A Comparative Study of Sea Lettuce Cultivation in Seawater and Scientific Saltwater using IoT Technology

Suttipong Klongdee[1], Sriwaree Sujaritchai[2], Sommart Promput[3,*]

[1,2] Department of Information Technology Faculty of Social Technology, Rajamangala University of Technology Tawan-ok, Chanthaburi Campus, Chanthaburi 22210, Thailand.

[3] Department of Mechatronics and Robotics Engineering, School of Engineering and Innovation, Rajamangala University of Technology Tawan-ok, Chonburi 20110, Thailand.

* Corresponding author: Sommart Promput (sommart_pr@rmutto.ac.th)

Abstract: Ulva Rigida, known as sea lettuce, is a variety of marine algae that exhibits a high degree of cultivation feasibility. Sea lettuce offers numerous health benefits and is increasingly being considered as a future food source that could promote commercial cultivation. However, challenges arise in assessing the feasibility of utilizing seawater appropriately, which could be addressed by incorporating the Internet of Things (IoT) into this study. This research aims to investigate and compare the growth of sea lettuce between seawater and scientific saltwater using IoT based on temperature-controlling systems. The IoT-enabled sea lettuce cultivation system can record and display real-time data using Arduino Nano. The results show that the scientific saltwater closely approximates the properties of seawater during the 21-day cultivation period. Sea lettuce cultivated in seawater exhibited greater growth and weight gain compared to cultivation in scientific saltwater. The average weight gain per day was 3.27 grams for seawater cultivation and 2.83 grams for scientific saltwater cultivation, indicating a difference of 0.44 grams. These experimental results demonstrate the feasibility of using scientific saltwater, which exhibits properties resembling seawater. Cultivating with scientific saltwater facilitates ease of cultivation and eliminates the need for coastal locations. Additionally, it has the potential to reduce pollution in marine environments.

A Comparative Study of Sea Lettuce Cultivation in Seawater and Scientific...
Suttipong Klongdee, Sriwaree Sujaritchai, Sommart Promput

364

วารสารวิทยาการสารสนเทศและเทคโนโลยีประยุกต์, 7(2): 2568
Journal of Applied Informatics and Technology, 7(2): 2025

1. Introduction

In today's era, people place great importance on health and wellness, leading to a significant trend toward interest in healthy foods, which has become a prominent phenomenon in the food industry. Modern consumers aspire to maintain their health by consuming foods that offer benefits to their bodies, thereby shaping the future of food trends, also known as future food. Future foods are typically categorized into four main groups: organic foods, medical foods, functional foods, and novel foods (Boonlertvanit, 2020). In the Asia-Pacific region, seaweed is predominantly utilized, and there's a growing consumer awareness and preference for seaweed. The value of growing sea lettuce as a sustainable food supply is significant because of its health benefits and environmental advantages, which has led to a growing interest in commercial farming. Fisheries department policies in Thailand, which promote commercial seaweed cultivation and the production of seaweed for the health food market, partly influence the trend in seaweed consumption. Consequently, there has been a significant increase in seaweed farms, with products widely available on the market. We directly consume sea lettuce as food, and it can also serve as a future food source for various industries (Tanchaiha et al., 2021). A study has found that the nutritional value of sea lettuce becomes a rich source of protein and beneficial nutrients because 100 grams of sea lettuce reveal protein content ranging from 10 to 25 grams and carbohydrate content between 42 to 47 grams (Somchun, 2023).

Currently, the Khung Kraben Bay Royal Development Study Center, established as a result of royal initiatives in Chanthaburi province, focuses on sea lettuce cultivation, propagation, and promotion of the processing of sea lettuce. The community actively participates in these activities to generate income (Vinil, 2023). Cultivating sea lettuce is a straightforward process that yields successful growth. However, seaweed cultivation requires clean seawater without contamination from pollutants. The seawater must have an appropriate level, be settled, and be filtered before being used for cultivation. This imposes constraints on cultivation experiments that demand close proximity to or direct availability of the sea. Farmers who intend to plant sea lettuce, although situated far from the coast, are forced to deal with extra expenses for preparing and transporting seawater to the production site.

As the promotion of sea lettuce cultivation for commercial purposes increases, studies on seaweed cultivation in environments with varying water qualities become increasingly important, which can be investigated in this study. Cultivating sea lettuce in seawater and scientific saltwater presents challenges in Internet of Things (IoT)-based environmental control, such as maintaining water quality, preparing cultivation areas, and ensuring system cleanliness. Therefore, this study aims to investigate the cultivation of sea lettuce in habitats with different water characteristics

A Comparative Study of Sea Lettuce Cultivation in Seawater and Scientific...
Suttipong Klongdee, Sriwaree Sujaritchai, Sommart Promput

365

วารสารวิทยาการสารสนเทศและเทคโนโลยีประยุกต์, 7(2): 2568
Journal of Applied Informatics and Technology, 7(2): 2025

based on temperature-controlling systems. By comparing the growth of sea lettuce cultivated in natural seawater and scientific saltwater and utilizing internet-based technology, researchers have effectively monitored water quality and controlled the environment of sea lettuce cultivation to ensure suitability. Parameters such as temperature, pH, and light intensity are efficiently measured and controlled (Rukhiran *et al.*, 2023; de Camargo *et al.*, 2023; Rukhiran & Netinant, 2020). This study contributes to how cultivators understand and effectively manage the challenges of sea lettuce cultivation, facilitating the sustainable development of the seaweed cultivation industry domestically and globally, and advancing the seaweed cultivation industry through innovative IoT-based environmental control systems. Accurate and reliable commercial studies are critical for driving innovation and advancement in this industry into the future.

2. Literature Review

2.1 Sea Lettuce Definition

Sea lettuce, classified under the green algae family Ulvaceae, is commonly known as Sea Lettuce (Ulva Rigida) or green laver in Japan, referred to as Ao-Nori (Mouritsen *et al.*, 2018). Sea lettuce is characterized by thin, flat blades with a holdfast at the base. Newly sprouted plants have cells arranged in a single row before branching out into multiple rows with two layers of cells that remain attached, as shown in Figure. 1. Growth occurs through cell division both horizontally and vertically,

resulting in flat sheets with frills along the edges. Sea lettuce is typically observed in a state of buoyancy close to shorelines or affixed to rocks and other types of sea lettuce. The environmental and nutritional factors suitable for sea lettuce cultivation include as follows:

- Salinity: 25 – 30 parts per thousand (Tolerant within 15 – 40 parts per thousand)
- Light intensity: 5,000 – 10,000 lux.
- Water temperature: 25 – 30 $^\circ$C
- Total nitrogen content: 0.5 – 1.0 milligrams N/liter and phosphate 0.01 milligrams P/liter
- pH level: between 8 – 9.

2.2 Seaweed Cultivation and Monitoring through IoT

Many studies exploring the potential of IoT in seaweed cultivation and monitoring (Iskandar *et al.*, 2021) focus on a buoy-based system. The IoT-based monitoring system is being developed to measure environmental parameters in a seaweed farm using sensors

Figure 1. Samples of sea lettuce

A Comparative Study of Sea Lettuce Cultivation in Seawater and Scientific...
Suttipong Klongdee, Sriwaree Sujaritchai, Sommart Promput

366

วารสารวิทยาการสารสนเทศและเทคโนโลยีประยุกต์, 7(2): 2568
Journal of Applied Informatics and Technology, 7(2): 2025

placed on a buoy. The result of this study is the dynamic parameter values that are continuously showcased on the dashboard, accessible through a web browser. On a low-power underwater sensor device, the unique small low-power NFC-enabled data collection system was created to monitor seaweed growth parameters in an agricultural environment (Peres *et al.*, 2021). The device records temperature, light intensity, depth, and motion, and the information can be messaged or downloaded to facilitate informed decision-making for farmers. These systems can potentially improve productivity and reduce costs in seaweed cultivation. Jahanbakht *et al.* (2021) offered a comprehensive survey of the Internet of Underwater Things (IoUT) and Big Marine Data (BMD) analytics, highlighting the potential for these technologies in seaweed cultivation and monitoring.

Therefore, this study addresses a research gap in seaweed farming by examining the cultivation of sea lettuce in both seawater and scientifically prepared saltwater. The study utilizes IoT technology, which is not commonly used in existing research on this topic. An innovative IoT-based system has been designed to monitor environmental factors in sea lettuce farms in real time.

3. Research Methodology

This practical study aims to compare the growth of sea lettuce in different types of water, namely natural seawater and scientific saltwater. The research methodology consists of:

- Studying the growth characteristics and maintenance of sea lettuce involves joint research with the Ao Kung Kraben Development Study Center, initiated by royal initiatives in Chanthaburi province.

- Designing and developing an architectural system for the IoT-based sea lettuce cultivation system by focusing on temperature control as a primary factor. The system that has been created is capable of receiving data from a range of sensors, including those that measure pH, salinity, light, room temperature, and water temperature. If the water temperature exceeds 30 $^{\circ}$C, the system will activate a relay in order to provide electricity to the pump for the purpose of spraying water. Ascend to the water's surface in order to decrease the temperature. In addition, the data is collected using cloud computing using Wi-Fi.

- During the experiment, sea lettuce cultivation is conducted under controlled conditions in natural seawater and scientific saltwater [Please show, in the Table, ingredients of scientific saltwater] without replenishing additional water in the containers. Sea lettuce cultivation examples

A Comparative Study of Sea Lettuce Cultivation in Seawater and Scientific...
Suttipong Klongdee, Sriwaree Sujaritchai, Sommart Promput

367

วารสารวิทยาการสารสนเทศและเทคโนโลยีประยุกต์, 7(2): 2568
Journal of Applied Informatics and Technology, 7(2): 2025

are controlled based on the weight of the sea lettuce with very minor differences allowed in the experiments. The water temperature is maintained within the appropriate range of 25-30 $^{\circ}$C throughout the 21-day duration to match the growth conditions of the sea lettuce.

- Evaluating the growth performance of sea lettuce under two different water conditions over the specified period.

- Reporting the comparison results of two different water conditions among a salinity level, pH, temperature, and weight of sea lettuce. To calculate the Average Daily Gain (ADG) of seaweed growth over a period of 21 days using the formula for weight gain per day, in Equation (1)

$$ADG = \frac{FinalWeight - InitialWeight}{"Number of Days"} \qquad (1)$$

where:

ADG is the weight gained per day.
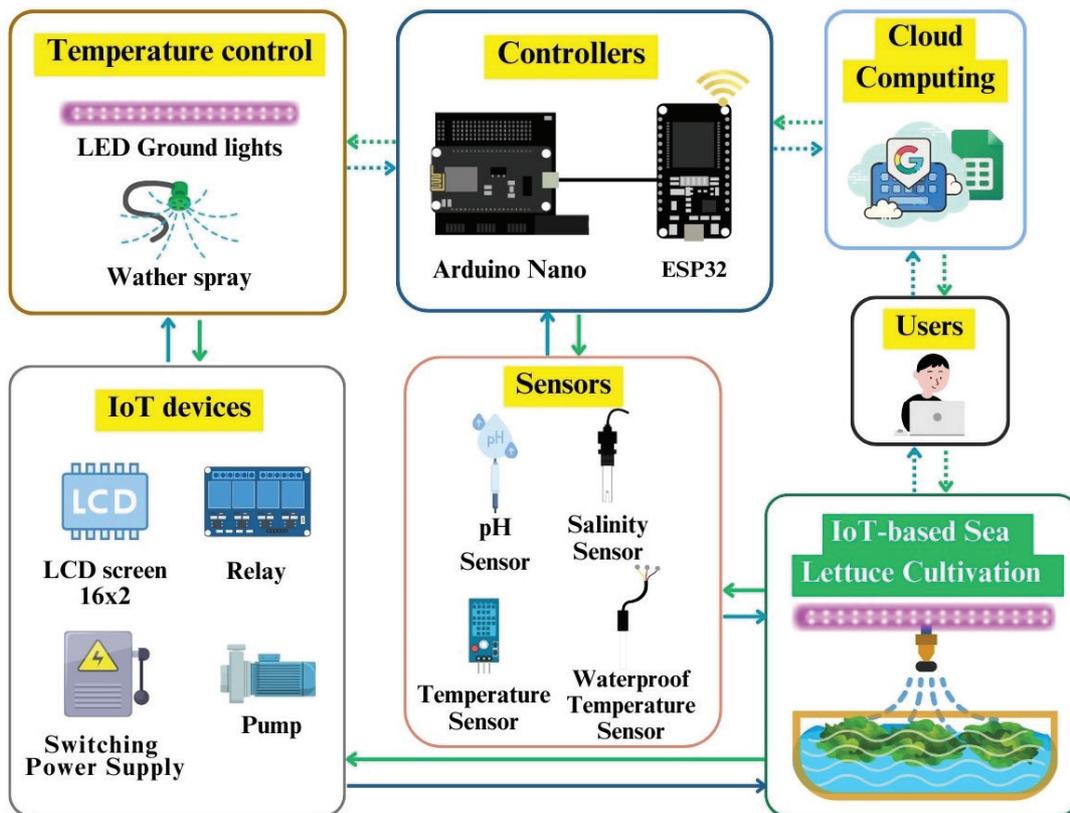
Final Weight is the total weight of the sea lettuce

Figure 2. Overview system architecture of IoT-based sea lettuce cultivation system

A Comparative Study of Sea Lettuce Cultivation in Seawater and Scientific...
Suttipong Klongdee, Sriwaree Sujaritchai, Sommart Promput

368

วารสารวิทยาการสารสนเทศและเทคโนโลยีประยุกต์, 7(2): 2568
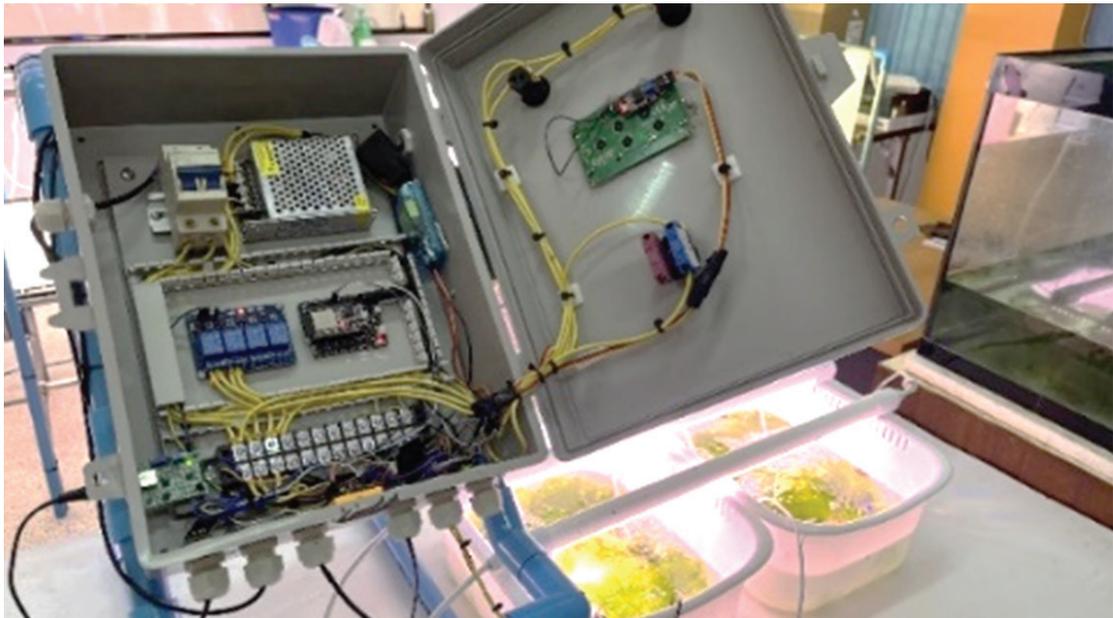Journal of Applied Informatics and Technology, 7(2): 2025

Figure 3. Prototype of IoT-based sea lettuce cultivation system

Initial Weight is the weight of the sea lettuce

Number of Days is the duration of the growth period, which is 21 days in this case.

4. Proposed IoT-Based Sea lettuce Cultivation System

4.1 System Architecture Design

The design and development of an IoT-based sea lettuce cultivation system to support, inspect, and control the environment suitable for sea lettuce seaweed cultivation. The hardware components consist of an Arduino Nano, which is used as a microcontroller for controlling operations. ESP32 receives data through a Wi-Fi connection and sends recorded data to cloud computing. A pH sensor for measuring acidity. A salinity meter is used for calculating the salinity of water. A temperature regulation system with lighting and irrigation capabilities can effectively maintain water temperatures within 25 to 30 $^{\circ}$C. The light-control system is an 18W LED through a relay module with 4 channels (5V 10A). An irrigation system is utilized to automatically manage the water spray to decrease the temperature within the culture tank. This control is achieved by a relay as well. The system architecture overview of the IoT-based sea lettuce cultivation system is illustrated in Figure 2. The final prototype of the proposed system is shown in Figure 3.

Table 1 presents a comprehensive overview of the IoT-enabled hardware used in developing a system-defined criteria.

A Comparative Study of Sea Lettuce Cultivation in Seawater and Scientific...
Suttipong Klongdee, Sriwaree Sujaritchai, Sommart Promput

369

วารสารวิทยาการสารสนเทศและเทคโนโลยีประยุกต์, 7(2): 2568
Journal of Applied Informatics and Technology, 7(2): 2025

Table 1. Hardware components of this study

Devices	Images
Arduino Nano 3.0 Mini USB	
ESP32 NodeMCU ESP-WROOM-32 Wi-Fi and Bluetooth Module	
pH Meter: E-201-C	
Waterproof Temperature Sensor: Sensor DS18B20	
Digital Temperature and Humidity Sensor: DHT11	
Salinity Meter 0-2500ppm: LYg-300	
Relay Module 12V 4 Channel Isolation Low Trigger 250V/10A	
Switching Power Supply 12V 3A	
LCD with Backlight of LCD Screen 24x4	

4.2 Conditions Design of Sea Lettuce Cultivation

In the conditional design for controlling factors in the cultivation process of sea lettuce, the sampling was established for cultivation using seawater: The weight of all sea lettuce specimens was recorded as 10.17 grams, with a total of 13 pieces. The average size was measured to be approximately 7.96 x 8.85 cm. These specimens were then tested for cultivation in a 10-liter cultivation tank filled with seawater, as shown in Figure 4, and Figure 5. shows the cultivation using the scientific saline solution: The weight of all sea lettuce specimens was recorded at 10.16 grams, for a total of 13 pieces. The average size was measured to be approximately 7.27 x 10.05 cm. These samples were then tested for cultivation in a 10-liter cultivation tank filled with scientific saltwater, as illustrated in Figure 6.

Figure 4. Weight collection process of seawater

A Comparative Study of Sea Lettuce Cultivation in Seawater and Scientific...
Suttipong Klongdee, Sriwaree Sujaritchai, Sommart Promput

370

วารสารวิชาการสารสนเทศและเทคโนโลยีประยุกต์, 7(2): 2568
Journal of Applied Informatics and Technology, 7(2): 2025

Figure 5. Weight collection process of scientific saltwater

Figure 6. Inspection during the cultivation of sea lettuce

To install a trial set for sea lettuce, we utilized two LED lights with a power output of 18 watts. These lights had a length of 60 cm. These bulbs have been designed specifically for plant growth. The light will be scheduled to automatically turn on and off every day for a duration of 13 hours (from 5:00 a.m. to 6:00 p.m. on and from 6:01 p.m. to 4:59 a.m. off) at a brightness level of 10,030 Lux. using Internet of Things technology. The experiment consisted of four planting phases on the 4th, 8th, 12th, and 16th days. Each experimental plot received a bio-extract nutrient solution at a ratio of 1 ml per plot during each phase. The harvesting occurred on the 21st day.

5. Results

5.1 Parameters Report

This study involved collecting data on various parameters from different sensors over a period of 21 days to compare the results between the growth of sea lettuce in seawater and scientific saltwater. The collected data included salinity levels, pH levels, and water temperature both in the water and in the room environment, along with the weight measurements of the seaweed harvest.

The experimental results of the initial salinity level in the test were 29 ppt (parts per thousand), and there was no water exchange during the experiment. It was observed that the salinity level of the seawater increased to 49 ppt after the experiment, while the salinity level of the scientific saltwater was measured at 47 ppt. This indicated a difference of 2 ppt between the salinity levels of the two types of water. Despite this difference, the results demonstrated similar salinity characteristics between seawater and scientific-grade saltwater, as depicted in Figure 7.
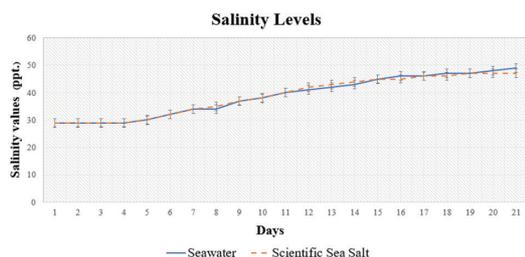
A Comparative Study of Sea Lettuce Cultivation in Seawater and Scientific...
Suttipong Klongdee, Sriwaree Sujaritchai, Sommart Promput

371

วารสารวิทยาการสารสนเทศและเทคโนโลยีประยุกต์, 7(2): 2568
Journal of Applied Informatics and Technology, 7(2): 2025

Figure 7. Comparison results of salinity levels between seawater and scientific sea salt
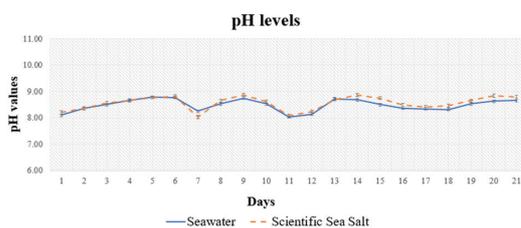
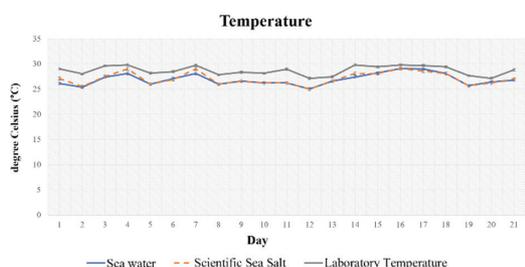**Figure 8** Comparison results of pH levels between seawater and scientific sea salt

Figure 9 Comparison results of temperature among seawater, scientific sea salt, and laboratory
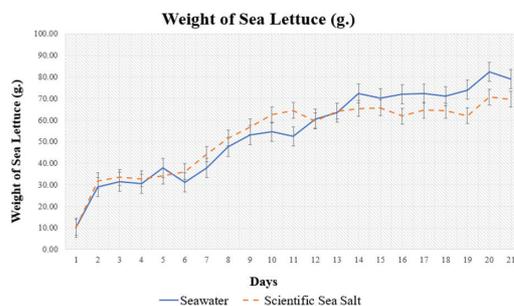

Figure 10 Comparison results of weight among seawater and scientific sea salt
Acknowledgment

In Figure 8, the comparison of the pH values that controlled pH levels within the range of 8-9 is reported. The average pH of seawater was 8.65, while the average pH of scientific saltwater was 8.79. The difference in pH between the two averaged 0.14. Figure 9. demonstrates the temperature control system successfully maintaining the water temperature within the range of 25 to 30 $^{\circ}$C. The average temperature of seawater and scientific saltwater was 24.35 $^{\circ}$C and 24.50 $^{\circ}$C, respectively., while the room temperature averaged 26.59 $^{\circ}$C.

Based on the data recorded after the seaweed cultivation experiment using seawater and scientific saltwater, it was found that cultivation using seawater resulted in greater growth and weight gain compared to cultivation using scientific saltwater. The weight gain per day from seawater cultivation was 3.27 grams, while from scientific saltwater cultivation, it was 2.83 grams. The difference between them was 0.44 grams, as shown in Figure 10. Additionally, the average size increase per day from seawater cultivation was 0.16 x 0.37 cm, while from scientific saltwater cultivation, it was 0.19 x 0.22 cm. The difference between them was 0.04 x 0.15 cm, as illustrated in Figure 11(a) and (b).
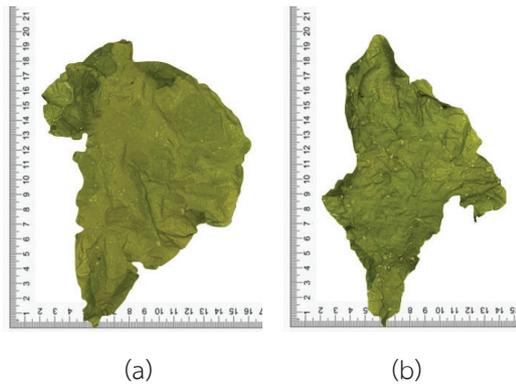
A Comparative Study of Sea Lettuce Cultivation in Seawater and Scientific...
Suttipong Klongdee, Sriwaree Sujaritchai, Sommart Promput

372

วารสารวิทยาการสารสนเทศและเทคโนโลยีประยุกต์, 7(2): 2568
Journal of Applied Informatics and Technology, 7(2): 2025

(a)   (b)

Figure 11 The size of the seaweed after cultivation: (a) In seawater (b) In scientific saltwater

6. Discussion and Conclusion

This study compares sea lettuce cultivation using natural seawater and scientific saltwater. The real-time data and monitoring and recording were accomplished through IoT technology developed from Arduino Nano and ESP32, utilizing Google Sheets. The findings of this study focus on the potential of seaweed cultivation, particularly sea lettuce, in different water environments, namely natural seawater and scientific saltwater. This study offers valuable information on the growth performance of sea lettuce under varying water conditions through various real-time data collection and analysis techniques facilitated by IoT technology. In the context of temperature control in sea lettuce cultivation, thresholds play a crucial role in maintaining optimal growing conditions, similarly to Iskandar *et al*. (2021) and Siddiqui, Zaidi, & Abdullah (2019). Thresholds are predefined limits or boundaries set for certain parameters, such as temperature, that trigger specific actions

or adjustments in the cultivation environment, as found in Rukhiran *et al*. (2023) and Purnamawati (2021). The authors determine the temperature control system using light and watering sprays related to the studies of Bachtiar, Hidayat, & Anantama (2022), and Liang *et al*. (2022).

In addition, the pH levels and water temperatures were effectively controlled within the desired ranges throughout the cultivation period (Liang *et al*., 2022; Nguyen *et al*., 2022). The comparison of growth performance over a 21-day period showed that the properties of scientific saltwater resemble those of natural seawater. The pH levels in both seawater and scientific saltwater fell within the optimal range of 8-9, demonstrating the suitability of both water types for sea lettuce cultivation. Moreover, the temperature control system successfully maintained water temperatures within the range of 25 to 30 $^{\circ}$C, conducive to sea lettuce growth.

The results indicate that sea lettuce cultivated in seawater exhibited greater growth and weight gain compared to cultivation in scientific saltwater. The average weight gain per day was 3.27 grams for seawater cultivation and 2.83 grams for scientific saltwater cultivation, indicating a difference of 0.44 grams. This study delivers a possible method of seaweed cultivation in environments where access to clean seawater is limited. Moreover, the proposed IoT-based environmental control system provides a valuable tool for monitoring and managing

A Comparative Study of Sea Lettuce Cultivation in Seawater and Scientific...
Suttipong Klongdee, Sriwaree Sujaritchai, Sommart Promput

373

วารสารวิทยาการสารสนเทศและเทคโนโลยีประยุกต์, 7(2): 2568
Journal of Applied Informatics and Technology, 7(2): 2025

sea lettuce cultivation, contributing to the sustainable development of the seaweed cultivation industry domestically and globally. By suggesting further research, additional factors can be explored influencing seaweed growth and expanding the application of IoT-based environmental control systems to enhance cultivation efficiency and sustainability.

References

Bachtiar, M. I., Hidayat, R., & Anantama, R. (2022). Internet of things (IoT) based aquaculture monitoring system. *MATEC Web of Conferences, 372*, 04009. https://doi.org/10.1051/matecconf/202237204009

Boonlertvanit, T. (2020). *A study to develop a technology roadmap for Thailand's novel food industry based on public policy-making and academics' perspectives* [Master's dissertation, Mahidol University]. https://archive.cm.mahidol.ac.th/handle/123456789/4243 [In Thai]

de Camargo, E. T., Spanhol, F. A., Slongo, J. S., da Silva, M. V. R., Pazinato, J., de Lima Lobo, A. V., Coutinho, F. R., Pfrimer, F. W. D., Lindino, C. A., Oyamada, M. S., & Martins, L. D. (2023). Low-cost water quality sensors for IoT: A systematic review. *Sensors, 23*(9), 4424. https://doi.org/10.3390/s23094424

Iskandar, Samuel, C. I., Favitri, D., Padlan, & Azizi. (2021). IoT-based of seaweed cultivation employing a low-cost autonomous experimental buoy. *2021 15th International Conference on Telecommunication Systems, Services, and Applications (TSSA)*, 1–5. https://doi.org/10.1109/tssa52866.2021.9768270

Jahanbakht, M., Xiang, W., Hanzo, L., & Rahimi Azghadi, M. (2021). Internet of underwater things and big marine data analytics—A comprehensive survey. *IEEE Communications Surveys & Tutorials, 23*(2), 904–956. https://doi.org/10.1109/comst.2021.3053118

Liang, Z., Wang, W., Liu, L., Li, G., & Xia, B. (2022). Influence of commercial-scale seaweed cultivation on water quality: A case study in a typical laver culture area of the Yellow Sea, North China. *Journal of Marine Science and Engineering, 10*(5), 681. https://doi.org/10.3390/jmse10050681

Mouritsen, O. G., Rhatigan, P., & Pérez-Lloréns, J. L. (2018). World cuisine of seaweeds: Science meets gastronomy. *International Journal of Gastronomy and Food Science, 14*, 55–65. https://doi.org/10.1016/j.ijgfs.2018.09.002

A Comparative Study of Sea Lettuce Cultivation in Seawater and Scientific...
Suttipong Klongdee, Sriwaree Sujaritchai, Sommart Promput

374

วารสารวิทยาการสารสนเทศและเทคโนโลยีประยุกต์, 7(2): 2568
Journal of Applied Informatics and Technology, 7(2): 2025

Nguyen, D. K., Nguyen, H. Q., Dang, H. T. T., Nguyen, V. Q., & Nguyen, L. (2022). A low-cost system for monitoring pH, dissolved oxygen and algal density in continuous culture of microalgae. *HardwareX, 12*, e00353. https://doi.org/10.1016/j.ohx.2022.e00353

Peres, C., Emam, M., Jafarzadeh, H., Belcastro, M., & O'Flynn, B. (2021). Development of a low-power underwater NFC-enabled sensor device for seaweed monitoring. *Sensors, 21*(14), 4649. https://doi.org/10.3390/s21144649

Purnamawati, Yahya, M., Jamaluddin, & Akil, M. (2021). Implementation of temperature monitoring system in seaweed drying room. *International Journal on Advanced Science, Engineering and Information Technology, 11*(5), 1912. https://doi.org/10.18517/ijaseit.11.5.13834

Rukhiran, M., & Netinant, P. (2020). Mobile application development of hydroponic smart farm using information flow diagram. *2020 5th International Conference on Information Technology (InCIT)*, 150–155. https://doi.org/10.1109/incit50588.2020.9310780

Rukhiran, M., Sutanthavibul, C., Boonsong, S., & Netinant, P. (2023). IoT-based mushroom cultivation system with solar renewable energy integration: Assessing the sustainable impact of the yield and quality. *Sustainability, 15*(18), 13968. https://doi.org/10.3390/su151813968

Siddiqui, M., Zaidi, A., & Abdullah, M. (2019). Performance evaluation of newly proposed seaweed enhancing index (SEI). *Remote Sensing, 11*(12), 1434. https://doi.org/10.3390/rs11121434

Somchun, C. (2023). *Sea lettuce seaweed eating fresh and processed is very valuable*. Retrieved 17 April 2023. Retrieved from https://www.thairath.co.th/news/local/2681306

Tanchaiha, A., Pichitkul, P., Wudtisin, I., & Tamtin, M. (2021). Effects of nitrogen fertilizers on growth and antioxidant activities of sea lettuce (Ulva rigida). *Khon Kaen Agriculture Journal, 50*(1), 100-111. https://li01.tci-thaijo.org/index.php/agkasetkaj/article/view/249532 [In Thai]

Vinil, K. (2023). *Upgrading sea lettuce seaweed to food & cosmeceutical products*. Retrieved 7 July 2023. Retrieved from https://www.thairath.co.th/news/local/east/2707495