The effect of hydrogen peroxide on N/P ratio and phytoplankton diversity in Vannamei shrimp (*Litopenaeus vannamei*) ponds in Banyuwangi, East Java

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**Abstract.** Abundance of plankton in a waters is influenced by environmental parameters and physiological characteristics. Complex factors support phytoplankton growth. They are light intensity, dissolved oxygen, temperature stratification, salinity and availability of nitrogen and phosphorus. Nitrogen is an important element in the formation of chlorophyll, protoplasm, protein and nucleic acids. Observation of the three ponds in North Banyuwangi (Wongsorejo, Bangsring and Bulusan) and three ponds area of South Banyuwangi (Bomo, Jatisari and Badean). The observed parameters were NH$_4$, NO$_2$, NO$_3$, PO$_4$. Hydrogen peroxide effectively improve water quality, however it has a different effect in each different area.

1. Introduction

*Litopenaeus vannamei* is one of the main commodities of the Indonesia. Several technology have been developed for improving the productivity. One of the effort is intensive culture method. Interaction biotic and abiotic factors affects the water quality. Hence, it will also affect the plankton in the water.

Plankton is a major component of the food chain. It is also an indicator of water quality. Several environmental parameters and physiological characteristics affect the growth and abundant of the plankton. The composition of plankton was affected by environmental conditions. Nitrogen and phosphorus (N/P Ratio) are two parameters that affect the waters [1]. Although there are nutrients in the water system, only a few can be utilized by algae and aquatic plants.

The nitrogen elements can be utilized as nitrite and nitrate, while for phosphorus are ortho phosphate compounds. The presence of nitrogen and phosphorus in aquatic environments have a positive impact. Excess N/P will negatively affects the water quality. The positive impact is the increase in plankton production and total fish production. The negative impact are decreasing the oxygen in the waters, and raising Harmful Alga Blooms (HABs) incident. The administration of hydrogen peroxide in the water will affect density, abundance and dominance of plankton [2]. H$_2$O$_2$, an anorganic chemical agent is weak acid and strong oxidizer. The H$_2$O$_2$ influence the dynamics of the NP ratio. Hence, it will affect the dynamics of plankton in the aquaculture waters [2]. This research was to investigate the effect of H$_2$O$_2$ at six different shrimp ponds in Banyuwangi, East Java, Indonesia.
2. Methodology

2.1. Plankton Samples
The areas of the research was North Banyuwangi (Wongsorejo, Bangsring and Bulusan village) and South Banyuwangi (Bomo, Jatisari and Badean Vilage). Each village represented one sample of the pond.

2.2. Water quality parameters
The observed parameters were NH₄, NO₂, NO₃, PO₄ which were observed once every three days, while the plankton diversity were daily investigated. Supporting parameters were observed were DO (Dissolved Oxygen), pH, temperature, salinity, brightness, and the water color [3].

3. Result and Discussion
Based on the result of the research. The application of hydrogen peroxide affected the chemical and biological processes in the water. NP ratio is one of the many parameters in water. The role of the hydrogen peroxide in the water can help to improve nitrification.

3.1. Wongsorejo village
The amount of Ammonium (NH₄) fluctuated during the middle study between weeks 8 and 9; during the interval of the following week ie. week 10, NH₄ decreased and Nitrite (NO₂) increased which followed by an increase on nitrate (NO₃) in the next following week. Phosphate content was relatively stable (figure 1A). The plankton observation revealed that chrysophyta, cyanophyta and chlophyta was differently fluctuated. On the first week, it appears that chrysophyta dominate the waters. It will be decrease and replaced by cyanophyta. On the contrary, chlorophyta species was relatively stable in number (figure 1B).

3.2. Bangsring village
Phosphate increased at week 4th, then decreased at week 5th. The value of phosphate stable after the following week. NH₄ increased at the end of week 8th to week 9th, then decreased at week of 10th which was accompanied by the increase of NO₂ at week 10th (figure 2A). The observation data of

### Figure 1.
The N/P and phytoplankton dynamic in Wongsorejo shrimp pond. A= N/P value, B= phytoplankton diversity.
phytoplankton showed that phytoplankton diversity of the cyanophyta and chlorophyta groups was high at the beginning of cultivation. This was also followed by high phosphate values at the beginning of the vanname shrimp cultivation period. Both types of phytoplankton were decreased in DOC 42 and 43. The dynamics of the phytoplankton species were fluctuative (figure 2B.) in this pond. This phenomena was due to the high nutrient in the water [4].

**Figure 2.** The N/P and phytoplankton dynamic in Bangsring shrimp pond. A= N/P value, B= phytoplankton diversity.

### 3.3. Bulusan village

The results showed that the phosphate content at the beginning of cultivation increased on week 3<sup>th</sup> and decreased on week 4<sup>th</sup>. For NH<sub>4</sub>, there was a high increase on week of 8<sup>th</sup> to week 9<sup>th</sup>. it decreased again at week of 10<sup>th</sup>. It started increase again on week of 11<sup>st</sup> and decreased on week 12<sup>nd</sup>. For NO<sub>2</sub>, it began dramatically increaded on the week of 11<sup>th</sup> (figure 3A). The results indicated that chrysophyta, cyanophyta and chlorophyta fluctuated. At the beginning of cultivation, it appears that chrysophyta dominate the waters, then along with longer cultivation, the population of chrysophyta decreased. It was replaced by the cyanophyta. The chlorophyta species was relatively stable in number from the beginning to end of cultivation (figure 3B).

**Figure 3.** The N/P and phytoplankton dynamic in Bulusan shrimp pond. A= N/P value, B= phytoplankton diversity.
3.4. Bomo village
All parameters, NH$_4$, NO$_2$ and NO$_3$ experienced steady movement until week of 11$^{th}$. All started to increase on week 12$^{nd}$ (figure 4A.). Results of the dynamics of phytoplankton diversity showed that fluctuations in the dynamics of phytoplankton diversity were relatively stable. Chrysophyta, cyanophyta and chlorophyta grew stable until the 90$^{th}$ days (figure 4B).

![Concentration Ratio of N & P E-1](image1)

**Figure 4.** The N/P and phytoplankton dynamic in Bomo shrimp pond. A= N/P value, B= phytoplankton diversity.

3.5. Jatisari village
Ammonium (NH$_4$) showed dramatically fluctuation in the week of 8$^{th}$. It started decrease after week 10$^{th}$. The decreased of NH$_4$ and increased of Nitrite of (NO$_2$) followed by an increase of nitrate (NO$_3$) on the next following weeks. Phosphate content was relatively stable (figure 5A.). Different fluctuations on chrysophyta, cyanophyta and chlorophyta occurred. At the beginning of cultivation ie. the first week, it appears that chrysophyta dominated the waters, then along with longer cultivation and accompanied by the increase in NH$_4$, the population of chrysophyta decreased and replaced by cyanophyta. The chlorophyta species were relatively stable during cultivation (figure 5B).
Figure 5. The N/P and phytoplankton dynamic in Jatisari shrimp pond. A= N/P value, B= phytoplankton diversity.

3.6. Badean village
The observations of research results in the ponds of Badean village were relatively stable. The content of phosphate, NH₄, NO₂ and NO₃ experienced a steady movement from week 11th to week 15th. Then all parameters decreased at the end of week 15th (figure 6A.). Phytoplankton analysis revealed that fluctuations in the dynamics of phytoplankton diversity were also stable. Chrysophyta, cyanophyta and chlorophyta growth were dynamic until the 90th day or DOC 90 (figure 6B.).

Figure 6. The N/P and phytoplankton dynamic in Jatisari shrimp pond. A= N/P value, B= phytoplankton diversity.

The existence of plankton has a very diverse role in the waters, such as aquatic feed, oxygen provider, producer of carbon dioxide, water coloring, and as an indicator of water fertility. Plankton abundance is strongly influenced by inorganic compounds in the waters, namely Nitrogen and Phosphate in the ratio of total ppm of Nitrogen and Phosphate, often called the N/P ratio. It is understood that the presence of
the N/P ratio hugely determines the type and abundance of plankton. The dynamics of plankton and movement of N/P ratio is strongly influenced by the state of water quality[7,8].

Oxygen solubility greatly affects the chemical balance of water and plankton life, but it also affects the amount of organic matter in the waters. The lower the oxygen content, the higher the organic matter. Planktons are the largest oxygen provider in the waters. The ratio of N and P is largely the ratio of the total N derived from ammonium and nitrate, and P from phosphate. According to Cardona et al., [2], the distribution of planktons such as cyanophyta and dinoflagellate groups are determined by the value of the proportion of nitrogen to phosphorus in the eutrophic environment with the ratio of total ppm N and ppm P. If under 10 it will be dominated by cyanophyta because it is able to absorb free nitrogen from the air, so the growth is not limited. Therefore, this does not support the required water balance, nitrogen and phosphate levels for the plankton [9].

Hydrogen peroxide can affect the dynamics of the N: P Ratio and cause the decrease of phosphorus so that it can control the dynamics of plankton abundance. This process occurs because it is influenced by the pH; if the pH decreases it contains many hydroxyl ions that allow the process of Ligand Exchange and increase the ability of phosphate ion adsorption. The number of hydroxyl ions decreases further in increasing pH conditions, leading to a decrease in Ligand Exchange capability and decreased ability to absorb phosphate ions [1]. The administration of Hydrogen peroxide in waters can affect the presence of Hydroxide (OH) ions in the waters [10]. The OH ion has been known to be a very strong oxidizer produced from the reaction between the holes with H2O / OH-adsorbed on the surface of the semiconductor [11, 12]. The electrons will adsorb molecules of O2 / H2O to form superoxide anion radicals (•O2-) which is a reducing species. The dissolved contaminant in the system is attacked by the oxidizer and reducing agent and degrades it into a harmless compound, and converts the organic compound to inorganic [13]. An increase in OH ions will also increase the salinity in aquatic areas [14].

The administration of Ca (OH) 2 (calcium hydroxide) and NaHCO3 (sodium bicarbonate) in the water can affect the dynamics of N / P Ratio and the abundance of plankton [15].

4. Conclusion

- Hydrogen peroxide is effective in improving water quality when administered regularly and at appropriate dosage.
- The administration of Hydrogen peroxide has a different effect in each area.

6. References

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