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INCREASED PRODUCTIVITY OF PEAT SOIL PONDS WITH BIOFERTILIZER TECHNIQUES AND NITROGEN FIXING BACTERIA AND EARTHWORMS AS DECOMPOSER ORGANISMS

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ABSTRACT

The main objective of this study was to determine the best biofertilizer kinds in order to improve productivity of peatland ponds, especially primary productivity. Three main treatments, human feces, cow feces and chicken feces biofertilizer, and control were to peat soil ponds in a completely randomized design and each treatment was replicated three times. The ponds of peat soil were fertilized two weeks before treated as biofertlizer of 750 gm-2 (0.75 kg m-2). The peat soil ponds were fertilized two weeks before prior to observation, and each dose of biofertlizer is 750 gm^{-2}*. Water physico-chemical parameters (such as temperature, turbidity, nitrate, phosphate, pH, DO (dissolved oxygen), ammonia, turbidity, C organic and phosphorus) were determined once a week for the duration of the experiment. Phytoplankton in the different treatments were enumerated once every 2 days. The relationship between phytoplankton communities and the water physico-chemical parameters were evaluated using PCA (Principal Component Analysis). The PCA indicated that the physico-chemical variables which best explain the distribution of phytoplankton were temperature, nitrate, phosphate, pH, DO (dissolved oxygen), and N total. Phytoplankton abundance was highest in human feces biofertilizer (P1) because the optimum nutrient conditions for the growth of phytoplankton were found in this treatment. The control was associated with one phytoplankton taxa, Macrophyceae. All the kinds of biofertilizers used have low Coliform and E. coli. And Azotobacter sp. developed ring the fermentation and earthworm (Lumbricus sp.) iIn each kinds of feces. Biofertilizer of human feces had the higest total Azotobacter sp. than other biofertilizer.*

KEYWORDS: *Productivity, peat soil, biofertilizer, phytoplakton, water physico-chemical parameters*

I. INTRODUCTION

The use of organic manure in fertilizing fish ponds is an age old tradition in Asia and it is well established in many parts of the world to augment primary productivity (Syafriadiman, 1999; Knud-hansen *et al*., 1991). Organic manure/feces is less expensive than chemical fertilizers. Animal feces has a long history of use as a source of soluble phosphorus, nitrogen and carbon for phytoplankton growth. It is often used in earthen ponds to improve primary production and fish growth (Terziyski *et al*., 2007; Kang'ombe *et al*., 2006; Syafriadiman *et al*., 2005). An increase in nutrient content provides favorable conditions for phytoplankton production.

Phytoplankton as well as microorganisms responsible for mineralization of organic matter, serves as a food source for zooplankton. Moreover, it increases biomass of zooplankton and benthic organisms which are important as natural fish food. In organically manured ponds, the organic matter is degraded by aerobic bacteria into carbon dioxide and ammonia (Syafriadiman, 2016; Syafriadiman *et al*., 2005). Phytoplankton will utilize the carbon dioxide. During photosynthesis, the algae will produce oxygen which will sustain fish, zooplankton and phytoplankton (Syafriadiman, 2014). Phytoplankton represent a major food source for fish in ponds.

Feces of chicken, cow and human biofertilizer are some of the most readily available organic manure in Riau Province (Syafriadiman *et al*., 2015). The potential of these organic manures to enhance fish production has not been fully exploited. There appears to have been some limited interest in using organic manure for aquaculture in peat land (Syafriadiman *et al*., 2005; Schroeder, 1974). The results from these studies were promising renewed interest in aquaculture. Indonesia's new interest in capture fisheries at KKP (Ministry of Marine Affairs and Fisheries) and Strategic Plan of Fisheries and Strategic Framework of National Aquaculture. Both these documents highlight the importance of increasing aquaculture productivity, profitability and sustainability. Peatland is quite extensive but very poor nutrients and low pH, cause high acidity (Agus, 2009; Parish *et al*., 2007; Noor, 2001; Suherman *et al*., 2000; Harjowigeno, 1996). Use of biofertilizer organic can increased inland aquaculture productivity in peat land if the right kinds of manure, in correct dosages, is applied in ponds stocked with suitable fish species.

Previous, the research focused more on the growth rate of the fish rather than the food items generated after the appli-cation of the manure. Furthermore, in recent times attention has focused on the possibility of fish cultured in ponds fertilized with animal manure as sources of human pathogenic bacteria (Ampofo and Cleck, 2010; Novotny *et al*., 2004). It has been reported that half of the microorganisms recovered from fish and water of ponds fertilized with animal manure were members of the family Enterobacteriaceae (Mandal *et al*., 2009). Reports of the occurrence of pathogenic strains of *E. coli* from fishery resources are also on the increase (Ampofo and Cleck, 2010; Mandal *et al*., 2009).

This study will investigate the total heterotrophic bacterial count, total coli-form count, *E. coli* count and *Azotobacter* sp count in the human, cow and chicken biofertilizer. *E. coli* is an important water quality indicator and its presence in water indicates a potential risk to consumers. Fish do not carry *E. coli* internally since they are not warm blooded. However, the water that covers the fish could contain *E. coli*. Since *E. coli* is found in the feces of warm blooded animals it is prudent to determine the *E. coli* count for each kinds of biofertilizer. Bacillus includes both free-living and pathogenic species. In organically manured ponds *Azotobacter* sp plays an important role in the breakdown of organic detritus (*Ali et al*., 2011).

A fish pond with good water quality and low nutrient content results in low fish yields. Such as the peat soil ponds which poor water quality, low nutrient content and low pond productivity. Therefore, the main objective of this study was to investigate the effect of biofertilizer from human feces, cow feces and chicken feces, which its be given bacteri of Nitrogen (*Azotobacter* sp) fixation and decomposer organisms (earthworms) to productivity (water quality, phytoplankton abundance) in peat soil pond.

II. MATERIALS AND METHODS

2.1. Experimental setup

The research was conducted outdoors at the peat soil ponds precisely on the oil palm plantation owned by residents in the village of Kualu Nenas Kecamatan Tambang, Kampar, Riau. Twelve units of peat soil ponds and each filled with water ± 7000 $L.pond^{-1}$ to determine the influence of human feces, cows feces and chickens feces of biofertilizer on the productivity of ponds, water quality and microbes. Water ponds was used the water well drill. The treatments of this research were human feces biofertilizer (human feces + Azotobacter $7.88x10^9$ $cfu.ml^{-1}.m^{-2}$ + earthworm 1.2 $kg.m^{-2}$)(P1), cow feces biofertilizer (cow feces + Azotobacter $7.88x10^9$ $cfu.ml^{-1}.m^{-2}$ + earthworm 1,2 $kg.m^{-2}$(P2), and chicken feaces biofertilizer (chicken feaces + Azotobacter $7.88x10^9$ $cfu.ml^{-1}.m^{-2}$ + earthworm 1,2 $kg.m^{-2}$)(P3), and control (P0).

Peat soil ponds were given lime CaCO3 a week before biofertilizer was introduced (pond bottom peat soil pH ≈ 7, and sampling parameters to find out the initial condition of the research). Biofertilizer is made from human feces (P1), cow (P2) and chicken (P3), by fermentation using *Azotobacter* bacteria as nitrogen-fixing, and then worm *Lumbricus* sp as decomposer organism. The experimental peatland pond filled well water drill, and was left for a week before the biofertilizer application. The three biofertilizer treatments and controls were performed on the research ponds using Completely Randomized Design (RAL) and each treatment was replicated three times. Peatland farms were fertilized with biofertilizer one week before the observation (to ensure the production of phytoplankton and other organisms such as bacteria) at the application level of 0.75 $kg.m^{-2}$ (Syafriadiman, 2015; Syafriadiman *et al*., 2010). The study runs from May 15 to December 08, 2016.

2.2. NPK analysis of biofertilizer used

Sampling the human (P1), cow (P2) and chicken feces biofertilizer (P3) and control (P0) were collected were analysized of NPK and was performed prior to application into the research pond. All bio-chemical analyses were done on a dry matter basis using standard methods (AOAC, 2003). The analysis of dry matter was done by drying pre-weighed samples in an oven at 105 LC for about 16 h to reach a constant weight. Nitrogen was analyzed using the Kje-dahl method and phosphorus and potassium analyzed using spec-trophotometry.

2.3. Water quality monitoring

Temperature (^{o}C), turbidity (NTU), pH, and DO (dissolved oxygen) (mg.L^{-1}) were measured in situ, using a Horiba U23 multiprope (Horiba, Osaka, Japan). Readings were recorded once a week at 09.00-10.00 WIB and 16.00-17.00 WIB. Water samples from each treatment were analyzed for ammonia (mg.L^{-1}), nitrate (mg.L^{-1}), total nitrogen (%), phosphate (mg.L^{-1}), phosphorus (%) and potassium (%) once a week, using standard methods as described by APHA (1985).

2.4. Plankton enumeration

Water samples for primary production were collected once a week from all treatments in 500 mL glass bottles and phytoplankton samples were taken with a 30 μm net plankton. The samples were preserved in 5% formalin and 2,5% lugols. The phytoplankton was identified under a light microscope at a magnification of 100 at a volume of 250 mL using a phytoplankton identification manual by Botes (2003). The phytoplankton is identified to the level of genera and species. This is done to find out the phytoplankton groupings that are tolerant of high organic content in peatlands. This is done to find out phytoplankton groups that are tolerant of high organic content in peatlands. Enumeration of phytoplankton was done using a counting chamber. The counting chambers were made of Plexiglas and had a polished bottom for best transparency.

2.5. Microbial analysis

Feces, biofertilizer and peat samples were collected, and analyzed to determine total heterotrophic bacterial counts, total coliform counts, *Escherichia coli* and *Azotobacter* sp count. Total coliforms were incubated at 37^{o}C for 24 hours. *E. coli* was incubated at 44^{o}C for 24 h, while total bacterial count were incubated for 48 h at 30^{o}C. All the bacterial media were obtained from Sigma and Aldrich Ltd., Pretoria

2.6. Statistical analysis

The water quality parameters, phytoplankton abundance and chlorophyll a concentration were subjected to one-way analysis variance (ANOVA) at the significance level ($p < 0.05$) using Statistical Package and Service Solutions (PC SPSS version 22 and XLstat). The data was tested for normally using the Shap-iro-Wilk normality test. PCA (Principal Component Analysis) is a direct gradient analysis used to examine the relationships between the measured variables and the distribution of communities (Braak and Šmilauer, 2012). It was therefore used to determine the relationship between water quality parameters with phytoplankton. The data was log $_{(x+1)}$ transformed to stabilize the variance and the statistical package CANOCO 5 was used. Monte-Carlo permutation tests were used to test the statistical significance of forward selected variables. The significant contribution of these variables to the ordination was tested at ($P < 0.05$).

III. RESULTS

Human feces biofertilizer (P1) had the highest nitrogen, phosphorus, and potasium (NPK) content than other biofertilizer (Table 1). Chicken feces biofertilizer (P3) exhibited the lowest nutrient concentrations. Cow feces biofertilizer (P2) shows the lowest NPK concentration. The different NPK concentrations significantly affected some water quality parameters. Nitrogen, phosphorus and potassium were significantly higher ($P < 0.05$) in human feces biofertilizer peat soil pond (Table 2). Peat soil pond fertilized with cow feces biofertilizer (P2) and chicken feces biofertilizer (P3) showed higher levels of nitrogen, phosphorus and potassium in comparison to the control (P0) (Table 2). Primary production was also significantly higher ($P<0.05$) in human feces biofertilizer (P1) than in the other treatments. Cow feces biofertilizer (P2) treatment was more turbid than the other treatments. There were significant differences in phytoplankton abundance between treatments ($p<0.05$). The highest abundance of phytoplankton in the treatment of human feces biofertilizer (P1) compared to other treatments while the control has the lowest abundance. Cyanophyceae was the taxa that occurred in all the treatments and numerically dominated the flora (Table 3). Macrophyceae is found only in controls (without biofertilizer). Apart from Cyanophyceae, seven other phytoplankton classes recorded a low abundance. However, overall the highest abundance of phytoplankton was found in human feces biofertilizer (P1) (84,717 indL^{-1}) and the lowest in control treatment (P0) (22,650 indL^{-1}) (Table 3).

Proximate composition (%) of the organic manure applied in aquadams.

Table 1. Composition Nitrogen, Phosphor dan Potasium (%) of feces, biofertiizer, and peat soil used during study

Material analyzed	Main Elements of Fertilizer						Reference
	Nitrogen (%)		Phosphor (%)		Potassium (%)		
	Feces	Biofertilizer	Feces	Biofertilizer	Feces	Biofertilizer	
Human (P1)	4,75±0,03	7,17±0,01	2,61±0,06	6,06±0,01	1,01±0,03	2,91±0,04	This Research
Cow (P2)	1,07±0,04	2,16±0,04	0,63±0,01	2,73±0,03	0,63±0,08	1,70±0,09	This Research
Chicken (P3)	2,52±0,06	3,65±0,03	3,08±0,06	4,01±0,04	1,35±0,02	2,08±0,03	This Research
Peat soil (P0)	0,89±0,12	-	0,09±0,02	-	0,06±0,03	-	This Research
Human	5,00-7,00	-	3,00-5,40	-	1,00-2,50	-	Rahayu and Wijayanti, 2008
Cow	1,31	-	0,14	-	0.60	-	Rapadsa and Moyo (2013)
Chicken	2,75	-	3,64	-	1,81	-	Rapadsa and Moyo (2013)
Cow	1,65	-	0,50	-	2,3	-	Manik (1994)
Chicken	1,00	-	0,80	-	0,40	-	Lingga (1986)
Peat soil	0,83-1,67	-	0,03-0,37	-	-	-	Alhaddad, A. (2012)

Table 2. The mean ± SE of major physico-chemical parameters analyzed for water quality of the different treatments

Parameters	Unit	Treatment			
		Control (P0)	Human feces Biofertilizer (P1)	Cow feces Biofertilizer (P2)	Chikken feces Biofertilizer (P3)
Temperature	(^{0}C)	28,9±0,1	27,8±0,3	28,0±0,0	27,8±0,3
Turbidity	(NTU)	81,3±1,8	79,6±1,1	81,0±0,64	81,1±0,5
Nitrate	(mg.L^{-1})	3,772±0,177	9,560±0,390	9,260±0,0569	8,782±0,166
Phosphate	(mg.L^{-1})	2,067±0,083	6,328±0,173	5,250±0,025	5,343±0,124
pH		3,8±0,1	6,2±0,1	6,0±0,1	5,9±0,1
DO	(mg.L^{-1})	3,23±0,277	4,10±0,289	3,75±0,221	3,85±0,162
Ammonia	(mg.L^{-1})	0,037±0,003	0,045±0.000	0,045±0,000	0,053±0,003
C organic	(%)	73,69±2,25	64,84±7,65	66,70±5,49	64,54±6,80
N total	(%)	1,41±0,03	2,62±0,22	1,83±0,03	1,55±0,04
C/N		52,3±2,0	25,4±5,6	36,7±2,5	41,8±4,2
Abundance	(no.L^{-1})	22650±393	84717±1637	51850±2485	50100±1811
Clorophyl a	(mg.L^{-1})	0,878±0,073	0,998±0,072	1,030±0,059	0,930±0,056

Table 3. The mean ± SE of phytoplankton abundance (no.L-1) in the different treatments

No.	Class	Treatment			
		Control (P0) (ind.L^{-1})	Human feces Biofertilizer (P1) (ind.L^{-1})	Cow feces Biofertilizer (P2) (ind.L^{-1})	Chikken feces Biofertilizer (P3) (ind.L^{-1})
I	Bacillariophyceae	1.100±64	5.950±269	5.600±269	7500±258
II.	Chlorophyceae	6.950±87	28.417±379	14.750±992	13.650±379
III.	Chrophyceae	700±24	900±65	50±6	50±7
IV.	Cyanophyceae	12.350±168	38.000±746	25.117±913	18.450±812
V.	Euglenophyceae	500±17	2.400±117	1.800±210	950±143
VI.	Macrophyceae	250±9	0±0	0±0	0±0
VII.	Protozoa	650±16	9.000±56	7.150±88	8.750±201
VIII	Xanthophyceae	150±8	50±5	50±7	750±11
	Total	22.650±393	84.717±1637	54.517±2485	50.100±1811

PCA was used to detect patterns of hytoplankton genera distribution in relation to water physico-chemical parameters. In the PCA ordination, axes F1 and F2 explain 94.54% in the species phytoplankton environment plot (Fig. 1, Table 4). Axes F1 represented mainly total N, DO (Dissolved Oxygen), pH, phosphate, nitrate, temperature and chlorophyll a (Table 5). Axes F2 represented ammonia and turbidity (Table 5). Along the axis of the turbidity lays the phytoplankton class chrophyceae and this was associated with cow feces biofertilizer (P2). Cyanophyceae, Euglenaphyceae and Chlorophyceae on the other hand were on the N total axis and this is associated with human feces biofertilizer (P1) (Figure 1). Furthermore, the distribution of Protozoa and Bacillariophyceae were in the DO (dissolved oxygen), pH, nitrate and phosphate associated with human feces biofertilizer (P1) (Fig. 1). The distribution of phytoplankton was numerically dominated by Cyanophyceae classes in all treatments (Figure 2). Heterotrophic bacterial counts vary nonsignificantly in biofertilizer treatment (Table 7). Treatment of human feces biofertilizer (P1) has a high total coliform count.

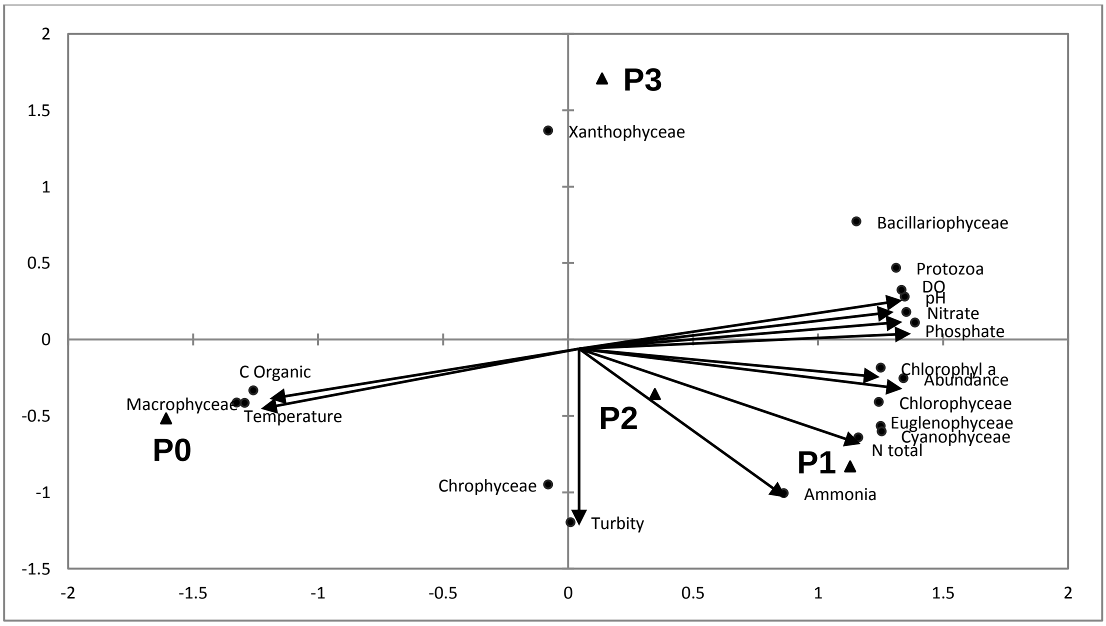

Fig 1. PCA plot of the relationship between water quality parameters and phytoplankton in human feces biofertilizer (P1), cow feces biofertilizer (P2), chicken feces biofertilizer and control (P0) treatments

Table 4. Eigenvalues of the correlation matrix of the species-environment relation

	F1	F2	F3
Eigenvalue	8,323	2,076	0,600
Variability (%)	75,667	18,875	5,458
Cumulative %	75,667	94,542	100,000

Table 5. The correlation matrix of phytoplankton–water quality relation

Parameters	Axes F1	Axes F2	Axes F3
Abundance	0,650	0,204	0,732
Chlorophyl a	**0,851**	0,481	0,210
Temperature	**-0,940**	0,053	-0,338
Turbidity	-0,150	**0,987**	-0,057
Nitrate	**0,935**	0,159	0,316
Phosphate	**0,872**	0,114	0,476
pH	**0,945**	0,076	0,317
DO	**0,824**	-0,128	0,551
Ammonia	0,338	**0,866**	0,369
C Organik	-0,715	0,239	-0,657
N total	**0,848**	0,359	0,391

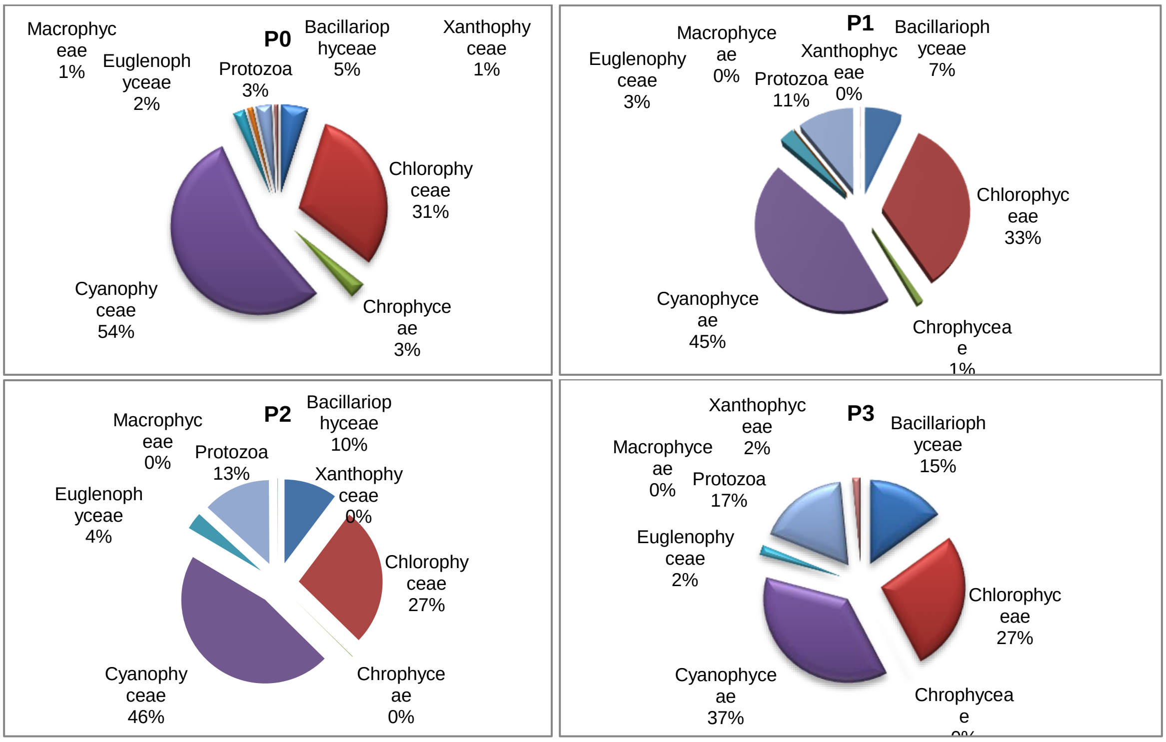

Fig 2. Comparison of phytoplankton abundance according to treatment during the study

Table 6. Summary of Principal Component Analysis (PCA) (r>0,8)

PC	Treatments	Name of Variabels	Loading Factors	Variance described
P1	Human feces biofertilizer	Chlorophyl-a	0,851	75,670
		Temperature	-0,940	
		Nitrat	0,935	
		Phosphat	0,872	
		pH	0,945	
		DO	0,824	
		N total	0,848	
P2	Cow feces biofertilizer	Tubidity	0,987	18,87
P3	Chicken feces biofertilizer	N total	0,848	5,46

Table 7. Total microorganisms in each feces and biofertilizer used during the study

Microba	Control	Humans		Cow		Chicken	
		Feces	Biofertilizer	Feces	Biofertilizer	Feces	Biofertilizer
Total of colony bacterial (cfu/g)	$0,7 \times 10^5$	$1,0 \times 10^{11}$	10^5	96	50	89	93
Total of coliforms (coloni/100 ml)	$0,2 \times 10^5$	$0,3 \times 10^7$	+	155	+	78	+
E. coli counts (coloni/100 ml)	78	$1,5 \times 10^5$	+	$1,95 \times 10^3$	+	+	+
Azotobacter sp. (coloni/100 ml)	$6,5 \times 10^7$	+	$1,8 \times 10^7$	+	$0,2 \times 10^5$	+	$2,1 \times 10^5$

Note : + = no. <1/100

IV. DISCUSSION

Human feces biofertilizer (P1) had the best NPK composition, this is why it produced a higher abundance of phytoplankton, than chicken feces biofertilizer (P3), cow feces biofertilizer (P2) and control (P0). NPK are normally the limiting nutrients and were highest in human feces biofertilizer (P1) and these results are consistent with Adewumi *et al*. (2011); Kang'ombe *et al*. (2006); Syafriadiman (2012); dan Syafriadiman (2015).

Cow feces biofertilizer (P2) was the worst performing manure in relation to phytoplankton. This is because cows are ruminants and the food ingested is digested more than once, therefore most of the nutrients are taken up in the body with little left in the feces (Edwards *et al*., 2000; FAO, 1985). Human and chicken are monogastric animals and the food is digested once. Most of the nutrient content of feed given to human is voided as feces waste (FAO, 1985; Perkins *et al*., 1964). These nutrients are thought to stimulate the primary productivity resulting in high abundance (Syafriadiman, 2015; Jha et al., 2008; Piasecki et al., 2004).

Than, the nutrients also stimulate plankton production (Jha *et al*., 2008; Piasecki et al., 2004). Chicken feces biofertilizer (P3) was the lowest biofertilizer associated with phytoplankton abundance, and this was different with Rapadsa and Moyo (2013) according the chicken manure was the best fertilizer than cow manure and pig manure. Furthermore, it was reported that cow manure was the least fertilizer associated with phytoplankton abundance. Human feces biofertilizer (P1) had the best nutrient composition; this is why it produced higher plankton abundances.

The position of Cyanophyceae (blue-green algae) approaches the center of the ordinate plot, and its correlation is low with physico-chemical water parameters. Phytoplankton under this Cyanophyceae tolerant to changes and different environmental conditions. Brunberg and Blomqvist (2006) and Furusato *et al*. (2004) reported phytoplankton Cyanophyceae is tolerant of poor environmental conditions. Furthermore, Syafriadiman *et al* (2010) reported the phytoplankton Cyanophyceae is highly tolerant of decreasing and increasing phosphate and N total on peat soil media.

The phytoplankton under Cyanophyceae class very much researched on peatland, that this phytoplankton is dominan in peatsoil ponds (Syafriadiman, 2012, 2015; Kya Wavour et al., 2006;

Wade and Stirling, 1999). The Cyanophyceae phytoplankton showed a high abundance in each fertilized with biofertilizer. Human feces biofertilizer (P1) was the best, and its use can increase the phytoplankton abundance in peat soil pond, and its had nutriens high.

Generally, the phytoplankton was a high corelated to all physico-chemical parameters, except turbidity. Phosphates were a high corelated to phytoplankton under Bacillariophyceae, Chlorophyceae, Cyanophyceae, Euglenophyceae, Macrophyceae, and Protozoa, and correlated with the human feces biofertilizer (P1). Abundance and chlorophyll-a were also high, and associated with phosphate, nitrate, temperature, and pH. Also, pytoplankton abundance highly associated with DO, C organic and N total (Table 8). N total, phosphate and nitrate, producing high nutrients suitable for phytoplankton production (Syafriadiman *et al*., 2010).

Table 8. A summary of the strong relationship between physico-chemical parameters and phytoplankton (primary productivity) (r> 0.8) during the study

	Physico-chemical Parameters Relationship							
No.	Phosphat	Nitrat	Temperature	pH	DO	C Organic	N total	Ammonia
1	Bacillariophyceae	Bacillariophyceae	Bacillariophyceae	Bacillariophyceae	Bacillariophyceae	Bacillariophyceae	Bacillariophyceae	Euglenophyceae
2	Chlorophyceae	Euglenophyceae	Macrophyceae	Macrophyceae	Chlorophyceae	Chlorophyceae	Chlorophyceae	
3	Cyanophyceae	Macrophyceae	Protozoa	Protozoa	Macrophyceae	Macrophyceae	Cyanophyceae	
4	Euglenophyceae	Protozoa	Abundance	Abundance	Protozoa	Protozoa	Euglenophyceae	
5	Macrophyceae	Abundance	Chlorophyl-a	Chlorophyl-a	Abundance	Abundance	Abundance	
6	Protozoa	Chlorophy-a						
7	Abundance							
8	Chlorophyl-a							

The planktons under Macrophyceae and Protozoa were highly correlated (r> 0.8) with temperature, pH and DO and C organic. The distribution of Chlorophyceae in biofertilizer-based ponds is strongly associated with concentration phosphate, DO, C and N and it associated with human feces biofertilizer (P1). Euglenaphyceae was high associated with ammonia (Table 8). Distribution of Bacillariophyceae was a high corelated with all physico-chemical parameters, except turbidity. According to Samsudin (1992) that the distribution Bacillariophyceae or Diatome has a wide distribution, and was found in many inundations, trenches, ponds, rivers, lakes, and is widely distributed in marine waters. Syafriadiman (2012) reported the abundance of diatoms is high in containers fertilized with human feces. The distribution of Bacillariophyceae was high associated with the availability of nutrients, especially phosphate, nitrate, temperature, pH, DO, C organic and N total and it was a low associated with ammonia (Table 8).

Phosphate fluctuations in peatland ponds were highly related to the phytoplankton under Bacillariophyceae, Chlorophyceae, Cyanophyceae, Euglenophyceae, Macrophyceae, and Protozoa, and it was a associated with human feces biofertilizer (P1). Then, the abundance of phytoplankton and chlorophyll-a is high correlated with phosphate, nitrate, temperature, and pH parameters.

During of this research, the abundance of phytoplankton was a high corelated to DO, organic C and N total (Table 8). N total, phosphate and nitrate were source and nutrient suitable for the production of phytoplankton (Syafriadiman et al., 2010; Syafriadiman, 2012; 2014; 2015). Macrophyceae and protozoa were high corelated to temperature, pH, DO and organic C soil. Chlorophyceae distribution was also high corelated to the total phosphate, DO, C and N and it was highly associated with human feces biofertilizer (P1). Euglenaphyceae was high related to ammonia (Table 8). The increased abundance of phytoplankton leads to high primary production and also a moderate increase in chlorophyll-a. This is obviously, the development of phytoplakton as the primary productivity in this research were caused by factors of water quality parameters, such as fluctuations of phosphate, nitrates, DO, C, N total, and ammonia.

The highest consentration of chlorophyll-a was obtained in ponds fertilized with human feces biofertilizer, and were dominated of the phytoplankton under class of Chlorophyceae, Cyanophyceae and Bacillariophyceae and averaged of all treatments. This kinds of phytoplankton were found in most freshwater habitats including lakes, ponds, creeks and rivers (Samsudin, 1992). Distribution of the species of the most abundant Cyanophyceae class were founded in peatland ponds on the fertilization with human feces biofertilizer (P1).

The feces cow biofertilizer (P2) has the second highest abundance and the lowest abundance in the control (P0). The low abundance of phytoplankton were due to the physico-chemical factors of water quality, zooplankton and benthic fauna feed on the phytoplankton, and nutrient content factors. According Rapadsa and Moyo (2013), that the abundance of phytoplankton of low greatly influenced by zooplankton, as well as various water quality parameters (Kan-g'ombe et al., 2006; Syafriadiman et al., 2010; Syafriadiman, 2012; 2015). Copepods are usually the dominant zooplankton fauna and are the main food organisms for small fish (Kan-g'ombe et al., 2006).

The abundance of heterotrophic bacteria, Coliforms and E. coli in the feces of human and control at the beginning is quite high, especially in human feces (P1) and peat (P0). However, the abundance of microbes was decreased after fermented with the bacteria Azotobacter sp, and was given the earthworm (Lumbricus sp.) decomposers organisms. The abundance of Coliforms and E. coli in all biofertlizer was less than 1/100 mL. When biofertilizer is applied to peat soil ponds, the availability of Azotobacter sp is high enough to cause high total N levels in each biofertilizer.

The human feces biofertilizer was more productive, and which is indicated by a much higher plankton abundance than other treatments. Cow feces biofertilizers have lower heterotrophic bacterial counts and these results were consistent with those found by El-Dakar et al., 2004; Jha et al., 2008; Kumar et al., 2006; Salton and El-Laithy, 2008; Zaki et al., 2011; Rapadsa and Moyo, 2013).

Azotobacter sp is efficient as a nitrogen-fixation microbe. This may explain that human feces biofertilizer (P1) has a high phosphorus content. In addition, it can improve water quality, reduce ammonia levels and enhance immune function and anti-oxidation activity (Shalaby, 2011; Qi et al., 2009; Zakaria et al., 2011).

V. CONCLUSION

Fertilization of peatland pools produces the primary productivity of phytoplankton groups. Biofertilizer of human feces treatment produced more primary pruductity abundance (phytoplankton) than chicken and cow because of its superior nutrient content. This biofertilizer also had the highest Azotobacter sp. count, the low coliform count coliform and E. coli (1.8 x 108 cfu.g-1) count.

For future studies the key question that must be answered is whether all the phytoplankton groups that were produced after application of biofertilizer are desirable for the production of fish food. There is thus a need to evaluate the phytoplankton that is most desirable in fish production. It is recommended that fish farmers in Riau use uman feses biofertilizer to enhance fish production in their farms, so that peatlands can be utilized either through extensification or intensification of business.

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REFERENCES

[1]. Adewumi, A.A., Adewumi, I.K., Olalege, V.F., 2011. Livestock waste-menace: fish wealth-solution. Afr. *J. Environ. Sci. Technol*. (5), 149–154.

[2]. Agus, F. 2009. Carbon reserves, greenhouse gas emissions and peatland conservation. Proceeding of Dies Natalis Seminar, Brawidjaya University 46. January 31, 2009. Malang.

[3]. Alhaddad, A. 2012. Canges of Nitrogen (N) and Phosphor (P) Nutrient of Peatland In Long-Affected Processing. *Jurnal Pedon Tropika.* 1(1), 1-9.

[4]. Ali, M.S., Abas, T., and Wafa, M.I.A. 2011.. Evaluation of Azotobacter and Azospirillum Biofertilizers as a Probiotics in *Oreochromis niloticus* Aquaculture. *J. Bot*., 43(6): 2707-2710.

[5]. American Public Health Association (APHA), 1985. *Standards Methods for Examination of Water and Waste Water*, 16th ed. Washington DC, USA.

[6]. Ampofo, J.A., Cleck, G.C., 2010. Diversity of bacteria contaminants in tissues of fish cultured in organic waste-fertilized ponds: health implications. *Open Fish Sci. J*. 3, 142–146.

[7]. Botes, L., 2003. Phytoplankton Identification Catalogue – Saldanha Bay, South Africa. GloBallast Monograph Series. No. 7. IMO, London, UK, pp. 77.

[8]. Bowen, S.H., 1982. Feeding, digestion and growth-qualitative considerations, in: Pullin, R.S.V., Lowe-McConnell, R.H. (Eds.), *The Biology and Culture of Tilapias*, IC-LARM Conf. Proc. 7, Manila, pp. 141–156.

[9]. Braak C.J.F. and Šmilauer P. (2012). *Canoco reference manual and user's guide*: software for ordination, version 5.0. Microcomputer Power, Ithaca, USA, 496 pp.

[10]. Brunberg, A., Blomqvist, P., 2006. Benthic overwintering of Microcystis colonies under different environmental conditions. *J. Plankton Res.* 24 (11), 1247–1252.

[11]. Edwards, D.R., Larson, B.T., Lim, T.T., 2000. Runoff nutrient and fecal coliform content from cattle manure application to fescue plots.*J. Am Water Resour. Assoc.* 36 (4), 711–721.

[12]. El Dakar, A.Y., Hassanien, G.D.I., Seham, S., Gad, S.E., Sakr, S., 2004. Use of medical and aromatic plants in fish diets: I. Effect of dried marjoram leaves on performance of hybrid tilapia Oreochromis niloticus Oreochromis aureus, fingerlings. *J. Egypt. Acad. Soc. Environ. Dev.* (B.Aquaculture) 5 (1), 67–83.

[13]. Food and Agricultural Organisation of the United Nations (FAO), 1985. *Training Manual Integrated Fish Farming in China*. NACA/TR/85/11. FAO, Bangkok, Thailand, pp. 371.

[14]. Furusato, E., Asaeda, T., Manatunge, J., 2004. Tolerance for prolonged darkness of three phytoplankton species, Microcystis aeruginosa (Cyanophyceae), Scenedesmus quadricauda (Chlorophyceae) and Melosira ambigua (Bacillariophyceae). *Hydrobiologia* (527), 153–162.

[15]. Hardjowigeno, S. 1996. Peatland development for agriculture is an opportunity and challenge. Scientific Oration of Professor of Permanent Soil Science Faculty of Agriculture IPB.22 June 1996.

[16]. Hopkins, K.D., Cruz, E.M., 1982. *The ICLARM-CLSU Integrated Animal–Fish Farming Projects*: Final report. ICLARM Technical, Report No. 5, pp. 96.

[17]. Hossain, Y., Begum, M., Ahmed, Z.F., Hoque, A., Karim, A., Wahab, A., 2006. A study on the effects of iso-phosphorus fertilizers on plankton in fish ponds. *South. Pac. Stud.* (26), 101–110.

[18]. Jha, P., Barat, S., Nayak, C.R., 2008. Fish production, water quality and bacteriological parameters of Koi carp ponds under live-food and manure based management regimes. *Zool. Res*. 29 (2), 165–173.

[19]. Kang'ombe, J., Brown, J.A., Halfyard, L.C., 2006. Effect of using different types of organic animal manure on plankton abundance, and on growth and survival of Tilapia rendalli (Boulenger) in ponds. *Aqualt. Res*. (37), 1360–1371.

[20]. Knud-hansen, C.F., Batterson, T.R., McNabb, C.D., Harabat, I.S., Sunantadinata, K., Eidman, H.M., 1991. Nitrogen input, primary productivity and fish yield in fertilized freshwater ponds in Indonesia. *Aquaculture* (94), 49–63.

[21]. Kumar, R., Mukherjee, S.C., Prasad, K.P., Pal, A.K., 2006. Evaluation of Bacillus subtilis as a probiotic to Indian major carp Labeo rohita. *Aqualt. Res.* (37), 1215–1221.

[22]. Mandal, S.C., Hasan, M., Rahman, M.S., Manik, M.H., Mahmud, Z.H., Sirqjul Islam, M.D., 2009. Coliform bacteria in Nile Tilapia, Oreochromis niloticus of shrimp- gher ponds and fish market. *World J. Fish Mar. Sci.* 1 (3), 160–166.

[23]. Noor, M. 2001. Peatland Agriculture Potential and Constraints. Kanisius Publisher. Jakarta.

[24]. Novotny, T., Dvorska, L., Lorencova, A., Beran, V., Pavlik, I., 2004. Fish: a potential source of bacterial pathogens for human beings. *Vet. Med. Czech* 49 (9), 343– 358.

[25]. Pamungkas, R. dan Syafriadiman. 2015. Effect of fecal fertilizer on Physical-Chemical Parameter Change on Peat Land Media. Faculty of Fisheries and Marine Sciences. Riau University.

[26]. Parish, F., A. Sirin, D. Charman, H. Joosten, T. Minayeva, M. Silvius, dand L. Stringer (eds). 2007. Assesment on peatlands, biodiversity and climate change, Main Report. *Global Environment Centre, Kuala Lumpur and Wetlands International*, Wageningen.

[27]. Perkins, H.F., Parker, M.B., Walker, M.L., 1964. Chicken manure – its production, composition and use as a fertilizer. Georgia Agricultural Stations. University of Georgia, *College of Agriculture Bulletin N.S 123*, pp. 24.

[28]. Prinsloo, J.F., Schoonbee, H.J., 1986. Summer yield of fish in polyculture in Transkei, South Africa, using pig manure with and without formulated feed. *S. Afr. J. Anim. Sci.* (16), 65–71.

[29]. Qi, Z., Zhang, X., Boon, N., Bossier, P., 2009. Probiotics in aquaculture of China – current state, problems and prospect. *Aquaculture* (290), 15–21.

[30]. Rapadsa, M. and N.A.G. Moyo. 2013. Performance evaluation of chicken, cow and pig manure in the production of natural fish food in aquadams stocked with Oreochromis mossambicus. *J. Physic and Chemistry of the Earth* (66), 68-74. Homepage:www.elsevier.com/locate/pce.
[31]. Salton, M.A., El-Laithy, S.M.M., 2008. Effect of probiotics and some spices as feed additives on the performance and behaviour of Nile tilapia, Oreochromis niloticus. *Egypt. J. Aquat. Biol. Fish.* 12 (2), 63–80.
[32]. Schroeder, G.L., 1974. Use of fluid cowshed manure in fish ponds. *Bamidgeh* 26 (3), 84.
[33]. Sen, B., Sonmez, F., 2006. A study on the algae in fish ponds and their seasonal variations. *Int. J. Sci. Technol*. (1), 25–33.
[34]. Shalaby, E.A., 2011. Prospects of effective microorganisms technology in waste treatments in Egypt. Asian. *Pac. J. Trop. Biomed.* (3), 243–248.
[35]. Sverdrup, K.A and Armbrust, A.V. 2008. *An Introduction to The World's Oceans – Ninth Edition*. New York: McGraw-Hill.
[36]. Syafriadiman, Saberina, Niken, A.P. 2005. Basic Principles Water Quality Management. MM Press. Pekanbaru. 132 hal. 2005.
[37]. Utilization of Human Feses for the development of *Azolla microphylla* in peat soils. *J. Terubuk*. 32-2, 12-24.
[38]. The utilization of liquid organic fertilizer contains microbial on chemical parameters of peat water quality and phytoplankton abundance. *J. Ilmu Kelautan*. 7, 33-45.
[39]. The utilization of *Azolla microphylla* as neutralizing pH and DO (dissolved oxygen) in a controlled peat soil medium tank. Center for Research and Development of Natural Resources. United Riau Foundation, Riau Province. Pekanbaru. 59 p.
[40]. S. Harahap, N.A. Pamukas, dan Y. Hamidy. 2010. The influence of liquid organic fertilizer of contains microbial to physico-chemical parameters of peat water quality from Rimbo Panjang Village, Kampar district, Riau. Research Institute, University of Riau. 189 p.
[41]. Condition of Peat Water Quality which is given human feces manure. (Biological, Physical and Chemical Review for Aquaculture in Peatlands). Center for Research and Development of Natural Resources. United Riau Foundation, Riau Province. Pekanbaru. 180 p.
[42]. Biology, Toxicology and Culture of Oyster, *Crassostrea irredalei*. *Ph.D Thesis*. School of Graduate Studies. National University Malaysia. 428 p.
[43]. Terziyski, D., Grozev, G., Kalcher, R., Stoeva, A., 2007. Effect of organic fertilizer on plankton primary production in fish ponds. *J. Aqualt. Int.* (15), 181–190.
[44]. Wade, J.W., Stirling, H.P., 1999. Fertilization of earth ponds. II: Effects on plankton communities. *J. Aquat. Sci.* 14, 13–18.
[45]. Zakaria, Z., Gairola, S., Shariff, N.M., 2011. Effective Microorganisms (EM) technology for water quality restoration and potential for sustainable water resources and management, In: *International congress on environmental modelling and software modelling for environment's sake*. Fifth Biennal meeting, Ottawa, Canada, pp. 80.
[46]. Zaki, M.A., El-Nakiel, F.A.M., Labib, E.M.H., 2011. *Sustainable Environmental Development for Fish Aquaculture by Using Effective Microorganisms (EM) as a Probiotic*. EMRO Co., Ltd., Monririh Building, 3F SOi Sailom, Phahonyothin Rd, Bangkok, Thailand, pp. 417.

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