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# Dynamic study on the effect of calcium hydroxide and sodium bicarbonate treatment on the N/P ratio and plankton abundance

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# Dynamic study on the effect of calcium hydroxide and sodium bicarbonate treatment on the N/P ratio and plankton abundance

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**Abstract.** The development and growth of plankton in water is influenced by nutrients like nitrogen and phosphorus, which can be determined by the N/P ratio. Excess nutrients in water can lead to Harmful Algae Blooms (HABs). The application of $Ca(OH)_2$ and $NaHCO_3$ in water can control the nutrient elements and plankton abundance. This study was conducted to determine the dynamics of the N/P ratio value and plankton abundance through the application of a ($Ca(OH)_2$) and ($NaHCO_3$) dose of 1 ppm in a fish pond using the descriptive method. Before the application, the pond's nitrogen range was 1.04 – 1.06mg/l. After application, this increased to 1.07 – 1.39mg/l, while the phosphorus was 0.29 – 0.33mg/l before application. After the administration, the phosphorus increased followed by a decrease ranging from 0.30 to 0.62mg/l and 0.62 to 0.09mg/l respectively. The N/P ratio value before administration was 3.15 – 3.68mg/l and after the application, the N/P ratio decreased to an average value of 1.73 on day 4 followed by a subsequent increase to 14.70 on day 7. The average total plankton density from the three points was 789,583 ind/l before application. After the application, this decreased to 624,166ind/l. In conclusion, the application of $Ca(OH)_2$ and $NaHCO_3$ can stabilize the N/P ratio and decrease the total plankton density.

## 1. Introduction

The optimal utilization of resources in an aquatic environment requires the management of the environment itself, including the function of the ecosystem in the water. The interaction between the components of the ecosystem will affect the existence of the nutrients in the water. Plankton are a major component of the food chain in an aquatic environment, hence the presence of nutrients and plankton is an indicator of water fertility. Therefore, plankton abundance in water has an important role [1].

Plankton abundance in water is influenced by some environmental parameters and physiological characteristics. The composition and abundance of plankton will change at various levels in response to both physical and chemical changes in the environmental conditions. The plankton growth factor is very complex and interacts between the physical and chemical factors such as the intensity of light, dissolved oxygen, temperature stratification and the availability of nutrients like nitrogen and phosphorus [2].

In the water system, there are many nutrients but only a few can be utilized by algae and aquatic plants. Nitrogen and phosphorus are amongst the parameters that affect the nutrient utilization in water. Nitrogen elements that can be utilized are nitrite and nitrate, while for phosphorus, there is the orthophosphate compounds [3].

The presence of nitrogen and phosphorus in aquatic environments has a positive impact, but when in excess, they can have a negative effect. The positive impact is an increase in plankton production and total fish production. The negative impact is a decline in biodiversity, enlarging the potential of the emergence and development of a type of dangerous plankton commonly known as *Harmful Algae Bloom* (HABs) [3].

The magnitude of the HABs risk in water requires technology that can reduce the occurrence of the HABs at a relatively low cost [3]. One of the ways to overcome the occurrence of HABs is through the application of $Ca(OH)_2$ (Calcium hydroxide) and $NaHCO_3$ (Sodium bicarbonate).

Calcium hydroxide in water can affect the dynamics of the N/P ratio; the phosphorus decreases in order to control the dynamics of plankton abundance. The binding of phosphate by calcium hydroxide and the occurrence of precipitation can purify the phosphorus in the water [4].

The administration of sodium bicarbonate in water can increase nutrients in the form of nitrogen. The sodium bicarbonate application can also supply carbon to the water in the form of $CO_2$, thus affecting the dynamics of the N/P ratio and the abundance of plankton in the water [5]. On the basis of the above thinking, this study was conducted to determine the ability of calcium hydroxide and sodium bicarbonate when it comes to affecting the dynamics of the N/P ratio and plankton abundance.

## 2. Materials and methods

### *2.1. Study location*

This research was conducted in December 2016 in the Fish Pond of the Fisheries and Marine +Faculty (FMF), Airlangga University, Surabaya, Indonesia.

### *2.2. Equipment and materials*

The tools used in this research included a DO meter, sampling rope, pH pen, plankton net, a bucket, hemocytometer, measuring stick, canoe, dropper, microscope, glass object, glass cover, sample bottle, burette, stative, clamp, 100ml measuring cup, 300 ml erlenmeyer, 500ml erlenmeyer, 2 ml volume pipette, and a bulb. The materials used included water samples from the pond, PP Indicator 1%, distilled water, $H_2SO_4$ 0,02N, Broom Cresol Green, Methyl Red, ammonium, nitrite, nitrate, phosphate, BOD and the COD Test Kits.

### *2.3. Working procedures*

The main research commenced on the 23rd December 2016 with the determination of the water quality conditions and plankton abundance before the products were dispersed the next day. The figures from the preliminary study were used as the data before the pond treatment.

The research was conducted from 24$^{th}$ December to the 30$^{th}$ December, 2016 as the impact of the production allowed the dynamics of the water quality and plankton abundance to be determined. From the results of the 23$^{rd}$ December, 2016, it was noticed that the lowest pH was at 05.00am, therefore the research products were applied at 03.00am since it was expected that at 05.00am, there was a change in the dynamics of the pond water quality. The commercial products containing calcium hydroxide ($Ca(OH)_2$) and sodium bicarbonate ($NaHCO_3$) were dispersed at a low pH due to the nature of the high solubility of the products in water at a low pH. The points used in the main research were the same as those for the preliminary study, which were points 1, 3 and 5, where the points represent the observations of one pond.

The applied products had a concentration of 1 ppm and the dose used was 815.31 gr. The commercial products consisted of a water-soluble white powder. The application of the products was done by first diluting the products with water, followed by an even distribution throughout the pond.

### *2.4. Water quality measurement*

The measurement of the water temperature and dissolved oxygen was done using DO meter YSI 550 A, the pH was measured using a Senz pH pen and the pH paper range was 6.5 – 10 Merck KGaA. The nitrite was measured with the use of the spectrophotometric method with a wavelength of 543nm based on SNI06-6989.9-2004. Nitrate was measured using spectrophotometry with a wavelength of 410nm based on SNI06-2480-1991, and the phosphate was measured using a spectrophotometer with a wavelength of 880nm based on the ‘Standard methods’ $20^{th}$ edition 1998 test kit was used for ammonium. COD was determined through the closed reflectance method involving a spectrophotometer with a wavelength of 420nm based on SNI 6989.72: 2009. BOD was determined through the Winkler titration method based on SNI6989.2:2009 and the plankton observation was carried out using hemocytometers and plankton identification books.

The water sampling for the testing of nitrite, nitrate, ammonium, phosphate, BOD and COD was carried out using the “closed bottle” principle. The bottle was lowered in water at a certain depth with the state of the bottle being closed. The bottle cap was opened while in the water to allow for the entry of the needed water sample into the bottle. The water quality of the sample was maintained at a temperature of $4^oC$ since the water quality of the samples may decrease depending on the placement and duration of storage [6].

The temperature measurement, dissolved oxygen, pH and plankton abundance were measured twice a day at 05.00am WIB and 13.00 respectively, since the lowest and highest temperature, pH and dissolved oxygen were recorded in those periods at the ponds. The three parameters fluctuated each day due to several factors such as the weather [7]. The measurement of the nitrites, nitrates, phosphates, ammonium and ammonia and the measurements of COD and BOD were performed every 3 days.

### *2.5. Sampling method and observation of plankton abundance*

Plankton sampling was done using a plankton net with a mesh size of 20 microns, since the size of phytoplankton (microplankton) is usually between 20 - 200 microns. The use of a plankton net with such a mesh size means that it can be used to filter phytoplankton like diatom and dinoflagellate as well as zooplankton. In addition, with the above mesh size, the water can still go out through the holes of the plankton net [8].

The plankton sampling in shallow waters with a depth of ± 1m was done using a container (bucket) whose volume was known. The volume of the plankton water samples taken can be adjusted to the water conditions in the following order; very fertile waters ± 5 liters, moderate waters ± 30 liters and poor waters ± 100 liters. In this research, 50 liters was used for the water samples [9].

The water samples obtained were filtered using a plankton net and a sample volume of 100ml was obtained. The date, position and depth of the pond samples were labeled. The plankton samples obtained were immediately observed with the use of a binocular microscope with a magnification 100 - 1000x.The plankton were then preserved with 4% formalin based on the method that described that plankton samples can be preserved using 4% formalin and that 4% formalin can also be used to stop the plankton from moving, especially zooplankton [8].

### *2.6. Observation and data collection*

The main parameters in this study were the N/P ratio and plankton abundance. The supporting parameter was the water quality data such as pH, DO, temperature, COD and BOD during the research.

*2.7. Data analysis*
To determine the dynamics of the N/P ratio value due to the administration of calcium hydroxide ($Ca(OH)_2$) and sodium bicarbonate ($NaHCO_3$) in the pond, descriptive data was used. An analysis was conducted on the plankton abundance data including plankton identification, the plankton density index, plankton similarity index and plankton dominance index.

## 3. Results and discussion

*3.1. Nitrogen dynamics (N)*
The results of the nitrogen values on day 0 in the pond before the addition of $Ca(OH)_2$ and $NaHCO_3$ had an average value of 1.05mg/l obtained from points 1, 3 and 5. After the application of $Ca(OH)_2$ and $NaHCO_3$, the average nitrogen value of the three points increased to 1.07mg/l on day 4. On the 7th day, the average nitrogen value increased to 1.39mg/l.

The increased nitrogen value was due to the amount of organic matter in the pond resulting in the binding of $Ca^{2+}$ion to the phosphate ion; deposition occurred to reduce the phosphorus in the water. The decline of phosphorus in water resulted in a decrease in the total plankton density in the pond as an increase in the organic matter can increase the nitrogen in the water. One of the causes of the increased nitrogen in water was because of the increased organic matter in the water [10]. The dynamics of the nitrogen values before and after the administration of $Ca(OH)_2$ and $NaHCO_3$ have been presented in Table 1.

**Table 1.** Dynamics of the nitrogen values before and after the administration of $Ca(OH)_2$ and $NaHCO_3$.

| Day | Nitrogen (mg/l) | | |
|---|---|---|---|
| | Point 1 | Point 3 | Point 5 |
| 0 | 1,04 | 1,06 | 1,05 |
| 4 | 1,06 | 1,08 | 1,08 |
| 7 | 1,09 | 2 | 1,1 |

The results of this research indicate that the nitrogen value in the research fish pond of FMF–Airlangga before and after the administration of $Ca(OH)_2$ and $NaHCO_3$ fell within optimal range for fish farming activities since the range was 1.06-1.38mg/l and the ideal nitrogen range for aquaculture activities ranges from 1 – 2 mg/l [11].

*3.2. Dynamics of phosphorus (P)*
The results of phosphorus in the research pond of FMF before application of $Ca(OH)_2$ and $NaHCO_3$ on day 0 was 0.29-0.33mg/l at the three points. After the administration of the two compounds, there was an increase in each point on day 4 which led to an average phosphorus of 0.62mg/l. The increased phosphorus in the pond was caused by the supply of bicarbonate ions through sodium bicarbonate, hence the bicarbonate ions are inorganic carbon sources that can be converted into carbon dioxide by phytoplankton. These ions become a carbon source in the process of photosynthesis which is an important process in the formation of organic matter in water [8].

On the 7th day, the average phosphorus from the three points decreased to 0.09mg/l. This decrease was due to the supply of$Ca^{2+}$ ion from calcium hydroxide post-application of calcium hydroxide; this can lower the amount of phosphorus in the water. The above result is in accordance with the statement by Budi [4], stating that the administration of calcium hydroxide can lower the phosphorus in water. The decrease of phosphorus through calcium hydroxide can be explained by a chemical reaction as follows:
$3Ca^{2+} + 2PO_4^{3} \leftrightarrow Ca_3(PO_4)_2$

The results of the dynamics of the phosphorus values before and after the administration of $Ca(OH)_2$ and $NaHCO_3$ have been presented in Table 2.

**Table 2.** The dynamics of the phosphorus values before and after the application of $Ca(OH)_2$ and $NaHCO_3$.

| Day | Phosphor (mg/l) | | |
|---|---|---|---|
| | Point 1 | Point 3 | Point 5 |
| 0 | 0.33 | 0.29 | 0.29 |
| 4 | 0.64 | 0.62 | 0.6 |
| 7 | 0.07 | 0.14 | 0.07 |

Based on the results of this research, the value of phosphorus in the studied fish pond before and after the application of $Ca(OH)_2$ and $NaHCO_3$ fell within the optimal range for fish farming as it had an average value of 0.34mg/l. According to [12], the maximal phosphorus value for fish cultivation should be 1mg/l, hence the phosphorus in the FMF pond was within the optimal range for fish farming.

### *3.3. N/P ratio dynamics*

The average N/P ratio value in the pond before $Ca(OH)_2$ and $NaHCO_3$ administration at points 1, 3 and 5 was 3.49, whereas after the administration of $Ca(OH)_2$ and $NaHCO_3$, on the 4th day there was a decrease in the dynamic of the N/P ratio which resulted in a ratio of 1.74. The next observation was an increase in the N/P ratio which recorded 14.71 as the average ratio from the three study points.

The decrease and increase of the N/P ratio in water is influenced by the phosphorus content in the water. This is in accordance with the opinion of [13], which states that the phosphorus in water is a limiting factor for the N/P ratio. The N/P ratio is derived from the calculated total nitrogen (N) divided by the total phosphorus (P). The greater the N/P ratio value, the smaller the level of phosphate and vice versa. Hence, the higher levels of phosphate in water increases both the diversity and dynamics of plankton abundance in waters.

The dynamics of the N/P ratio value in the research fish pond of FMF before and after the application of $Ca(OH)_2$ and $NaHCO_3$ have been presented in Table 3.

**Table 3.** The dynamics of the N/P ratio before and after the $Ca(OH)_2$ and $NaHCO_3$ application.

| Day | N/P Ratio | | |
|---|---|---|---|
| | Point 1 | Point 3 | Point 5 |
| 0 | 3.15 | 3.68 | 3.65 |
| 4 | 1.67 | 1.74 | 1.8 |
| 7 | 15.13 | 13.8 | 15.18 |

It was established that the N/P ratio in the research fish pond of FMF before and after the $Ca(OH)_2$ and $NaHCO_3$ administration was dominated by *Blue Green Algae* and *Green Algae* phytoplankton. which were in an N/P ratio that ranged from 6.41 - 6.88. According to [13], the N/P ratio in the water influenced the type of plankton that dominated, the water's composition and also that an N/P ratio above 20 will be more dominant in diatomaceous planktons. An N/P ratio of the 10th range will be more dominant in green plankton (chlorella) and an N/P ratio below 10 is a conducive environment for dark green-pigmented plankton (BGA).

### *3.4. Plankton abundance*

The results of the plankton abundance calculations at 05:00 a.m. and 13:00 p.m. have been presented in Tables 4 and 5 below.

**Table 4.** Biology Index of the Plankton Abundance at 05:00 a.m.

| Point | Day | Biologic Index | | | Total Density ($10^4$ ind/l) |
|---|---|---|---|---|---|
| | | H' | E | C | |
| I | 0 | 0,75 | 0,38 | 0,96 | 1.103.125 |
| | 1 | 0,66 | 0,36 | 0,96 | 534.375 |
| | 2 | 0,5 | 0,36 | 1 | 90.625 |
| | 3 | 0,33 | 0,3 | 0,96 | 284.375 |
| | 4 | 0,53 | 0,33 | 1 | 31.250 |
| | 5 | 0,53 | 0,33 | 1 | 31.250 |
| | 6 | 0,56 | 0,4 | 1 | 25.000 |
| | 7 | 0,42 | 0,38 | 1 | 21.875 |
| III | 0 | 0,29 | 0,26 | 0,98 | 578.125 |
| | 1 | 0,38 | 0,34 | 0,98 | 161.250 |
| | 2 | 0,63 | 0,39 | 0,97 | 93.750 |
| | 3 | 0,3 | 0,43 | 1 | 37.500 |
| | 4 | 0,24 | 0,34 | 1 | 25.000 |
| | 5 | 0,5 | 0,36 | 0,98 | 25.000 |
| | 6 | 0,52 | 0,37 | 0,98 | 28.125 |
| | 7 | 0,45 | 0,41 | 0,98 | 33.125 |
| V | 0 | 0,57 | 0,41 | 0,96 | 687.500 |
| | 1 | 0,62 | 0,38 | 0,96 | 275.000 |
| | 2 | 0,58 | 0,42 | 0,98 | 46.875 |
| | 3 | 0,55 | 0,39 | 1 | 31.250 |
| | 4 | 0,56 | 0,4 | 0,96 | 25.000 |
| | 5 | 0,5 | 0,31 | 1 | 21.875 |
| | 6 | 0,65 | 0,4 | 1 | 21.875 |
| | 7 | 0,45 | 0,41 | 1 | 28.125 |

**Table 5.** Biology Index ofthe Plankton Abundance at 13:00 p.m.

| Point | Day | Biologic Index | | | Total Density ($10^4$ ind/l) |
|---|---|---|---|---|---|
| | | H' | E | C | |
| I | 0 | 0,69 | 0,38 | 0,94 | 437.500 |
| | 1 | 0,57 | 0,41 | 0,96 | 281.250 |
| | 2 | 0,45 | 0,32 | 1 | 71.875 |
| | 3 | 0,59 | 0,32 | 1 | 59.375 |
| | 4 | 0,53 | 0,38 | 0,98 | 28.125 |
| | 5 | 0,66 | 0,41 | 0,96 | 21.875 |
| | 6 | 0,4 | 0,36 | 0,98 | 9.375 |
| | 7 | 0,57 | 0,41 | 0,96 | 12.500 |
| III | 0 | 0,45 | 0,41 | 0,98 | 206.250 |
| | 1 | 0,45 | 0,42 | 0,98 | 206.250 |
| | 2 | 0,35 | 0,32 | 0,98 | 28.125 |
| | 3 | 0,38 | 0,34 | 0,98 | 25.000 |
| | 4 | 0,42 | 0,38 | 1 | 25.000 |
| | 5 | 0,49 | 0,35 | 0,96 | 18.125 |
| | 6 | 0,43 | 0,39 | 0,98 | 59.375 |
| | 7 | 0,57 | 0,41 | 0,98 | 81.250 |
| V | 0 | 0,65 | 0,4 | 0,96 | 425.000 |
| | 1 | 0,6 | 0,37 | 0,98 | 221.870 |
| | 2 | 0,57 | 0,31 | 0,94 | 140.000 |
| | 3 | 0,48 | 0,34 | 0,96 | 43.125 |
| | 4 | 0,59 | 0,41 | 0,96 | 18.750 |
| | 5 | 0,45 | 0,41 | 1 | 12.500 |
| | 6 | 0,54 | 0,39 | 0,98 | 13.750 |
| | 7 | 0,62 | 0,38 | 0,96 | 18.750 |

Observations from this study revealed 33 genera of plankton that represented 9 classes, namely Chlorophyta; 3 genera (9.09%), Diatom; 5 genera (15.15%), Pyprophyta; 5 genera (15.15%), Cyanophyta; 7 genera (21.21%), Desmidiaceae; 3 genera (9.09%), Entomostraca; 2 genera (6.06%), Rotatoria; 6 genera (18.18%), Cilliata; 1 genus (3.03%) and Gastropoda; 1 genus (3.03%).

The total density of the plankton at 05.00am before the supply of $Ca(OH)_2$ and $NaHCO_3$ at points 1, 3 and 5 were 1,103,125 x $10^4$ ind/l, 578.125 x $10^4$ind/l and 678,500 x $10^4$ind/l respectively. The dominant plankton in the pond was phytoplankton such as the *Chlorella* species, *Oocystis* species, *Polyedrium* species, *Dinophysis miles* and *Glocotrichaechinulata.* After the addition of $Ca(OH)_2$ and $NaHCO_3$, the total plankton density in the pond at 05.00am each day experienced a change by either an increase or decrease.

The total plankton density at 13:00 before the $Ca(OH)_2$ and $NaHCO_3$ administration at points 1, 3 and 5 was 437,500 x $10^4$ ind/l, 206,250 x $10^4$ind/l and 425,000 x $10^4$ind/l respectively. The dominating plankton in the pond was mainly phytoplankton such as the *Chlorella* species, *Gonyanulax polyderm*, *Calothrix* species and *Glocotri chaechinulata.* The total plankton density also increased and decreased at 13.00 after the $Ca(OH)_2$ and $NaHCO_3$ application.

The decrease in plankton density was due to the $Ca(OH)_2$ compounds, since they can bind the phosphorus compounds in the water [14]. On the 4th day, the phosphorus content increased due to the high intensity of rainfall. This is since rainfall has the ability to stir the pond bottom or sediment. The phosphorus in water can only be found in basic soils, sediments, rocks and organic matter. Even when the phosphorus content in the water increased, the phosphorus content was only used a little by the phytoplankton because the phytoplankton experienced death due to the high rain intensity and phosphorus binding at the start of the study. This is in line with [15].

The increase in the above density occurred due to the dominance of the zooplankton group of plankton. The dominance is caused by the binding of the phosphorus compounds in the water by calcium hydroxide. This was evidenced by the phosphorus content on the 7th day, which declined. The rainy season can also increase the dominance of the zooplankton because the penetration of sunlight in the water was reduced during this period. Therefore, the presence of phytoplankton was replaced by zooplankton because there was less solar energy to be used by the phytoplankton to carry out photosynthesis [16].

The Diversity Index (H) values before the addition of $Ca(OH)_2$ and $NaHCO_3$ at 05.00am at points 1, 3 and 5 were 0.75, 0.29 and 0.57 respectively, while at 13.00, the same points 1, 3 and 5 recorded 0.69, 0.45 and 0.65 respectively. The Diversity Index values after the administration of the two products at 05.00am experienced an increase and a decrease ranging from 0.24-0.66 and the same at 13.00, which also experienced an increase and decrease ranging from 0.35 to 0.66. Since the diversity and community stability of the three observation points was all lower than 2.3062, based on the Shannon-Weaver Diversity Index, they were classified in the low categories with low species counts and with a low distribution of individual numbers for each species.

The Uniformity Index (E) value before the application of $Ca(OH)_2$ and $NaHCO_3$ at 05.00am at points 1, 3 and 5 was 0,38, 0,26 and 0,41 while at 13.00, the uniformity index value of points 1, 3 and 5 were 0,38, 0,41 and 0,4. The Uniformity Index value after the administration of $Ca(OH)_2$ and $NaHCO_3$ at 05.00am also experienced an increase and decrease, ranging from 0.3 - 0.42 and at 13.00 also, there was an increase and decrease ranging from 0.32 to 0.42. Based on the Uniformity Index of [6], the spread of the number of individuals per species at all three observation points was close to 0.0 and this spread of individuals can be said to be unequal. There is a tendency for dominance by certain types.

The Dominant Index (C) values before the $Ca(OH)_2$ and $NaHCO_3$ administration at 05.00am at points 1, 3 and 5 were 0.96, 0.98 and 0.96 respectively. Meanwhile at 13.00, points 1, 3 and 5 showed 0,94, 0,98 and 0,96 respectively. The Dominant Index values after the supply of $Ca(OH)_2$ and $NaHCO_3$ at 05.00am increased and later decreased in the range of 0.96 – 1; this is the same as the case at 13.00 where it increased and decreased with a range of 0.94 – 1. Based on the Simpson Domination Index, there are species that dominate others within the phytoplankton and plankton community structure at all three observation points (close to 1.0) in unstable conditions [6].

3.5. *Supporting water quality parameters*

The water quality parameters measured included temperature, dissolved oxygen, nitrite, nitrate, ammonium, ammonia, phosphate, BOD and COD. The results of the measured water quality parameters have been presented in Table 6 below.

**Table 6.** Dynamics of the water quality support before and after the application of $Ca(OH)_2$ and $NaHCO_3$.

| Parameters | Time | Point | Day 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|---|
| Temperature (°C) | 05.00 | 1 | 26,9 | 27 | 27,9 | 28,4 | 28,3 | 28,8 | 28,5 | 28,6 |
| | | 3 | 26,9 | 27 | 27,9 | 28,3 | 28,3 | 28,7 | 28,4 | 28,6 |
| | | 5 | 26,9 | 26,9 | 27,9 | 28,2 | 28,4 | 28,6 | 28,5 | 28,6 |
| | 13.00 | 1 | 28,1 | 29,1 | 29,8 | 29,8 | 29,7 | 29,6 | 30 | 29 |
| | | 3 | 28,1 | 28,9 | 29 | 29,7 | 29,5 | 29,5 | 29,7 | 29,5 |
| | | 5 | 28,1 | 29 | 30 | 29,8 | 29,7 | 29,5 | 30 | 29,5 |
| DO (mg/l) | 05.00 | 1 | 4,71 | 4,88 | 5,32 | 4,13 | 4,11 | 3,88 | 3,58 | 4,47 |
| | | 3 | 4,07 | 4,44 | 4,84 | 3,84 | 3,28 | 3,32 | 3,23 | 4,15 |
| | | 5 | 5,44 | 5,44 | 5,60 | 5,26 | 4,61 | 4,07 | 3,53 | 4,67 |
| | 13.00 | 1 | 7,19 | 7,63 | 8,41 | 7,02 | 7,13 | 5,11 | 5,79 | 6,12 |
| | | 3 | 7,56 | 7,85 | 7,87 | 7,32 | 6,62 | 5,33 | 5,89 | 5,90 |
| | | 5 | 7,95 | 8,13 | 8,90 | 7,89 | 7,78 | 6,38 | 7,03 | 7,25 |
| Nitrite (mg/l) | 05.00 | 1 | 0,011 | - | - | - | 0,014 | - | - | 0,026 |
| | | 3 | 0,014 | - | - | - | 0,014 | - | - | 0,03 |
| | | 5 | 0,013 | - | - | - | 0,014 | - | - | 0,03 |
| Nitrate (mg/l) | 05.00 | 1 | 0,1 | - | - | - | 0,24 | - | - | 0,345 |
| | | 3 | 0,232 | - | - | - | 0,32 | - | - | 0,448 |
| | | 5 | 0,216 | - | - | - | 0,278 | - | - | 0,356 |
| Ammonium (mg/l) | 05.00 | 1 | 0,5 | - | - | - | 0,5 | - | - | 0,5 |
| | | 3 | 0,5 | - | - | - | 0,5 | - | - | 0,5 |
| | | 5 | 0,5 | - | - | - | 0,5 | - | - | 0,5 |
| Ammonia (mg/l) | 05.00 | 1 | 0,625 | - | - | - | 0,625 | - | - | 0,625 |
| | | 3 | 0,625 | - | - | - | 0,625 | - | - | 0,625 |
| | | 5 | 0,625 | - | - | - | 0,625 | - | - | 0,625 |
| Phosphorus (mg/l) | 05.00 | 1 | 1 | - | - | - | 1,94 | - | - | <0,22 |
| | | 3 | 0,88 | - | - | - | 1,88 | - | - | 0,44 |
| | | 5 | 0,88 | - | - | - | 1,82 | - | - | <0,22 |
| BOD (mg/l) | 05.00 | 1 | 16,8 | - | - | - | 12,25 | - | - | 4,4 |
| | | 3 | 14,02 | - | - | - | 5,6 | - | - | 1,87 |
| | | 5 | 39,9 | - | - | - | 5,78 | - | - | 12,6 |
| COD (mg/l) | 05.00 | 1 | 42 | - | - | - | 46 | - | - | 23,5 |
| | | 3 | 32,5 | - | - | - | 28,5 | - | - | 19,5 |
| | | 5 | 72,5 | - | - | - | 26 | - | - | 55 |

The temperature dynamics at 05.00am during the study at points 1 and 5 ranged from 26.9 - 28.6°C, while point 3 ranged between 26,9 - 28,7°C. At 13.00, the temperature at points 1 and 5 during the research was said to be around 28,1 - 30°C, and point 3 was between 28,1 - 29,7°C. The above temperature range can be said to be optimal for aquaculture since the optimal temperature range for fish cultivation is 15 - 35°C, according to [17].

The dissolved oxygen content in the pond during the research was equally within the optimal limit for aquaculture activity, especially for the plankton. This is in accordance with the submission of [18], stating that plankton can flourish at oxygen concentrations greater than 3mg/1.

The nitrite and nitrate levels in the research pond during the study also fell within the recommended range for fish cultivation since it was in agreement with [19], who reported that the optimum range of nitrite for fish cultivation was less than 0.02 mg/l, while the optimum nitrate range for aquaculture was 0.1 - 4.5 mg/l.

The levels of ammonium and ammonia in the pond during the study were within the tolerant limit for aquaculture activity. According to [11], the range of ammonium and ammonia that can still be tolerated in aquaculture is less than 1mg/l.

The phosphorus levels in the studied pond was within acceptable limits for aquaculture since [20] gave the ideal range for phosphorus in aquaculture as being 0.01 – 3mg/l.

The BOD content in the pond at the end of the study indicated that the pond water fell within the range for uncontaminated waters and that it was slightly polluted at point 5. According to [21], the BOD value that were greater than 10mg/l are considered to be contaminated. According to [22], the range of the COD values in uncontaminated water is usually those less than 20mg/l, whereas contaminated waters is more than 200mg/l.

## 4. Conclusion

From this study, it is concluded that the administration of $Ca(OH)_2$ and $NaHCO_3$ at a dose of 1 ppm has the ability to stabilize the N/P ratio and decrease plankton abundance. This change in dynamics was confirmed to be influenced by environmental conditions such as rainfall and not only the applied compounds.

It is recommended that such study can be done in a different period of the year to further ascertain the effects of $Ca(OH)_2$ and $NaHCO_3$ on the N/P ratio dynamics and plankton abundance during the different seasons of the year.

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