0 ppm; The reality of this study shows that N and Ca are the two nutrients needed in large quantities in the growing media, but the concentration of these two elements is relatively low in organic matter such as to catfish trash fish meal waste. Furthermore, based on the response curve of the supply of P, K, and Fe nutrients in hydroponic growing media with the dry weight of mustard greens and lettuce, it is also known that P. K and F nutrients have critical levels of deficiency of 80 ppm, 300 ppm, and ten ppm. The range is approx. 80-160 ppm, 300-600 ppm, 10-25 ppm, the critical level of toxicity is 160 ppm, 600 ppm, 25 ppm. According to (Van patten, 2008), the average requirement for hydroponic nutrient concentrations of P: 80.0 ppm; K:300.0; and Fe: 5.0 ppm.

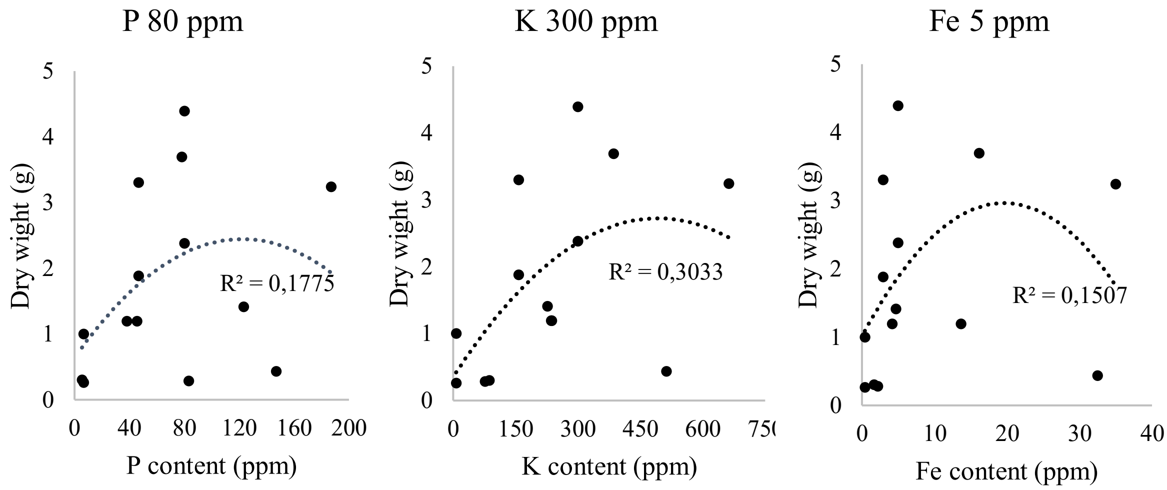

Figure 4. P, K, and Fe nutrient concentrations correlate in hydroponic media with the dry weight of pakcoy and lettuce plants.

The treatment of catfish waste in the planting medium resulted in higher lettuce plant growth than in the planting medium with trash fish. It probably happened because the N content in the media that was given catfish waste was higher than the media that was given trash fish. In the case of planting media that was given cow dung waste, although the N of the growing media on the media with cow dung was higher than the N of the growing media given chicken manure, the plant growth was lower; this is probably because the media with cow waste contained very high micronutrients Fe, namely 64.9 ppm or 1298 % of the standard requirement for Hydroponics, so that plant growth is retarded as a result of the plant experiencing Fe toxicity. Fe is a micronutrient that plays an essential role in various metabolic and biochemical processes of plants, such as DNA synthesis, respiration, and photosynthesis. Elemental Fe is a prosthetic group and cofactor of many enzymes, such as cytochromes of the electron transport chain. It is involved in the biosynthesis and maintenance of the structure and function of chlorophyll (Rout & Sahoo, 2015). The average iron concentration for hydroponic cultivation is 2.7 - 5 mg·L-1; above 5.0 mg·L-1 is toxic (Dorlodot et al. 2005), the best iron concentration for hydroponic growth of tomato plants is 0.6 mg L-1 (Ejraei, 2013)

CONCLUSION

The results showed that the concentration of nutrients N, P, K, Ca, and Fe in the solution resulting from the mineralization of organic matter was not ideal for optimally supporting the growth of organic hydroponic plants. Planting media that was given catfish waste contained about 93.6% of nutrients; trash fish waste 53.2%; cow dung 466.8%; 197.6% chicken manure and catfish wastewater only 9.5% relative to standard hydroponic nutrient concentrations. The growth of lettuce on the growing media given trash fish meal and catfish was relatively the same, namely 37.7% and 37.9%, respectively. Meanwhile, the growth of mustard pakcoy on media that was given chicken manure was 47.6% higher than that of cow manure, which was 33.3%. The addition of 50% ABmix nutrients increased growth in the media, giving chicken manure waste to 81.7%, higher than the change in the media-given cow dung, which is 59.1%. The growth of lettuce on growing media given catfish waste increased to 64.4%, higher than trash fish media (61.9%). Research shows the potential for cultivating vegetable crops using nutrient solutions derived from organic matter, although growth is slower than growing in media with conventional inorganic nutrients.

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