Biological treatment of wastewater in marine shrimp farm with *Enhalus acoroides* grown in paper cups and gunnysack

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Abstract

The marine shrimp farming industry is a vital economic pillar for Southern Thailand. However, the cultivation process requires substantial water consumption and generates wastewater laden with inorganic pollutants, specifically ammonia-nitrogen, nitrite-nitrogen, nitrate-nitrogen, and orthophosphate. Excessive accumulation of these substances poses significant threats to aquatic life and marine ecosystems. Current treatment methods, such as sedimentation and continuous aeration, incur high operational costs, while chemical-based biological treatments often leave harmful residues. Simultaneously, field observations at Hat Mod Tanoy, Trang Province, revealed a severe degradation of Enhalus acoroides (Tape seagrass). Conventional propagation methods involving rhizome immersion in seawater exhibit slow growth rates, insufficient for timely ecological restoration.This study, titled "Biological treatment of wastewater in marine shrimp farm with Enhalus acoroides grown in paper cups and gunnysack" explores the dual benefits of phytoremediation and accelerated seagrass growth. Drawing on research from Prince of Songkla University, which highlights the nutrient-absorption capabilities of seagrass, this project aims to evaluate the efficiency of wastewater treatment and compare different cultivation techniques. The experiment consists of four treatments, each with three replicates:1. Shrimp farm wastewater with sand cultivation. 2. Shrimp farm wastewater with paper cup cultivation. 3. Shrimp farm wastewater with jute sack cultivation. 4. Natural seawater without sand (Control).Growth performance will be assessed based on leaf width, leaf length, and leaf count, alongside survival rates. Water quality parameters, including pH, temperature, transparency, dissolved oxygen (DO), nitrate, nitrite, and salinity, will be monitored. The findings of this research are expected to provide an optimized approach for marine ecosystem restoration and enhance the efficiency of wastewater management in the shrimp farming industry.

Keywords : water treatment, *Enhalus acoroides*, breeding, paper cups, gunnysack

Research Question:

1.Does the quality of marine shrimp farm wastewater differ when treated with tape grass cultivated in paper cups and gunnysack?

2.Does the growth of tape grass vary between cultivation in paper cups and gunnysack within a shrimp farm wastewater environment differ?

Hypothesis:

1.The quality of shrimp pond effluent treated with tape grass cultivated in paper cups differs from that treated with tape grass cultivated on gunnysack.

2.The growth rate and survival rate of tape grass cultivated in paper cups differ from those cultivated on gunnysaclk.

Introduction:

The marine shrimp farming industry is a vital economic pillar for Southern Thailand. However, the cultivation process requires substantial water consumption and generates wastewater laden with inorganic pollutants, specifically ammonia-nitrogen, nitrite-nitrogen, nitrate-nitrogen, and orthophosphate. Excessive accumulation of these substances poses significant threats to aquatic life and marine ecosystems. Current treatment methods, such as sedimentation and continuous aeration, incur high operational costs, while chemical-based biological treatments often leave harmful rest. At once, field observations at Hat Mod Tanoy, Trang Province, revealed a serious degradation Tape seagrass. Conventional propagation methods involving rhizome immersion in seawater exhibit slow growth rates, poor for timely ecological restoration.This study, Biological treatment of wastewater in marine shrimp farm with tape grass grown in paper cups and gunnysack explores the dual benefits of phyto management and accelerated seagrass growth. Drawing on research from Prince of Song Ila University, which highlights the nutrient-absorption capabilities of seagrass, this project aims to evaluate the efficiency of wastewater treatment and compare different cultivation techniques. The findings of this research are expected to provide an optimized approach for marine ecosystem restoration and enhance the efficiency of wastewater management in the shrimp farming industry.

1) Materials

1.1. gunnysack

1.2. paper cups

1.3. tank for tape grass cultivated

1.4. air pump

1.5. Water thermometer

1.6. pH meter

1.7. DO meter

1.8. TDS meter

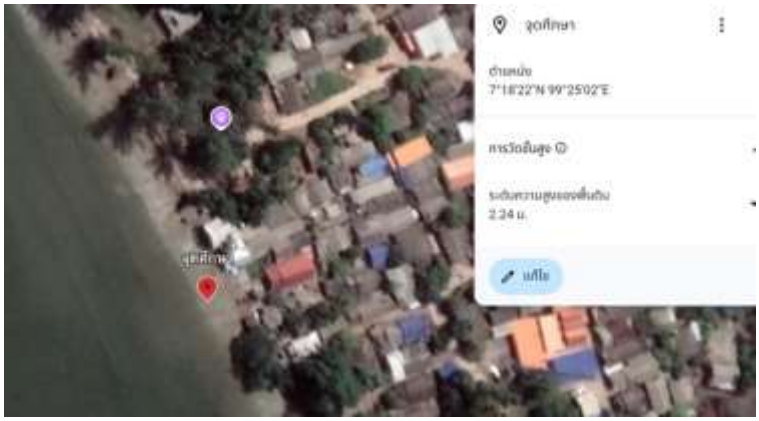
1.9. Salt meter

1.10. Tape measure

Methods

1) Study site

This research was conducted at Modtanoi Beach, Trang Province, latitude 7.306111, longitude 99.417222.



ภาพที่ 1 แสดงจุดศึกษาหาดมดตะนอย จังหวัดตรัง

2) Experimental Design

First, healthy seagrass rhizomes were selected for the experiment. The experiment was divided into 4 main formats (3 replicates each) to compare seagrass growth and water quality:

2.1 Controller Set: Cultured in shrimp farm effluent using sand as a natural planting substrate.

2.2 Original Method: Cultured in normal seawater without using sand.

2.3 Paper Cup Set: Planted in shrimp farm effluent using paper cups as a rhizome support material.

2.4 Gunnysack Set: Planted in shrimp farm effluent using gunnysacks as a rhizome support material.

Picture 2 gunnysack set

Picture 3 original set

Picture 4 Controller set

Picture 5 Paper cups set

3) Data Collection and Measurement

Water quality and seagrass (Halophila ovalis) growth were monitored by applying GLOBE (Global Learning and Observations to Benefit the Environment) protocols for water measurement.:

1. Water Quality Protocol

Following GLOBE principles, water quality data was collected from the tanks at the same time every day to minimize temperature influence:

- **pH:** Use a pH meter or pH test paper according to GLOBE standards. It is essential to calibrate the instrument before every use to ensure precision and accuracy in monitoring changes in the effluent.
- **Dissolved Oxygen (DO):** Measured using a DO Meter to analyze the relationship between seagrass photosynthesis and water quality.
- **Total Dissolved Solids (TDS):** Measured using a TDS Meter to evaluate the concentration of dissolved substances and minerals in the effluent.

2. Seagrass Growth (Land Cover/Biometry Protocol)

Biometric methods were applied to monitor plant response to the planting materials

- **Leaf Counting:**
    - New leaves were counted weekly.
    - The percentage change was calculated using the formula:

      ((New leaves – Initial leaves)/ Initial leaves)*100

- **Leaf Morphometrics:**

  A ruler or vernier caliper was used to measure the Width and Length of randomly selected leaves to compare physical growth rates between materials

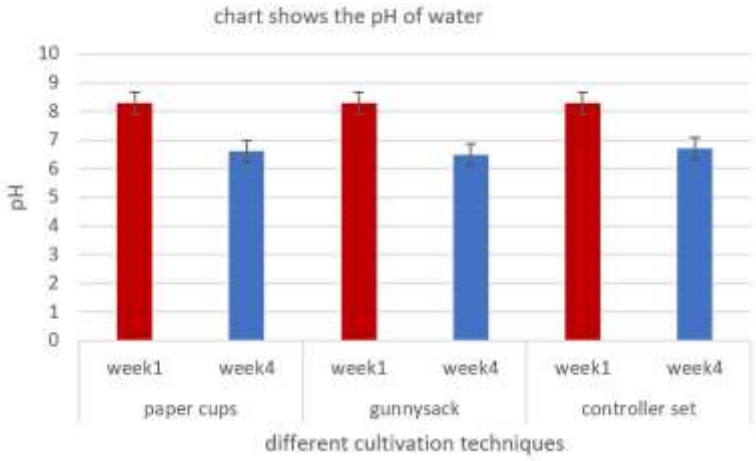
4) Data analysis

- average
- pair sample t-test

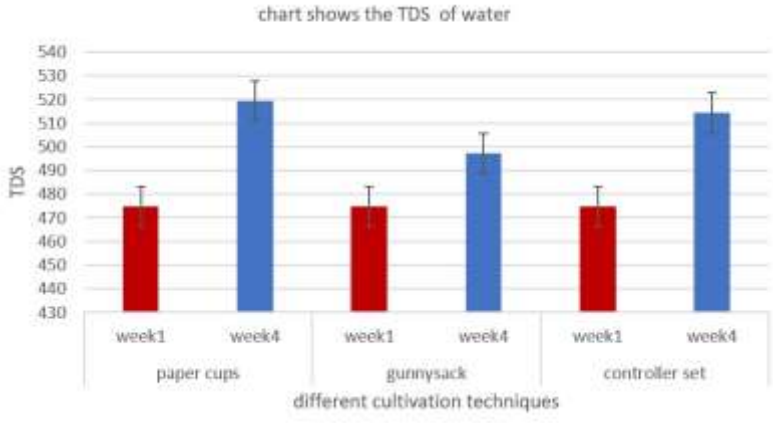
Results:

This science project, Biological Treatment of Wastewater from Marine Shrimp Farms using Seagrass (*Enhalus acoroides*) Grown in Paper Cups and Gunnysacks,' is divided into two parts 1. Experimental study on the quality of effluent from marine shrimp farms, comparing the Controller, Gunnysack, and Paper cups sets. Part 2: Study of seagrass growth, comparing the Control, Gunnysack, Paper cups sets, and Original Method groups.

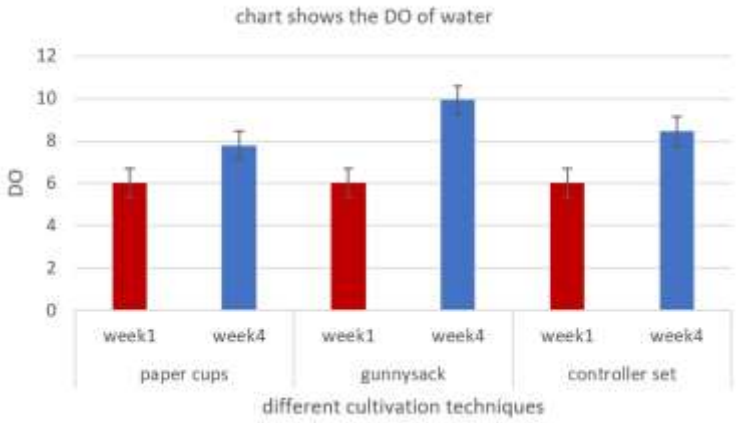
Part 1: Experimental Study of Effluent Quality from Marine Shrimp farm



picture 6: this chart shows the pH of water

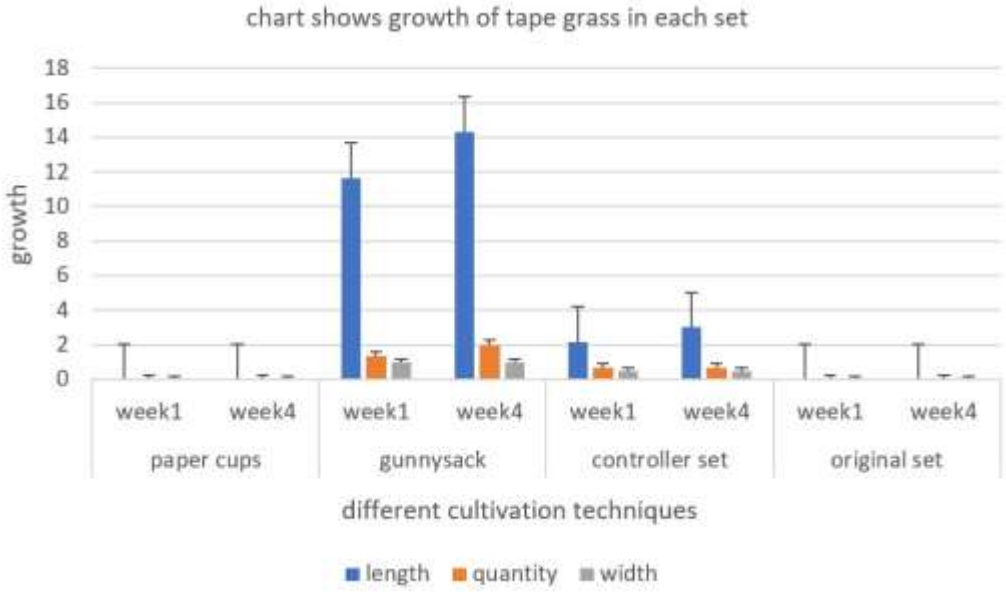


picture 7: this chart shows the TDS of water



picture 8: this chart shows the DO of water

Part 2 A study of seagrass growth following the four cultivated methods.



picture 9 : this chart shows growth of tape grass in each set

Discussion and Conclusion:

Efficiency in Improving Effluent Quality (Hydrosphere Impact): The study found that Halophila ovalis has significant potential to improve shrimp farm effluent quality, particularly by increasing Dissolved Oxygen (DO) and stabilizing pH suitable for the ecosystem. When comparing support materials, "Gunnysack" was the most effective.

Growth Rate and Biological Factors (Biosphere/Biometry): Biometric results show that planting material significantly affects survival and development. Seagrass planted in gunnysacks had the highest growth rate in terms of leaf number, width, and length over 4 weeks.

This study proves that using gunnysacks as a support material for seagrass is the Optimized Design for environmental engineering in shrimp farm wastewater treatment. It promotes both plant growth and water rehabilitation efficiency. This data can be applied as a prototype for marine ecosystem restoration and local pollution management, leading to global sustainability in accordance with GLOBE guidelines.

Acknowledgments

Biological treatment of wastewater in marine shrimp farm with *Enhalus acoroides* grown in paper cups and gunnysack has been successfully completed. Thank you to the school administrators. Teachers of Princess Chulabhorn Science High School Trang for their support and thank Mrs. Sirikwan Nuphuti for providing advice, advice and guidance on solutions and defects that are extremely beneficial to the project.

Citations:

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Submit the collected data to the GLOBE Data Entry system:

pH	
Measured Date:	2026-01-28
Organization Name:	Princess Chulabhorn Science High School Trang
Site ID:	409318
Site Name:	สาหร่าย เรือนเพาะชำ
Country Name:	Thailand
Country Code:	THA
Latitude:	7.55476
Longitude:	99.5583
Elevation:	10.9m
Measured At:	2026-01-28T13:06:00
Water Body pH:	7.5 pH units
Water Body State:	normal
pH Method:	meter
pH Buffer 7:	true

Dissolved Oxygen	
Measured Date:	2026-01-28
Organization Name:	Princess Chulabhorn Science High School Trang
Site ID:	409386
Site Name:	[illegible]
Country Name:	Thailand
Country Code:	THA
Latitude:	7.1875
Longitude:	99.6832
Elevation:	7m
Measured At:	2026-01-28T15:14:00
Water Body State:	normal
Dissolved Oxygen Salinity:	26 ppt
Dissolved Oxygen via Kit:	6 mg/L
Oxygen Kit Mfg:	other
Oxygen Probe Mfg:	other

Badges:

I am an Earth System Scientist: This project demonstrates the link between the Hydrosphere (shrimp pond effluent quality) and the Biosphere (seagrass growth). The researchers applied GLOBE inquiry methods to investigate both physical-chemical water quality and biometry to explain systemic interactions. The study analyzes how inorganic substances in water affect plants and how plants restore water balance, reflecting an understanding of the changing and interdependent nature of the Earth system.

I am a Problem Solver: This research uses Earth system science processes to find Solutions for water pollution from shrimp farming, a critical local environmental issue. The researchers focused on Bioremediation to replace chemical use and energy-intensive aeration. Experiments to find suitable, biodegradable planting materials (paper cups and gunnysacks) demonstrate an effort to create a Better World by reducing negative impacts on coastal ecosystems and increasing sustainability for the community's primary industry.

I make an Impact: The report clearly states that the research question originates from a critical Local Issue: the degradation of seagrass at Mod Tanoy Beach and the impact of shrimp farm effluent. This study does not stop at laboratory results but aims to provide Recommendations for practical marine ecosystem restoration. This research creates a positive impact on the community by developing rapid and effective seagrass propagation methods, linking local problems to broader marine resource conservation.