# Research Article
## The Influence of Micropore Oxygen Aeration on the Pond Water Quality Environment

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**Abstract:** In order to know the effects of micropore oxygen aeration on the water quality and economic output, take each 3 of micropore oxygen aeration (experimental pond) and impeller oxygenation (control pond) to make the comparison, indexs of two different aeration methods water were detected from May, 2012 to October, 2012. Such as water temperature, dissolved oxygen, ammonia nitrogen and nitrite, phytoplankton, chemical oxygen demand ($COD_{Mn}$). Results showed that, (1) the indexes of the dissolved oxygen, ammonia nitrogen, chemical oxygen demand ($COD_{Mn}$) and nitrite of the experimental pond are all superior to that of the control pond, of which the concentration of the dissolved oxygen of the experimental pond is 8.37 mg/L which is higher than that of the control pond (5.7 mg/L). And, $COD_{Mn}$ in the experimental pond is 7.54 mg/L, lower than that in the control pond (10.19 mg/L). The difference between the control pond and the experimental pond was statistically significant ($p<0.01$). The ammonia nitrogen of the experimental pond is 0.1 mg/L, obviously lower than the control pond (0.16 mg/L). Besides, the nitrite is 0.13 mg/L in the experimental pond, lower than that of the control pond (0.21 mg/L). (2) Compared with the control pond, the experimental pond has quite higher general abundance of algae, with about $5.69 \times 10^8$ ind/L. Yet, there is no obvious difference between them. (3) Compared to the impeller oxygenation, the micropore oxygen aeration technology can be better to increase the dissolved oxygen in the aquaculture pond and improve the water quality. However, there is no significant influence to the phytoplankton abundance and diversity.

**Keywords:** Diversity, impeller oxygenation, micropore oxygen aeration, phytoplankton, pond

## INTRODUCTION

In the aquaculture environment of the pond, the dissolved oxygen, as one of the important factors for the water quality indexes, not only directly has the significant influence to the cultured organisms but also makes other chemical indexes and biological population change through affecting the microorganisms. The oxygenation system installed in the aquaculture pond can maintain the good water quality to promote the health growth of the cultured organisms. The mechanical oxygenation method commonly used include the impeller, water wheel, inflatable style and water spraying (Lu, 2001). The micropore aeration oxygenation, as a kind of inflatable styles which takes the air inflation from the bottom of the pond, is widely applied in the cultivation production (Cai *et al.*, 2012). This technology can obviously enhance the dissolved oxygen of the cultivated water, improve the pond cultivated ecological environment and reduce the possibility of the occurrence of the diseases, which contributes to the growth of the aquatic animals.

The phytoplankton, as the primary producer of the pond ecological system, can provide the oxygen for the water through the photosynthesis. They consume the oxygen through the respiration yet absorbing water nutrient elements such as nitrogen and phosphorus, which have the great significance for maintaining the normal function of the water and improving the water environment. Part of scholars conducts the research on the influence of the micropore oxygen aeration to the water quality (Fu *et al.*, 2012; Chen, 2011). This study makes the comparative test of the influences of micropore oxygen aeration and impeller oxygenation to the environment of the water quality, providing the reference for improving the cultivated environment of the pond.

## MATERIALS AND METHODS

**Introduction of the experimental pond:** In 2012, in Jiangsu Taizhou Modern Husbandry Science Demonstration Park, 6 ponds were selected for the comparative test of the micropore oxygen aeration (test group for short) and impeller oxygenation (control group for short). There is no pollution source around 6 ponds and they all have their own drainage system. Besides, the pond is in east-west direction. Each experimental pond's area is 667 m², respectively labeled from 1 to 6. No.1, No.3 and No.5 are the

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experimental ponds and No.2, No.4 and No.6 are the control ones. The total area reaches 4000 m$^2$. In March, it is installed with the micropore oxygen aeration equipment manufactured by Yangzhou TEAN Technology Co., Ltd. The installation and application method of the equipment refer to the Technical Manual of Pond Submerged Aeration (DB 3302/T 062-2008, 2008). Each control pond is installed with 1 impeller oxygenation machine with the power of 1.5 KW. The species cultivated involve silver carp and the golden crucian carp which generated by common carp hybrid with crucian carp. For the cultivation condition such as the stocking density and daily management, it is same both for the experimental pond and control pond.

**Sampling and analysis method:** From May 2012 to October 2012, it took 6-times sampling. In two corner points of east and west of the fish pond, we used the organic glass hydrophore to take the sample from the 0.5 m surface water, to detect the water temperature, pH, transparency and dissolved oxygen on site. And, we detect the ammonia nitrogen (NH$_3$-N), nitrite nitrogen (NO$_2^-$-N), nitrate nitrogen (NO$_3^-$-N), phosphate and COD$_{Mn}$ in the laboratory. The determination refers to Water and Wastewater Monitoring and Analysis Method 4th Edn (CSEPA (China State Environmental Protection Administration), 2002). Meanwhile, 1000 mL is sampled with adding 6% Lugol's solution, which is fixed to count the number of the phytoplankton. The counting method can be seen in Regulation for Lake Eutrophication Investigation (Jin and Tu, 1990). The specific identification method of the algae refers to Aquatic Algae and Water Pollution Detection (Lin and Xie, 1988), Chinese Freshwater Algae: System, Classification and Ecology (Hu and Wei, 2006), Chinese Freshwater Algae (IV) (Qi, 1995), Chinese Freshwater Algae(X) (Qi and Li, 2004) and Chinese Freshwater Algae (XII) (Si, 2004).

**Data processing:** Data processing adopts OFFICE-EXCEL software and SPASS software. The diversity analysis of the phytoplankton community takes the Shannon-Wiener index *(H′)* and Margalef index (*D*) (SongandYu, 2009) as well as utilizes the One-ANOVA to check the significance difference between *H′* and *D*.

## RESULT AND ANALYSE

**Physicochemical indexes result analysis:** The water temperature in this test is within 22.6°C~32.5°C. The

transparency is in the range of 25~38 cm. The pH value is about 7.4-8.6. There is no significant difference in water temperature, transparency and pH value in the micropore oxygen aeration fishpond and impeller oxygenation pond. And, the linear relationship between the transparency and the water temperature is opposite. The other detection results are shown in Table 1. The ammonia nitrogen in the experimental pond is 0.1 mg/L on average yet 0.16 mg/L in the control pond on average. Through One- ANOVA analysis, the difference was very remarkable (p<0.05). The nitrate concentration of the experimental pond is 0.84 mg/L on average, it was higher than that of the control pond which is 0.69 mg/L but not significantly. The nitrite concentration of the experimental pond is 0.13 mg/L on average, lower than that of the control pond which is 0.21 mg/L, which still never reaches the significant difference. For the labile phosphorus concentration, it is 0.51 mg/L in the experimental pond, higher than that of the control pond which is 0.44 mg/L. There is still no obvious difference. In terms of COD$_{Mn}$, it is averagely 7.54 mg/L in the experimental pond, lower than that in the control pond with 10.19 mg/L, The difference was significant (p<0.01). And, the Dissolved Oxygen (DO) in the experimental pond is averagely 8.37 mg/L, higher than that of the control pond that is 5.70 mg/L, with the significant difference (p<0.01).

**Analysis of planktonic algae:**

**The composition of planktonic algae:** Through 6-times sampling, the results showed that 72 species and varieties of phytoplankton had been identified, which belong to 33 genera, 22 families and 7 categories. Among them, the chlorophyta has the most species which belong to 32 species and its variations, 16 genera and 6 families, followed by bacillariophyta which has 23 species and its variations, 8 genera and 6 families. The third is the cyanophyta and euglenophyta, which respectively possess 10 species and its variations, 4 genera and 5 families as well as 4 species and its variations, 2 genera and 2 families with their variations. For the Xanthophyta, Pyrroptata and Cryptophyta, they all have 1 specie, 1 genus and 1 family.

**The abundance change of main algae:** For the main algae abundance of two groups of ponds, the share of

Table 1: Main water quality indicator of the experimental pond and control pond

| | The experimental pond | | | | | | The control pond | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling date | NH$_3$-N mg/L | NO$_3^-$-N mg/L | NO$_2^-$-N mg/L | COD$_{Mn}$ mg/L | DO mg/L | Phosp-hate mg/L | NH$_3$-N mg/L | NO$_3^-$-N mg/L | NO$_2^-$-N mg/L | COD$_{Mn}$ mg/L | DO mg/L | Phosphate mg/L |
| May 21 | 0.062 | 0.28 | 0.01 | 4.98 | 6.90 | 0.37 | 0.064 | 0.22 | 0.02 | 5.38 | 5.43 | 0.28 |
| Jun 22 | 0.085 | 0.59 | 0.12 | 8.33 | 8.19 | 0.49 | 0.090 | 0.47 | 0.17 | 8.67 | 5.78 | 0.33 |
| July 23 | 0.090 | 0.37 | 0.21 | 7.54 | 8.92 | 0.41 | 0.124 | 0.19 | 0.28 | 10.28 | 6.12 | 0.45 |
| Aug 22 | 0.098 | 0.87 | 0.25 | 8.10 | 9.90 | 0.50 | 0.143 | 0.70 | 0.46 | 12.01 | 5.81 | 0.44 |
| Sep 22 | 0.110 | 1.48 | 0.10 | 8.20 | 8.35 | 0.67 | 0.217 | 1.24 | 0.18 | 13.85 | 5.44 | 0.62 |
| Oct 21 | 0.126 | 1.46 | 0.08 | 8.08 | 7.98 | 0.61 | 0.300 | 1.30 | 0.15 | 10.93 | 5.61 | 0.51 |
| Average | 0.10 | 0.84 | 0.13 | 7.54 | 8.37 | 0.51 | 0.16 | 0.69 | 0.21 | 10.19 | 5.70 | 0.44 |
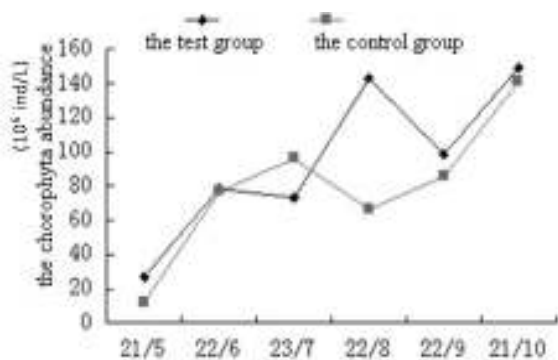
Fig. 1: The abundance change of chorophyta
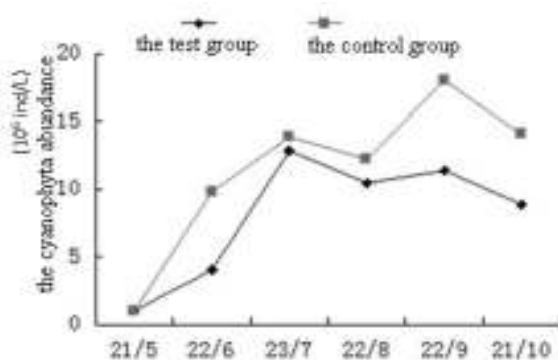


Fig. 2: The abundance change of cyanophyta



Fig. 3: The abundance change of diatom



Fig. 4: The total abundance of the algae
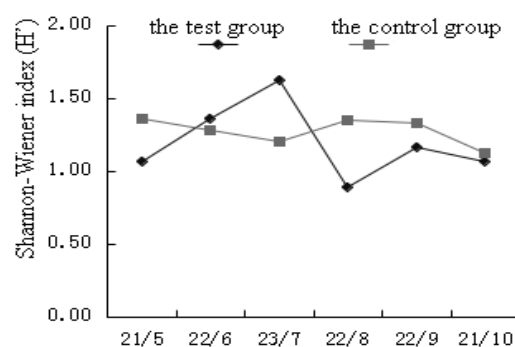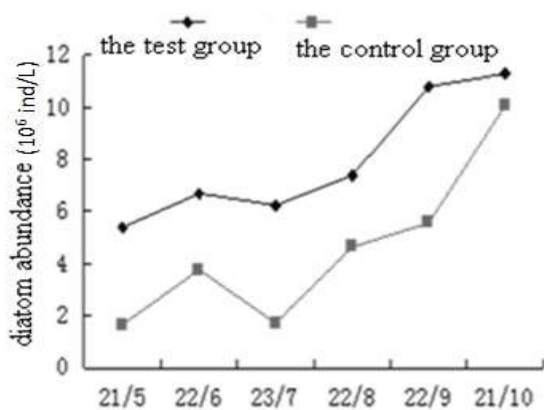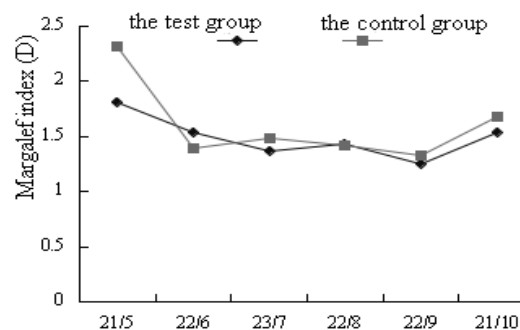


Fig. 5: Changes of Shannon-Wiener index



Fig. 6: Changes of Margalef index

the chorophyta is largest, accounting for 70%. And the cyanophyta and diatom respectively take up 10%. The share of other algae is little. From the Fig. 1 to 4, we can see that the total abundance of the algae in the experimental pond is $5.69 \times 10^8$ ind/L, higher than that in the control pond with $3.58 \times 10^8$ ind/L (Fig. 4). Yet, there is no significant difference (p<0.05). The abundance change tendencies of cyanophyta, chorophyta and diatom of two ponds are similar. They change as the cultivation time goes on. The cyanophyta was low in May. The control group reached the peak in

September, with $1.8 \times 10^7$ ind/L. The abundance change is inclined to be high in the middle and low at both ends (Fig. 2). The diatom abundance in the test group is quite higher than that in the control group and it will gradually rise as time goes by Fig. 3. In October, it reached $1.13 \times 10^7$ ind/L. The chorophyta, as the dominant species of two ponds, has the similar abundance change trend (Fig. 1). In August, the test group reach the highest point which was $1.26 \times 10^8$ ind/L. Compared to the control group, it is a bit higher yet having no obvious difference.

**The change of Shannon-wiener index ($H'$) and Margalef index ($D$)**: From the perspective of diversity of the community structure, the test group has the

similar trend with the control group in the diversity change. Through the analysis of One-ANOVA, the difference between $H'$ (Fig. 5) and $D$ (Fig. 6) of phytoplankton in two ponds is not significant.

## DISCUSSION

With the extension of the culture cycle, a number of residual feeds, manure, metabolic waste and water animal or plant remains will be gradually accumulated in the ponds. The decomposition needs to consume lots of dissolved oxygen and generates a great quantity of harmful productions with the incomplete decomposition. Also, it causes that the harmful substances such as ammonia nitrogen, nitrite and hydrogen sulfide exceed the standard, which will be harmful to the cultivated animals (Zhang and Zhang, 2009). Under the situation with the enough oxygen, it can avoid the organic anaerobic decomposition and conduct the oxidation to make the poisonous ammonia nitrogen and nitrite become the innoxious nitrate. The ammonia nitrogen, nitrite content and $COD_{Mn}$ in the experimental pond are all lower than those in the control pond. However, the labile phosphate, nitrate and DO content of the experimental pond are all higher than those in the control group. With One-ANOVA analysis, the ammonia nitrogen in two ponds has the significant difference ($p<0.05$). Besides, for $COD_{Mn}$ and DO, there is the extremely obvious difference ($p<0.01$), which is the same to the result of Fu Caiping (Fu *et al.*, 2012). The micropore oxygen aeration directly supplies the oxygen from the bottom of the pond while the impeller oxygenation provides the oxygen for the bottom by stirring the water and taking the conversion of the upper and lower water layers. Through the comparison, the method of the micropore oxygen aeration is more direct, which is better to enhance the pond bottom oxidation-reduction potential. In this way, it is good for the growth of the aerobic microorganism, to make the decomposition of organics more complete.

Shannon-Wiener index ($H'$) and Margalef richness index ($D$) are as follows: 0~1 refers to heavy pollution, 1~3 stands for moderate pollution and that over 3 is light pollution (Song and Yu, 2009) .The pollution level of the experimental and control ponds are both moderate pollution. According to the analysis about the phytoplankton abundance and the relative $H'$ and $D$ data, we find that there is no significant influence of the microporous oxygen aeration and impeller aeration to the phytoplankton population structure growing in the pond. This is consistent with Chen Hongrui's research results (Chen, 2011), while inconsistent with those of Fu *et al.* (2012). The experimental group adopts the microporous oxygen aeration in the bottom layer and the control group takes the impeller type oxygen aeration for the former. While for the latter, they take

the microporous oxygen aeration underlying for mariculture as the experimental group and the waterwheel type oxygen aeration as the control pond. The pond conditions in this test is similar to the former.

## CONCLUSION

The micropore oxygen aeration technology, compared with the impeller oxygenation, can obviously enhance the dissolved oxygen in the water of the culture pond, reduce the quality concentration of ammonia nitrogen and nitrite, promote the decomposition of organics and promote the self-purification of water of the culture pond, to provide the better water quality environment for the aquatic farming animals. The influences of two kinds of oxygenation methods to the change of phytoplankton community structure have no obvious difference.

## ACKNOWLEDGMENT

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