

A comparison of bio-fermented solutions from fish waste, shrimp waste, and crab waste on water quality and the growth rate of sea grapes (*Caulerpa lentillifera*).

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Abstract

This study aimed to compare the effects of bio-fermented liquids derived from shrimp, crab, and fish waste by-products of seafood processing on water quality and the growth performance of Green Caviar (*Caulerpa lentillifera*). Three formulas were prepared using equal proportions of each waste type and assigned to four experimental treatments: 1. Control, 2. Shrimp waste bio-ferment, 3. Crab waste bio-ferment, and 4. Fish waste bio-ferment. These treatments were applied to one-month-old Sea Grapes cultivated under identical environmental conditions for a duration of 8 weeks, with water quality and growth parameters (weight and frond length) monitored every 7 days. The results revealed that the pH levels in all experimental treatments remained neutral, while Treatment 3 (crab waste) achieved the highest Dissolved Oxygen (DO) level at 6.80 ± 0.21 mg/L. This superiority is attributed to the calcium carbonate in crab shells, which helps stabilize the water's pH, and the slower decomposition rate of crab waste, which reduces microbial oxygen consumption. Regarding salinity, Treatment 2 (shrimp waste) recorded the highest value at 33.90 ± 1.09 ppt, likely due to the high mineral and salt content typically accumulated in shrimp from their marine habitats, which is released during fermentation. The surface water temperature remained consistent across all treatments at 29.01 ± 0.59 degrees Celsius. In terms of growth performance, Treatment 3 showed the greatest increase in both weight and frond length, followed by Treatment 4, 1, and 2, respectively. This optimal growth in the crab waste treatment is due to its high chitin content, which serves as a crucial nitrogen source and growth stimulant. Furthermore, the presence of calcium carbonate and essential minerals not only buffers the pH but also reinforces the cellular structure of the Green Caviar.

Keywords: bio-fermented liquids, water quality, growth performance

Introduction

Sea Grapes (*Caulerpa lentillifera*) has gained significant attention in both aquaculture and nutritional science due to its superior nutritional profile, containing essential minerals and amino acids rarely found in terrestrial plants, while being low in calories, salinity, and fat. The growth and physiological integrity of *C. lentillifera* are highly dependent on water quality parameters, including pH, dissolved oxygen (DO), salinity, and temperature. Despite its potential, high production costs remain a substantial barrier, limiting the accessibility of its cultivation to large-scale investors or specific groups of farmers.

Concurrently, the improper disposal of seafood processing waste—such as fish, shrimp, and crab remains—poses a significant threat to aquatic ecosystems. Transforming these organic wastes into bio-fermented liquids offers a sustainable solution to enhance nutrient availability and manage water quality in seaweed cultivation. Since different biological raw materials yield varying nutrient compositions, it is crucial to evaluate their specific impacts on algal growth. This study, therefore, aims to utilize seafood by-products to produce bio-fermented liquids and investigate their efficacy in promoting the growth of Sea Grapes and their effects on water quality. The findings of this research serve to add value to seafood waste, mitigate environmental pollution, and establish a cost-effective, sustainable framework for small-scale seaweed aquaculture in the future.

Research Questions

1. Does water quality change when sea grapes are cultured using bio-fermented solutions, and if so, how?
2. Do bio-fermented solutions affect the growth rate of sea grapes, and if so, how?

Hypothesis

1. Water quality obtained from culturing sea grapes using bio-fermented solutions shows changes.
2. Bio-fermented solutions affect the growth rate of sea grapes.

Materials

- | | |
|-------------------|------------------------|
| 1. pH Meter | 7. Plastic Baskets |
| 2. Salinity Meter | 8. Digital Scale |
| 3. DO Meter | 9. Molasses |
| 4. Thermometer | 10. LDD 2 Activator |
| 5. Air Pump | 11. Fermentation Tanks |
| 6. Plastic Basins | 12. Lighting System |

Methods

1) Study sites

The study was conducted at the coastal area of the Blue Crab Learning Center at Trang Province, Thailand, take samples from 1 study sites



Blue Crab Learning Center ,Trang.
(Latitude 7.5524"N)
(Longitude 99.5584"E)

2) Preparation of Bio-Fermented Liquid

The bio-fermented liquid was prepared by mixing 2 liters of clean water with 1 liter of molasses and 1 kilogram each of fish, shrimp, and crab scraps. The ingredients were stirred in a fermentation vessel until a homogeneous mixture was obtained. Subsequently, the LDD 2 microbial activator was inoculated into the mixture at a ratio of 1 gram per 2 liters of the fermenting liquid. The vessel was tightly sealed and the fermentation process was maintained for a duration of 15 days. During the fermentation period, the container was periodically opened and the contents were stirred to release accumulated gases. Upon completion, the mixture was filtered to separate the solid residue from the liquid. The final bio-fermented product was stored in a clean, airtight container for further experimental application.

3) Experimental Design and Acclimatization

Each treatment was conducted in basins containing 8 liters of seawater. One-month-old sea grapes (*Caulerpa lentillifera*) were initially acclimatized in the seawater for 3 days prior to the commencement of the experiment. The experimental design consisted of four distinct groups, each performed in triplicate (12 basins in total): Group 1 served as the control (seawater only), while Groups 2, 3, and 4 were treated with bio-fermented liquids derived from shrimp, crab, and fish scraps, respectively. For the treated groups, the bio-fermented liquid was added at a ratio of 1 mL per liter of seawater.

In each basin, 130 grams of the pre-conditioned sea grapes were introduced, and an aeration system was installed to maintain a consistent level of dissolved oxygen. The experiment was conducted within a nursery house under controlled thermal conditions, with temperatures ranging between 20–35°C and 6 hours of daily natural light exposure. To maintain the environment, seawater was replenished every 7 days throughout the study period.

4) Water Quality Monitoring and Growth Rate Analysis

Water quality parameters for all experimental groups were monitored following the GLOBE Program protocols. The physical and chemical properties, including pH level, dissolved oxygen (DO), salinity, and surface water temperature, were measured and recorded. To evaluate the growth performance of the sea grapes (*Caulerpa lentillifera*), the wet weight and frond length were measured every 7 days. All collected data were systematically recorded to analyze the correlation between water quality and the growth rate of the sea grapes throughout the experimental period.

5) Data Analysis

1. Analyze water quality and growth rates of sea grapes using arithmetic mean and standard deviation.
2. Compare water quality and growth rates among experimental groups using One-way ANOVA.

Results

1. Water Quality Analysis

1.1 Analysis of Average pH Levels

The study of average pH levels in the water indicated that Treatment 1 (Control) had the highest average pH, followed by Treatment 3, Treatment 2, and Treatment 4, respectively, as shown in Figure 2.

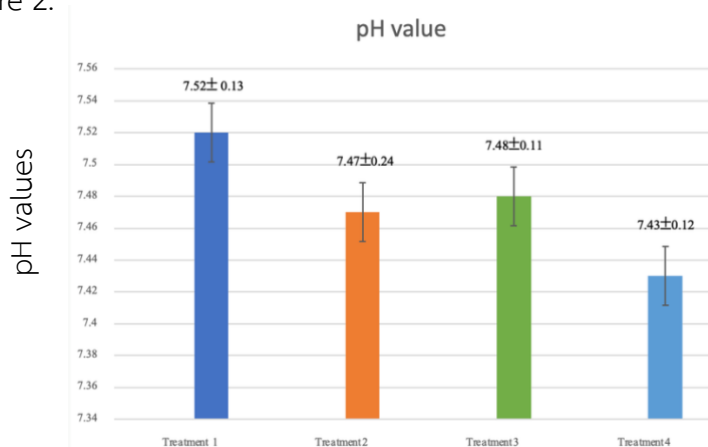


Figure 2 : Shows a bar chart of average pH values.

1.2 Analysis of Average Dissolved Oxygen (DO) Levels

The study of average dissolved oxygen (DO) levels in the water revealed that Treatment 1 had the highest average DO, followed by Treatment 3, Treatment 2, and Treatment 4, respectively, as shown in Figure 3.

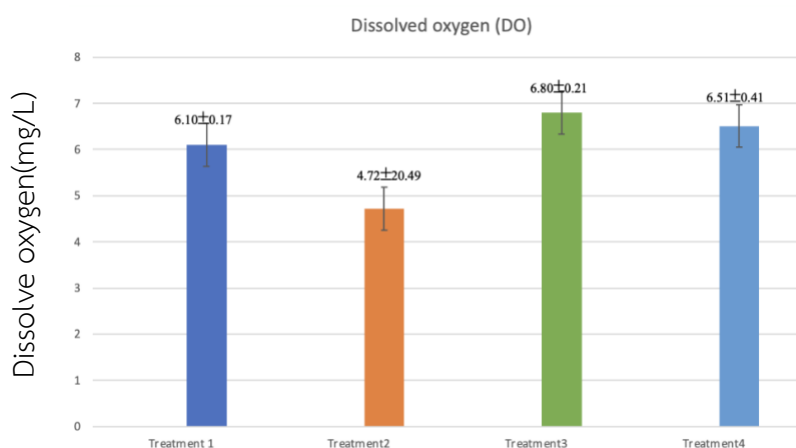


Figure 3 : Show a bar chart of average Dissolve oxygen (DO) values

1.3 Analysis of Average Salinity Levels

The study of average salinity levels in the water revealed that Treatment 2 had the highest average salinity, followed by Treatment 4, Treatment 1, and Treatment 3, respectively, as shown in Figure 4.

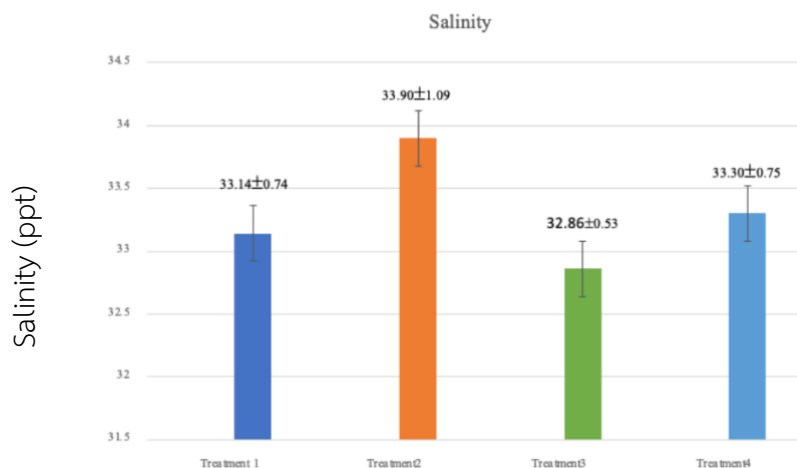


Figure 4 : Show a bar chart of average salinity levels.

1.4 Analysis of Surface Water Temperature

The study of surface water temperature indicated that the temperatures ranged between 28.4°C and 29.9°C, as shown in Figure 5.

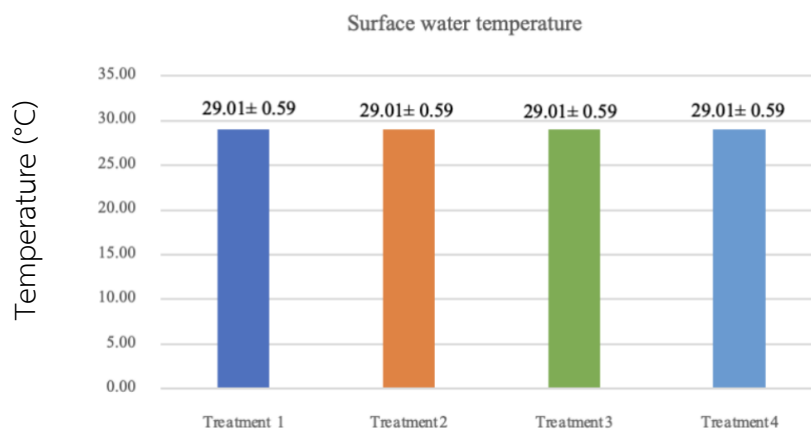


Figure 5 : Show a bar chart of temperatures for each week.

2. Growth Analysis of Sea Grapes (*Caulerpa lentillifera*)

The study of sea grape growth indicated that the growth rates were statistically significant across all treatments. Treatment 3 achieved the highest results in both wet weight and frond length, as illustrated in Figure 6 and Figure 7, respectively.

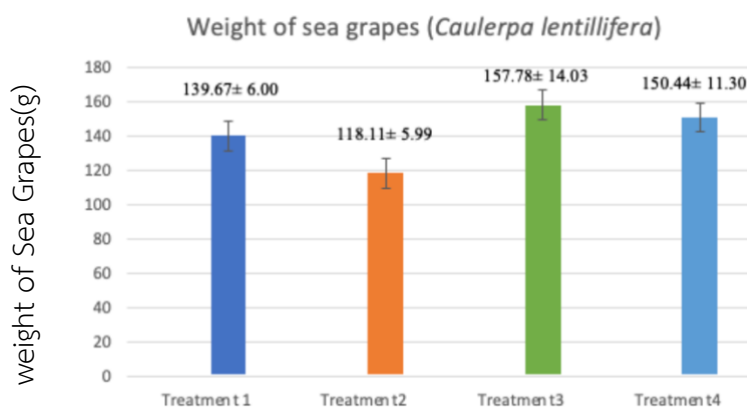


Figure 6 : Show a bar chart of displaying the average weight of sea grapes

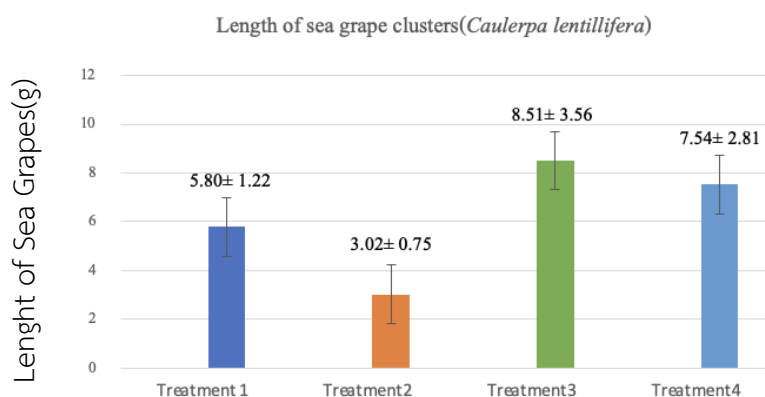


Figure 7 : Show a bar chart of displaying the average Lenght of sea grapes

Discussion and Conclusions

The study on the application of bio-fermented liquids from fish, shrimp, and crab waste for Sea Grapes cultivation revealed that while all experimental groups maintained a neutral pH balance, the crab waste bio-ferment achieved the highest dissolved oxygen level at 6.80 ± 0.21 mg/L. This superior water quality is attributed to the presence of calcium carbonate in crab shells, which effectively buffers the water and stabilizes acidity. Furthermore, the slower decomposition rate of crab waste resulted in minimal oxygen consumption by microorganisms, thereby maintaining high dissolved oxygen levels. Regarding salinity, the shrimp waste bio-ferment recorded the maximum value at 33.90 ± 1.09 ppt because shrimp

remains contain high concentrations of salts and minerals that dissolve into the water during the fermentation process. Meanwhile, the surface water temperature remained consistent across all treatments at 29.01 ± 0.59 degrees Celsius.

In terms of growth performance, the crab waste bio-ferment produced the most significant results with a maximum weight of 175 grams and a frond length of 14.2 cm, followed by the fish waste bio-ferment, the control group, and the shrimp waste bio-ferment, respectively. The optimal growth observed in the crab waste group is due to its high chitin content, which serves as a vital nitrogen source and a primary growth stimulant for the algae. The combination of calcium carbonate and essential minerals also reinforced the cellular structure of the Sea Grapes and ensured environmental stability. In contrast, the shrimp waste bio-ferment resulted in the lowest weight and frond length because the high salt content in shrimp shells led to unstable salinity levels, while the lower chitin content provided an insufficient nitrogen source for healthy development.

Acknowledgements

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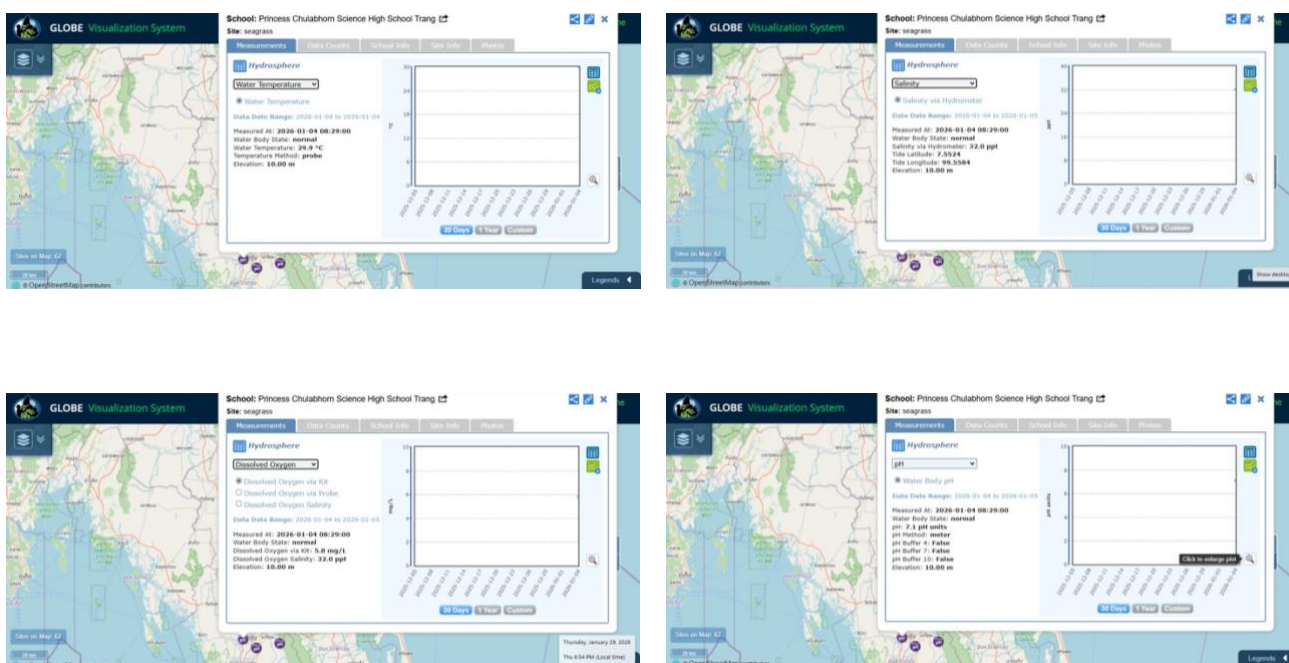
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GLOBE's databases



Optional Badges

1. I am a collaborator

We collaborated with local community members, this research was conducted to optimize sea grape cultivation in response to specific environmental conditions and local challenges. The project was characterized by a strong spirit of unity and collaborative effort, with responsibilities distributed effectively among team members to ensure the successful completion of the study.

2. I make an Impact

We demonstrate a successful model for circular aquaculture by converting fishery by-products into high-value organic nutrients. The findings provide a sustainable framework for enhancing *Caulerpa lentillifera* productivity while maintaining water quality stability through biological sequestration. The project empowers the local community by providing a low-cost, eco-friendly alternative to commercial fertilizers, significantly reducing production overhead for sea grape farmers. Our collaborative approach fosters community resilience and integrates local wisdom with scientific innovation to solve environmental challenges.

3. I am a Data Scientist

We are a leader in various tools, both technical and statistical. We collect data for analysis from raw data. We are good communicators with management and pay attention to every detail in operations. We have problem-solving skills, including presentation skills, and the ability to explain complex ideas in an easy-to-understand format.