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Undesirable Algae (Cyanobacteria) and the Use of Probiotic in Shrimp (*Penaeus Monodon) F*arming

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Abstract:
Shrimp farm effluents increase concomitantly the deterioration of the mangrove ecosystem, as well as to the production in farming herself. The long term effects of this pollution drove to the proliferation of the undesirable algae (Cyanobacteria). The use of the probiotic (Epicin) is the means adopted to fight against these undesirable algae. The aim of this study was to find out the conditions in which probiotic can be efficient and its effects on the water quality in shrimp farming. A multiple linear regression was established to know the parameters of the reservoir channel that can influence the evolution of Cyanobacteria in ponds and ANOVA was used to see if there is a significant difference between the Cyanobacteria concentration for each monitored pond. The results showed that with a R^2=0.550 and R^2 adjusted=0.517, the alkalinity and the rate of phosphate of the water of the reservoir channel are the main variables that have an influence on the growth of the Cyanobacteria in ponds. High alkalinity is an element that inhibits the efficiency of the probiotics in the fight against the undesirable algae. The installation of the bioremediation by these bacteria causes the reduction of phytoplankton density in the ponds, and also, it decreases the rate of pollution of the water quality.

Keywords: Cyanobacteria, alkalinity, phosphate, probiotic, bioremediation

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1. Introduction

The advancement of shrimp aquaculture in the last two decades has begun to have an impact on the environment [1], especially in the mangrove ecosystem. This destruction of the ecosystem affects breeding itself, because the mangrove considered as water purifying element loses its effectiveness. Therefore, the quality of the water used in farming becomes less favorable to the welfare of shrimp because a high amount of undesirable algae have been observed. This has incited farmers to move towards a new management farming practice.

The integration of the probiotic in ponds is one of the new lines. Indeed, the probiotic increases the mineralizing capacity [2], and then it can reduce organic matter excess and inhibit the growth of undesirable algae (Cyanobacteria) in rearing environment. However, according to Boyd [3], the probiotic is only effective to a certain state of water quality. Bacteria introduced into any environment cannot develop if any of its physiological conditions is not reached. This review of Boyd was confirmed by Matias. et *al.* [4] who could show that the probiotic provides no significant effect on water quality, but there are only certain bacteria which are able to multiply in the rearing environment.

This study will determine the quality of water column that can promote bioremediation by introducing probiotic to reduce the growth of undesirable algae in the culturing environment and characterize at the same time the quality of water column resulting from the activity of the probiotic.

2. Experimental Section

2.1 Experimental Method

The experiment focused mainly on the quality of the reservoir channel water and the rearing ponds during the year 2013. The experimental method inspired by Hussenot [5] which followed the efficiency of start fertilizer in farming imperial shrimp (*Penaeus japonicus*) was taken as a reference. Thus, the study focuses on monitoring the water quality of the reservoir channel before filling ponds and crops get starting. Then, monitoring the quality of the water column for each pond during the first months of ageing in which the contribution of organic matter from the nutrition does not have enough influence on the water quality changes. Besides, the availability of phosphate in ponds was reduced as much as possible by removing the start fertilizer. This has been done to analyze the conditions for the effectiveness of probiotics in the fight against the proliferation of Cyanobacteria without the fact that management of shrimp farming practice (water supply the amount and quantity of feed) does not have any influences on the change in water quality. This will allow stating that at the beginning of the cycle, the water quality of the reservoir channel is crucial to the conditions of effectiveness of the probiotic and recognize the quality of water for breeding if the use of probiotic is needed.

2.2 Materials and Methods

The study was carried out in the breeding of *Penaeus monodon* magnification of the company based in AQUALMA Mahajamba farm. Commercially available probiotics with *Bacillus*, *Lactobacillus*, and S*accharomyces*, *Acetobacter* species called Epicin manufactured by Epicore Bionetworks Inc. were used. Epicin were farming in pond three times a week at 9.4 g / ha.

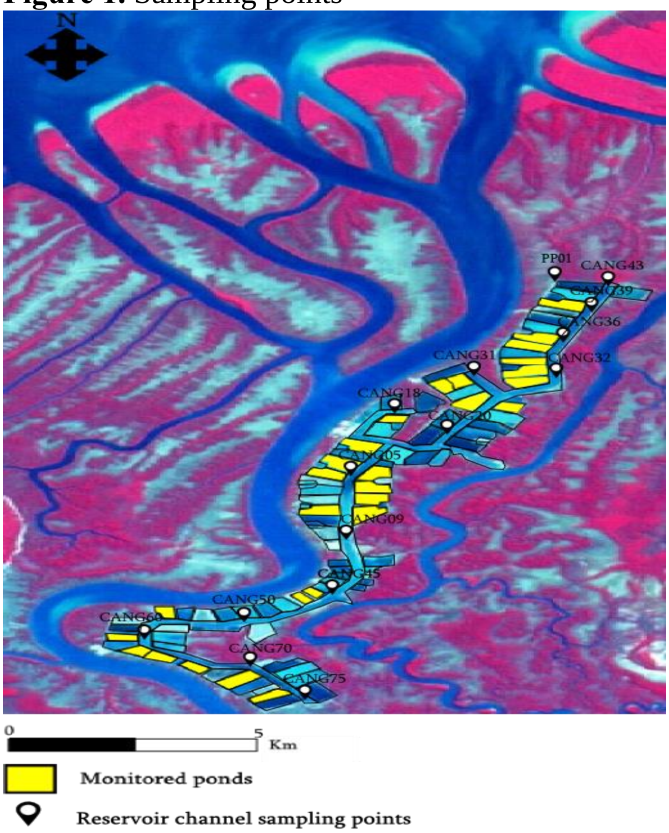
The monitoring was carried out on 30 ponds with soil bottom that had a new crop beginning in the year 2013. Pond surfaces are between 6 and 12 ha. The water level of each pond varies from 1 to 1.5 m.

Table 1. Frequency Analysis parameters monitored

<table>
<tr><td>Sampling point</td><td colspan="2">Parameters</td><td>Frequency Analysis</td></tr>
<tr><td rowspan="3">Channel reservoir</td><td colspan="2">Chemical parameters (alkalinity, MO, SS, and PO_4^- TP)</td><td>2 times a month</td></tr>
<tr><td colspan="2">Physical parameters (temperature, salinity and pH)</td><td>2 times a month</td></tr>
<tr><td colspan="2">Biological parameters (cyanobacteria concentration)</td><td>2 times a month</td></tr>
<tr><td rowspan="5">Ponds</td><td rowspan="3">Physical parameters</td><td>pH</td><td>1 time a day</td></tr>
<tr><td>Turbidity</td><td>1 time a day</td></tr>
<tr><td>Dissolved oxygen</td><td>2 times a day</td></tr>
<tr><td colspan="2">Biological parameters (Cynobacteria concentration)</td><td>4 times a day</td></tr>
<tr><td colspan="2">Gill disease</td><td>1 to week</td></tr>
</table>

MO suspended organic matter; SS: Suspended Solids; PO_4-: Rate of reactive phosphate; TP: total phosphorus ratio; pH: Hydrogen Potential.

Figure 1. Sampling points



PP01 : pumping station

The sampling of the reservoir channel points are 15 in number including: PP01, CANG43, CANG39, CANG36, CANG32, CANG31, CANG20, CANG18, CANG05: CANG09, CANG45, CANG50, CANG60 and CANG75.

The rearing ponds are monitored 30 in number as follows: G01, G03, G04, G08, G13, G14, G15, G16, G18, G25, G28, G30, G32, G33, G33bis, G34,, G36, G37, G41, G52, G53, G57, G64, G66, G67, G68, G70 and G73.

The analysis of the alkalinity (mg/l) is effected by titration with H_2SO_4 0.022 N (normal). Total phosphorus (mg/l) is obtained by the alkaline digestion followed by spectrophotometry analysis. Phosphate-phosphorus (mg/l) is performed by ascorbic acid method. Suspended solids (mg/l) is done by reading the absorbance in a spectrophotometer set at 810 nm of a mixture of water sample and distilled deionized water. Suspended organic matter (mg/l) was estimated using the calcination method.

Water temperature (°C) and dissolved oxygen (mg/l) are measured by an oximeter (HACH). PH measurement was performed with a pH meter (HACH). Salinity (‰) was measured with a refractometer (HACH). The measurement of turbidity (cm) is expressed in value with the Secchi-disk. Cyanobacteria concentration (cfu/ml) were estimated by a direct counting under microscope (x10) using a blade-Palmer Maloney cell.

Dirty gills evaluation is to assign the status of gills of shrimp to a class (Class A for low infected gills and Class D gills heavily infected).

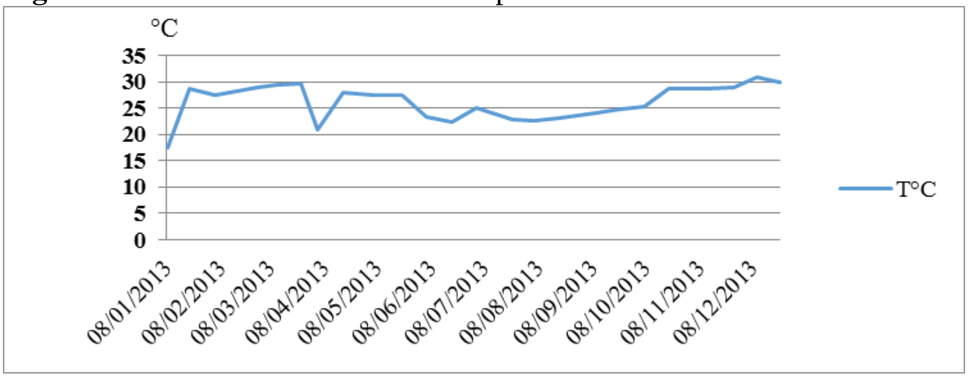
The software used was JMP 5.0.1.2. Statistical analyzes are oriented in order to demonstrate the goals. Descriptive statistics were used to characterize the water quality of the reservoir channel and rearing ponds. To know the parameters of the reservoir channel which can influence the evolution of Cyanobacteria in ponds, there was an establishment of a multiple linear regression. ANOVA was used to see if there is a significant difference between the Cyanobacteria concentration for each pond.

3. Results and Discussions

3.1 Reservoir channel's water quality

Time changes

Figure 2. Evolution in time of the temperature of the reservoir channel water

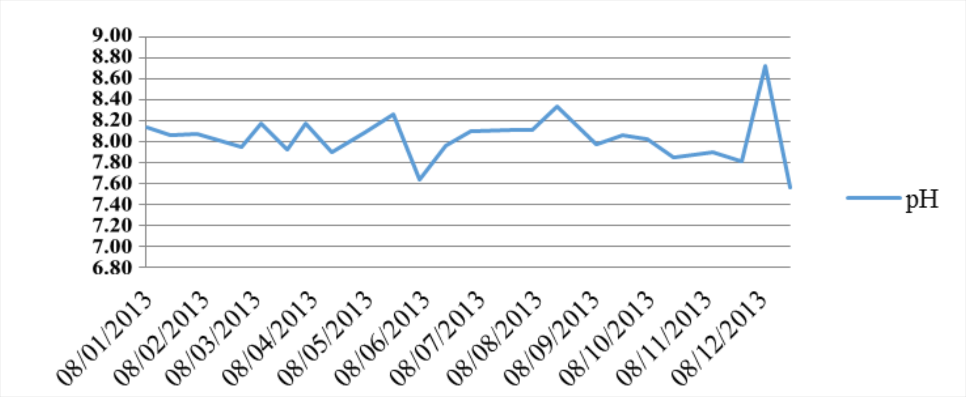


T ° C: temperature in degrees Celsius

The maximum temperature is reached in December with 30.846 ± 0.041°C. In January, a minimum of 17.526 ± 0.281°C was observed. During the month of June to September, the water temperature is always below 25 ° C.

Temperature is the first parameter to be considered in shrimp farming. All biological activity in the water column depends on it. Boyd [6] affirmed that the biological activities are doubled if the temperature increases by 10 ° C. For this study, the temperature of the water varies with the season. The analyzes which is done by Rasolonjatovo [7] was confirmed. The optimum temperature for shrimp growth is observed during the rainy season. Furthermore, in high temperature, all living things apart from shrimp accelerate their growth metabolism. Therefore, the breeding management becomes more complex, besides feeding shrimp is also intensified.

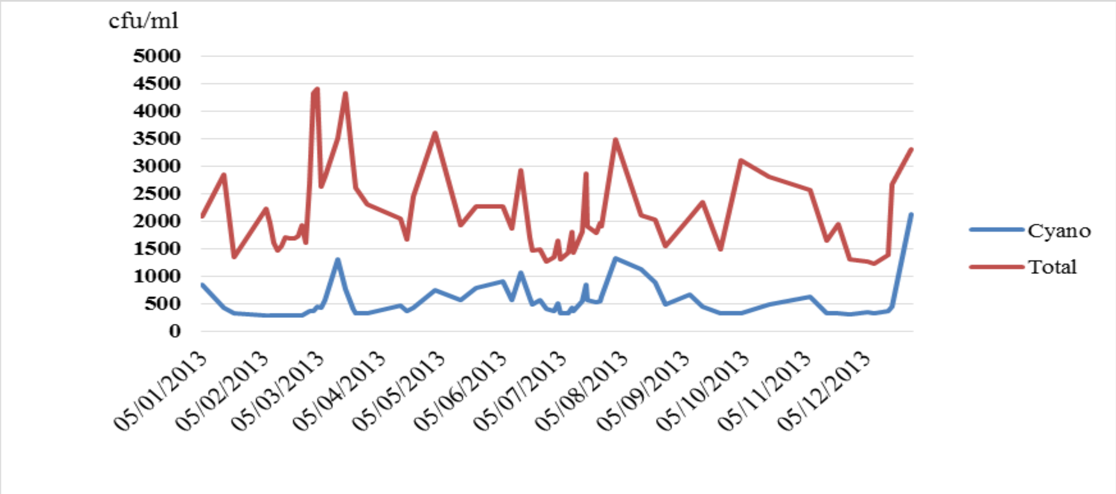
Figure 3. Evolution in time of the pH of the reservoir channel water



pH: hydrogen potential

The pH of the reservoir channel is more or less constant during the year 2013 and reached a minimum of 7.572 ± 0.094 in December and a maximum of 8.748 ± 0.032 in the same month. The average pH of the reservoir channel in the year 2013 is 8.049 ± 0.303.

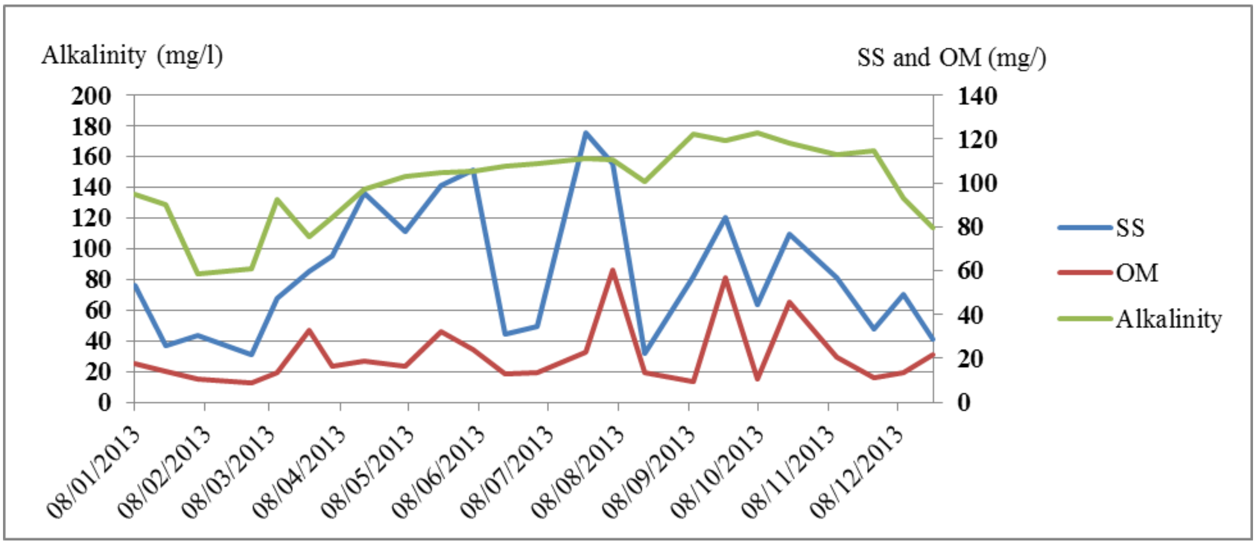
Figure 4. Phytoplankton concentration of the reservoir channel water



Cyano: Cyanobacteria concentration; Total: Total: sum of the population of Cyanobacteria + population of dinoflagellates + population Diatioms in water

Cyanobacteria growth increases concomitantly in October with a maximum of 1314.388±984.660 cfu/ml. The lowest concentration of Cyanobacteria which is 277,029±0,110 cfu/ml is reached during the rainy season especially in February. This high concentration of cyanobacteria means that the dry season is favorable for cyanobacteria growth.

Figure 5. Evolution in time of alkalinity, suspended solids and suspended organic matter in reservoir channel water



OM: suspended organic matter (mg / l), SS: suspended solids (mg / l)

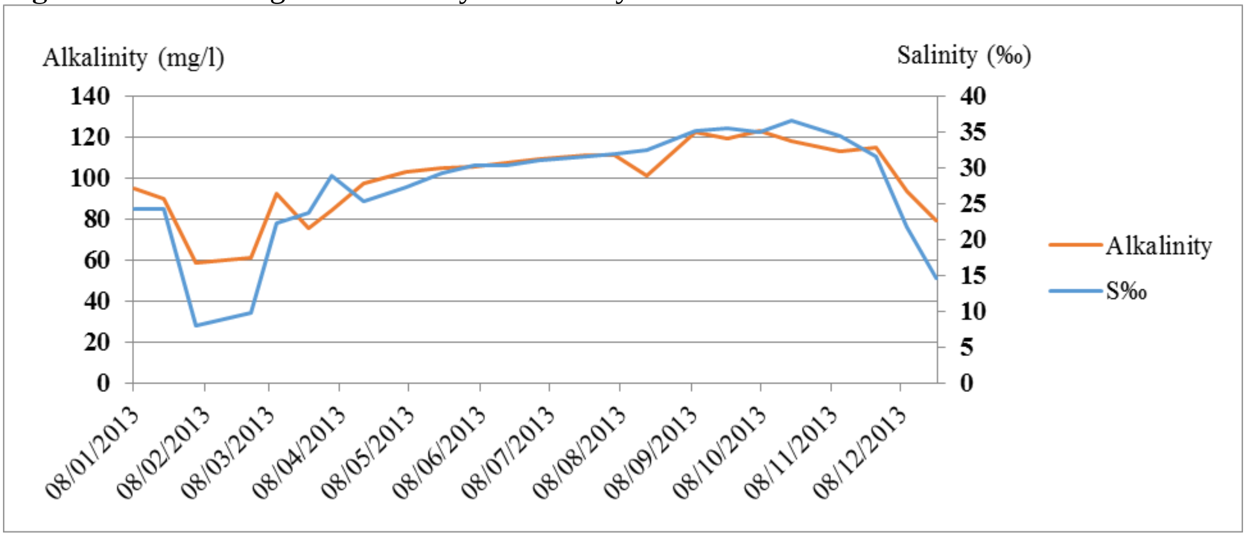
The alkalinity varies with the season; it can drop to 61.086 ± 11.513 mg/l in February. It reaches a maximum value of 122.306 ± 1.101 mg/l in October. The average alkalinity in the year 2013 is 99.782 ± 18.181 mg/l. The rate of suspended solids tends to rise when the alkalinity increases. Until February, suspended solids rate in water was down to a minimum of 30.000 ± 4.615 mg/l and increased with the alkalinity to achieve a maximum of 155.733 ± 26.312 mg / l in August. The rate of suspended solids average for the year 2013 is 88.228 ± 69.936 mg / l.

At low alkalinity, suspended organic matter changes does not bring any effect on the rate of suspended solids. But the more the alkalinity increases, the more the rate of organic matter influences the rate of suspended solids in water. The minimum concentration of suspended organic matter is encountered in February during the rainy season, with a value of 12.866 ± 1.251 mg/l. The maximum value of 83.600 ± 11.867 mg / l was observed in August during the dry season. The average value of organic matter suspended in the reservoir channel in 2013 was 30.845 ± 34.337 mg/l.

The alkalinity is the sum of all the bases throughout the water column. The study showed that the average for the alkalinity in the reservoir channel water is in the range of the standard required for shrimp aquaculture which varies from 75 to 200 mg/l [8]. The factors which promote the variation of alkalinity are liming and rain. Liming tends to increase the level of calcium in the water while the rain which is naturally acidic decreases the alkalinity in water by dilution. According to Wurts et *al*. [8], high alkalinity contributes in phytoplankton growth because it promotes the release of water-soluble phosphate. That's way the suspended solids grow with the alkalinity. At low alkalinity, change in the rate of suspended organic matter does not have any effect on the variation of suspended solids rate. But the more alkalinity increases, the more the rate of suspended organic matters tends to influence the rate of suspended solids in water. This means that at high alkalinity, suspended organic matters are dominated by phytoplankton and suspended solids are mostly suspended organic matter.

Apart from the supply line, the purpose of drying pond bottoms between crops is also a factor that can increase the availability of phosphate in the water because the mismanagement during this time can promote the release of phosphates already adsorbed during the cycle foregoing. According to Benzizoune et *al*. [9], increasing the pH of the sediment can reduce its adsorption capacity and phosphate release retained; therefore, the amount of lime to be applied during the drying pond bottoms must be reduced because it raises the pH of the soil. It should be noted that the liming is essential; but high amount, it can promote the release of phosphate already adsorbed in the sediment.

Figure 6. Time changes in alkalinity and salinity of the reservoir channel water



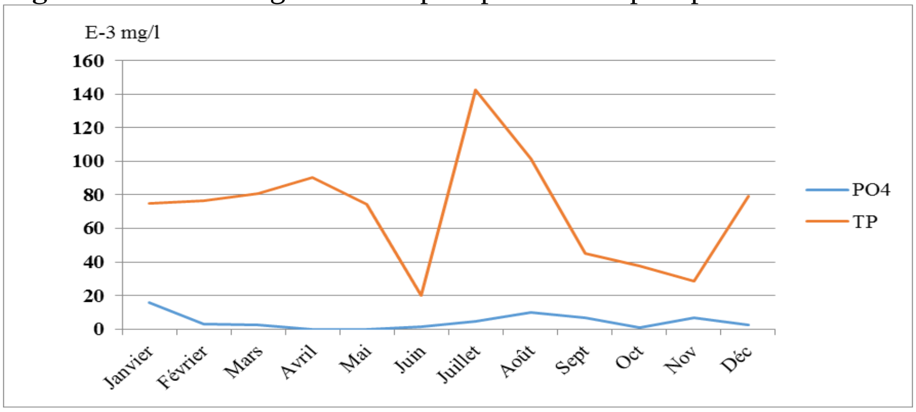
Salinity varies seasonally. It reached a minimum value of 8.730 ± 4.875 ‰ in February and a maximum of 36.400 ± 0.929 ‰ in October. The average salinity of the reservoir channel in the year 2013 is 27.579 ± 7.328 ‰. Salinity is highly correlated with alkalinity change (R^2=0.729 and adjusted R^2=0.728). The correlation equation is:

$$\text{Salinity (mg/l)} = -9{,}08353 + 0{,}3673005 \text{ Alkalinity (mg/l)} \quad (1)$$

$R^2 = 0.729$; $n = 436$

This study showed that there is a strong correlation (R^2 = 0.729 and R^2 adjusted = 0.728) between alkalinity and salinity. This is it because their variation depends on rainfall. The dilution water supplied by rain causes the decrease of both alkalinity and salinity.

Figure 7. Time changes of total phosphorus and phosphate reservoir channel water

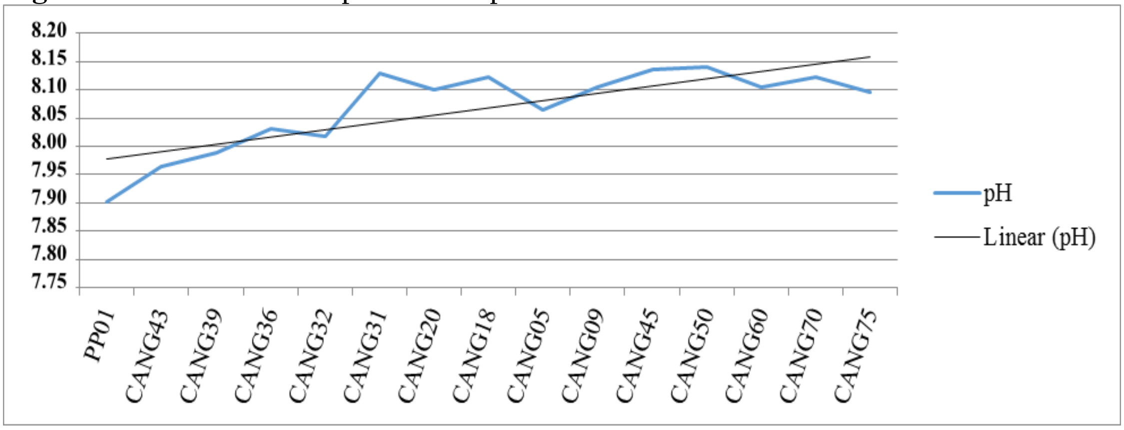


PO_4-: phosphate (mg/l); TP: total phosphorus (mg/l)

The variation of the total phosphorus concentration began with a fairly average value of 0.075 ± 0.035 mg/l in the beginning of the year and then down to 0.020 ± 0.035 mg/l in June. The maximum value was reached in July, and then it decreased progressively until November. For reactive phosphate concentration, it began to have a high rate during the dry season, with an average concentration of 0.010 ± 0.020 mg/l.

Space change

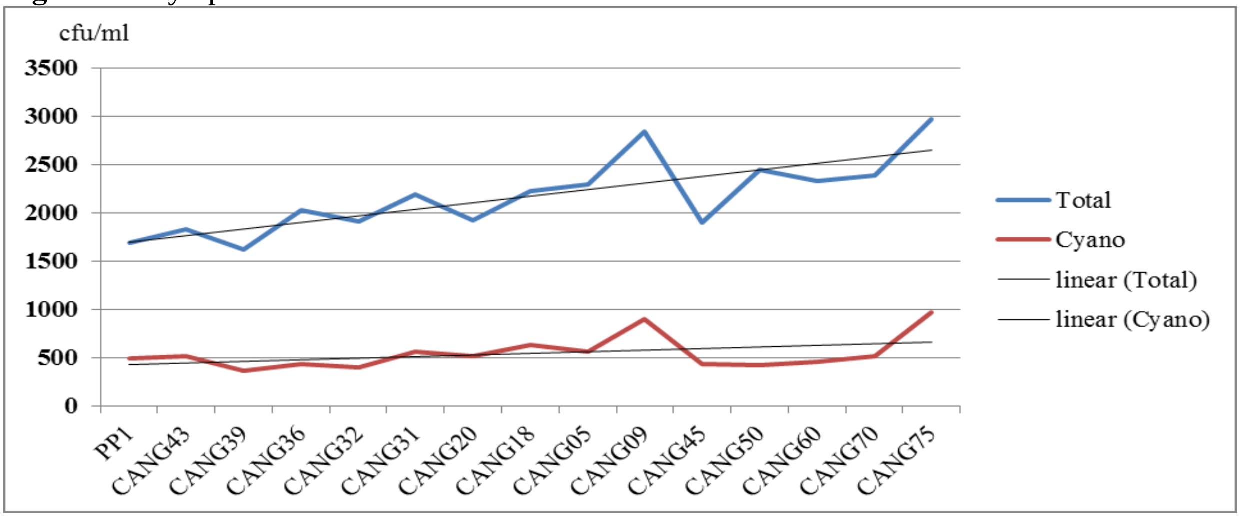
Figure 8. Distribution in space of the pH of the reservoir channel water



pH: hydrogen potential, Linear (pH) : trend of the change in pH

The pH is higher when the sampling point is moved away from the pumping station. The minimum pH value is at the pumping station with 7.903 ± 0.377 and the maximum value is registered at point CANG50 with 8.140 ± 0.205.

Figure 9. Phytoplankton concentration



Cyano: Cyanobacteria concentration; Total: Total: sum of the population of Cyanobacteria + population of dinoflagellates + population Diatioms in water; linear (total): trend of changes in the rate of phytoplankton concentration; linear (Cyano): trend of the changes in the rate of cyanobacteria concentration

The population of Cyanobacteria also increases as the pump station is far away. Indeed, cyanobacteria thrive better if they have no competitor [10]. This phenomenon is explained by the fact that the rate of dissolved oxygen decrease as the pumping station is far away from the sampling point [7] and the water becomes less favorable to the development of other than cyanobacteria algae, since cyanobacteria can use elements other than oxygen in an anaerobic condition for its growth [10]. There is also a significant difference between the pH of the water pumping station and that of the farthest point because the pH increases proportionally with increasing algal activity [6].

To avoid this heterogeneity in the reservoir channel, the best solution is to install a second pump station at the south end of the farm. Thus, all breeding ponds can enjoy a good quality of water favorable to the growth and development of shrimp.

Temperature, alkalinity, phosphate and total phosphorus don’t have any significant difference in space change.

3.2 Water quality and Cyanobacteria

This multiple regression concluded with a $R^2 = 0.550$ and R^2 adjusted = 0.517 (n = 30), alkalinity and phosphate concentration of the water of the reservoir channel are the key variables that influence the growth of cyanobacteria in ponds. The regression equation is:

$$Y\ (cfu/ml) = 2270.866\ alkalinity\ (mg/l) + 405456.700\ PO_4^{-}(mg/l) - 192755.100 \quad (2)$$

$R^2 = 0.550$ (n = 30), Y: rate of Cyanobacteria in ponds (cfu / ml), PO_4-: phosphate (mg / l)

Alkalinity and phosphate levels in the reservoir channel vary proportionally with the population of Cyanobacteria. High alkalinity and high rate of phosphate are suitable for development of Cyanobacteria. Probiotic (Epicin) is the recommended way to fight against Cyanobacteria. With high alkalinity and high phosphate concentration, probiotic cannot effectively grow to inhibit the development of Cyanobacteria in the shrimp ponds.

The appreciation of the evolution of algal bloom in the first months of aging is also important to determine the nature of the bloom which will settle in the pond along the rearing cycle [5]. During the first months of ageing, phytoplankton growth depends entirely on the quality of water filled because nutrient intake through diet is still negligible.

At the beginning of the cycle, the factor that can influence the water quality is the quality of treatment during the drying pond bottoms. During this investigation, those measures did not take place due to lack of means. Still, the standard of these regression equation residues contributed to infer that variables which are not considered in this regression have the same influence on the model [11]. Thus, in the case, treatment during the drying pond bottoms has the same effect on all considered ponds.

About the growth of Cyanobacteria, they still tend to dominate in shrimp ponds. Cyanobacteria are among the algae which are not incorporated into the food chain of the pond ecosystem. This is due to its toxin production [10], [12]. Moreover, their growth is more pronounced in the backwaters compared to running water. Alkalinity and phosphate are among the predictors of variation of changes in Cyanobacteria concentration because:

(*) At high alkalinity, the release of soluble phosphate is higher thus promoting algal growth. PH stability in this range of alkalinity is also conducive to the development of algae [8]. Besides, high alkalinity increases the salinity ($R^2 = 0.7290$). When the alkalinity is at its maximum value, the salinity is around 30 to 35 ‰. According to Blackburn et *al*. [13], Cyanobacteria have their optimum growth at salinity between 1 and 15 ‰. However, in this study, the growth of Cyanobacteria is lower at low salinity. This leads to consider the effect of probiotic at low salinity and alkalinity in inhibiting the growth of Cyanobacteria.

(**) According to Servais et *al*. [14], on the one hand, bacterial growth is correlated ($R^2 = 0.9306$) with the level of suspended solids in the water column, this means that the bacteria need to be suspended in the water column to increase their mineralization efficiency [15]. Avnimelech and Kochba [16] reported that the favorable support for bacteria to keep them in suspension in the water column is the clay particles in suspension because they have a high capacity to flocculate with bacteria and suspended organic matter. It should be noted however that these clay particles are only available during the rainy season, inwhich the inland waters are dominant in the bay [17]. Also, it is during the rainy season as the alkalinity is at its lowest level. On the other hand, the rate of biodegradable organic matter is correlated with the salinity ($R^2 = 0.885$) [14]: at high salinity, less organic matter in the water column can be used by the bacteria. Since the salinity is correlated with alkalinity ($R^2 = 0.729$). So, at high alkalinity, organic matter cannot be used by the bacteria.

Vieira and Gustavo [18] were able to demonstrate that the activity of the probiotic may reduce the levels of phosphate in the water column. Thus, if the probiotic is able to grow in the water column, the phosphate availability will be reduced. That is why, at high alkalinity, probiotic is ineffective in its role of mineralization and this inefficiency is the benefit of Cyanobacteria. They are the only ones able to grow under these conditions. Moreover, Cyanobacteria growth is supported by the availability of phosphate in these conditions.

The alkalinity is indirectly one of the parameters that can define the growth of bacteria. Normally, Cyanobacteria thrive well in low salinity but the presence of the probiotic inhibits this development. Thus, the growth of Cyanobacteria happens when there are a few bacteria activity (high alkalinity). These results demonstrate the hypothesis of Boyd [3], saying that the probiotic is effective only in an environment where they have all the elements necessary for their growth, such as: the support for them to be in suspension and the availability of biodegradable nutrients. The availability of these elements depends on the alkalinity. The change in alkalinity leads variations in salinity, suspended solids, biodegradable organic matter and phosphate availability.

3.3 Ponds

Even without the start fertilizer, no macrophytes algae were noted in ponds. Thus, the water in the reservoir channel contains enough nutrients for growth and development of phytoplankton once accumulated in the grow-out ponds [5]. During the first thirty days of culturing, no severe mortality was observed in ponds. The difference in daily water exchange for each pond is not significant. However, in ponds with high Cyanobacteria concentration, gill soaking were frequently observed. Dirty gills early-cycle already mean premature deterioration of the rearing environment [19].

It should be noted that during the first thirty days of the cycle, followed ponds didn’t undergo any treatment liming. The only factor that could change the alkalinity is rain. That is why the alkalinity of the water added to the rearing ponds is equal to or more than that of water in the reservoir channel. Analysis of data on the evolution of Cyanobacteria for each pond showed a significant difference in their growth in taking as a factor the season of each crop starting (Table 2).

Table 2. Typology of the Population of Cyanobacteria in basins

Starting crops	Ponds	Average population of cyanobacteria (cfu / ml)	Proportion
23/09/2013	G32	205143.931±149882.952[a]	99 %
28/10/2013	G73	155067.530±119617.261[ab]	97 %
19/08/2013	G34	124380.611±110369.242[abc]	99 %
22/10/2013	G41	99976.800±120142.635[bcd]	88 %
15/07/2013	G28	81123.980±84250.600[cd]	77 %
16/12/2013	G37	3398.645±3066.757[e]	84 %
27/05/2013	G52	1581.451±2755.055[de]	42 %
23/12/2013	G33bis	1468.850±3848.515[e]	52 %
25/03/2013	G15	977.785±1721.832[de]	51 %
17/06/2013	G53	693.640±558.363[de]	54 %
04/02/2013	G57	564.747±239.651[e]	36 %

cfu / ml: colony size unit per milliliter.

Table 2 describes the significant growth of Cyanobacteria during the dry season, when the alkalinity is at its highest rate in August to October. In the dry season, the average value of Cyanobacteria in the reservoir channel can vary from 397.611 ± 210.365 to 952.382 ± 555.320 cfu/ml with a proportion of 13% to 41% of the total phytoplankton. Once accumulated in the pond, the population of Cyanobacteria grows exponentially to reach a value of 81,123.980 ± 84,250.600 to 205,143.931 ± 149,882.952 cfu/ml or 77% to 99 % of total phytoplankton. This high proportion in the ponds marks out their excessive dominance in the phytoplankton population of breeding ponds in the dry season.

Excessive dominance of undesirable algae in rearing ponds causes negative impacts on the shrimp consumption rate [20]. The early growth of these Cyanobacteria may hurt production especially at the end cycle in which the rearing environment is increasingly eutrophic. In addition, this early growth of Cyanobacteria is an indicator that gives an opportunity to develop preventive methods to ensure the welfare of shrimp at the end of the cycle.

Identification and characterization of ponds with bioremediation

According to Castex [2] and De Paiva-Maia et *al*. [12], the probiotic inhibits growth of cyanobacteria. Thus, the ponds which are able to install optimal bioremediation are those where growth in Cyanobacteria tend to decrease. These ponds are those that began a cycle during the rainy season. These ponds can be distinguished: G57, G53, G15, G33bis, G52, G37 (Table 2). These ponds provide an overview of the effectiveness of probiotic acting on the physical quality of the water column. This means that the water quality of the rainy season is an advantage for bacteria Epicin to fight against undesirables algae. The Table 3 illustrates the mean values of the physical parameters of the water quality in these ponds.

Table 3. Parameter values for water ponds bioremediation

Parameters	Minimum	Maximum	Mean	SD
RE (%)	0	29.701	2.322	5.207
Am temperature (°C)	21	31.600	27.225	2.796
Pm temperature (°C)	24	34.800	29.514	2.786
Salinity (‰)	11	39	25.892	7.663
Secchi (cm)	20	100	55.004	18.757
Am pH	8	8.600	8.358	0.105
Pm pH	8.200	8.900	8.619	0.136
Am dissolved oxygen (mg/l)	3.500	7.200	5.234	0.638
Pm dissolved oxygen (mg/l)	4	11.401	7.879	1.137
Gill disease (%)	75	100	96.579	5.198
Cyano (cfu/ml)	277	76920	2652.065	7302.633
Dyno (cfu/ml)	277	6658.560	452.309	687.005
Diat (cfu/ml)	277	9432.960	633.750	1208.715
Total (cfu/ml)	831	77474.880	3738.132	7382.342
Aer time on (h/week)	6	124	45.271	31.547

cfu / ml: colony size unit per milliliter; RE: Average daily water exchange; Am Temperature: Water temperature in the morning; Pm Temperature: Water temperature in the early evening; Salinity: salinity; Secchi measurement of turbidity in cm; Am pH: pH of the water in the morning; pm pH: pH of the water in the early evening; Bsa: percentage of shrimp without dirty gills disease; Cyano: population of Cyanobacteria in water; Dyno: population of dinoflagellates in water; Dyat: population of diatoms in water; Total: sum of the population of Cyanobacteria + population of dinoflagellates + population Diatioms in water, and; Aer Time On: time work of the aerator.

The dominance of bacterial activity reduces the effect of algal activity on the water column; this is characterized by low pH change and a small change in the level of dissolved oxygen morning and evening. Since the plankton population is the main source of oxygen, in ponds with probiotic, it is replaced by the aerators.

The probiotic is introduced into culturing ponds to maintain water quality to be favorable to the growth and development of shrimp, but according to some authors, the probiotic had no significant effect on water quality [4], [21]. Furthermore, Padmavathi et *al*. [22] were able to demonstrate that the probiotic inhibits development occurred following the deterioration of the water quality pathogenic bacteria. Also, it reduces the concentration of ammonia, nitrite and phosphate in water.

This study demonstrates the potential effects of the probiotic that does not confirm those reported by Padmavathi et *al*. [22] and De Paiva-Maia et *al*. [12] stating that the probiotic is still effective when introduced into a breeding pond. Indeed, there are cases where the addition of the probiotic had no significant effect on the maintenance of the quality of the environment and this is reflected on the growth of cyanobacteria.

Probiotics can fight against cyanobacteria because:

(*) the probiotic competes in available nutrients with the cyanobacteria [23], and;

(**) the probiotic, through the mineralization, prevents the eutrophication of the environment and promotes a favorable environment for the development of other phytoplankton species that can compete with cyanobacteria [8], [23].

4. Conclusions

The probiotic can preserve an environment conducive to shrimp farming areas, because the value of the parameters are in the standard for shrimp farming. This investigation reported throughout the rearing cycle, can be considered as a reference for estimating the carrying capacity and maintaining an environment favorable to the development of probiotic until the end of the crops. Knowledge of the effectiveness of the probiotic in the early breeding makes it possible to adjust the breeding management to preserve these rearing conditions throughout the cycle. Using probiotic is one of the mean used to ensure a sustainable development of shrimp farming.

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Conflict of Interest

The authors declare no conflict of interest.

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