# COMPARATIVE ANALYSIS OF ARTIFICIAL NUTRIENT SOLUTION AND *Kappaphycus alvarezii* (GUSO) EXTRACT IN GROWING OF *Lactucasativa L*. (LETTUCE) HYDROPONICALLY

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# ABSTRACT

The increasing demand for efficient resource management and high-quality food production has driven the shift towards hydroponics. Various commercial and specialty crops can be grown using hydroponics, among them are leafy vegetables like lettuce. This study compared the efficiency of *Kappaphycus alvarezii* extract and Artificial Nutrient Solution in hydroponic farming of *Lactuca sativa L.* (lettuce). *Kappaphycus alvarezii* extract was obtained through blending and filtration, while Artificial Nutrient Solution was purchased locally. Lettuce seeds were germinated for 10 days, and then transferred to jars. Treatments included *Kappaphycus alvarezii extract* (10%)/distilled water (90%) (Treatment A), Artificial Nutrient Solution (Treatment B), and a Negative Control (Treatment C). After 30 days, observations were made on changes in its mass, height, and number of leaves. The results revealed that Artificial Nutrient Solution (Treatment B) had the highest mean, followed by *Kappaphycus alvarezii* extract (Treatment A). Both treatments were not significantly different from each other; however, treatment B showed a significant difference from the Negative Control (Treatment C). The researchers recommend that *Kappaphycus alvarezii* extract can be used as an alternative to hydroponic farming if there is an abundant amount of resources present within the community.

# CHAPTER 1

# THE PROBLEM AND ITS SCOPE

## Background of the Study

Rapid urbanization and industrialization are leading to a reduction in cultivable land, and conventional agricultural practices are contributing to a host of environmental problems. To sustainably feed the world's growing population, methods for growing sufficient food have to evolve. Modification in growth medium is an alternative for sustainable production and to conserve fast-depleting land and available water resources (Malik et al., 2014). Conventional agriculture is confronted with multiple challenges, including urbanization, natural disasters, climate change, and the indiscriminate use of chemicals and pesticides, leading to soil fertility depletion. Hydroponic systems, encompassing structures like wick, ebb and flow, drip, Nutrient Film Technique (NFT), and Kratky method, offer a sustainable alternative. Hydroponic cultivation is gaining global popularity as a solution to various challenges faced by traditional soil-based agriculture. The increasing demand for efficient resource management and high-quality food production has driven the shift towards hydroponics (Nisha et al., 2018)

Hydroponics is a branch of agriculture where plants are grown without the use of soil. Hydroponics is a technique of growing plants in nutrient solutions with or without the use of an inert medium such as gravel, vermiculite, rockwool, peat moss, sawdust, coir dust, coconut fiber, etc., to provide mechanical support. Hydroponics is presented as an efficient cultivation system with positive benefits to the environment due to adequate water use, rapid plant development, and high productivity (Zhou et al., 2018). Various commercial and specialty crops can be grown using hydroponics, among them are leafy vegetables like lettuce. Additionally, tomatoes, cucumbers, peppers, and strawberries. and various other varieties can thrive in hydroponic systems, with lettuce *(Lactuca sativa)* being particularly noteworthy as one of the most commonly cultivated hydroponic vegetables (Sajad Mushtaq, 2023).

Lettuce *(Lactuca sativa L.)* is a green leafy vegetable belonging to the Asteraceae family. Commonly consumed in salad mixes, lettuce surpasses all others except potatoes in terms of land devoted to production and crop value. Lettuce is very nutritious and a rich source of vitamin C, minerals, and fiber (Mulabagal, V et al., 2010). Lettuce has been used as a medicine for different ailments, including stomach problems, inflammation, pain, and urinary tract infections, since ancient times due to the presence of secondary metabolites such as terpenoids, flavonoids, and phenols (Noumedem et al., 2017).

However, as plants rely on nutrients and water for their growth, typically sourced from soil, in hydroponics, they still acquire both water and nutrients from an artificial, nutrient-rich solution. This has spurred efforts to seek out organic materials that can serve as an organic nutrient solution, supplying essential nutrition just like their artificial counterparts.

In the Philippines, hydroponics has gained prevalence as an innovative agricultural practice; however, despite the increasing adoption of hydroponics, scholarly investigations into the cultivation of lettuce within hydroponic systems using organic substances as nutrient solutions are conspicuously scarce. Furthermore, a notable underexplored facet in this context is the limited research addressing the potential benefits and challenges associated with incorporating organic nutrient solutions in hydroponic lettuce cultivation.

In view of the foregoing scenario, the researchers aim to test the efficiency of *Kappaphycus alvarezii* and artificial substances as nutrient solutions in *Lactuca sativa L.* through hydroponic farming.

**Statement of the Problem**

Generally, this study aimed to compare the efficiency of *Kappaphycus alyarezii* extract and artificial nutrient solution for *Lactuca sativa L.* through hydroponic farming.

Specifically, this study sought to answer the following questions:

1. What is the effect of *Kappaphycus alvarezii* extract and Artificial Nutrient Solution on the growth of *Lactuca sativa L.*. in terms of the plant height (cm), mass (g), and number of leaves 30 days after the application of treatments?
2. Which between *Kappaphycus alvarezii* Extract and an Artificial Nutrient Solution has greater efficacy in enhancing the height (cm), mass (g), and number of leaves of *Lactuca sativa L*. 30 days after the application of treatments?

3. Is there a significant difference between the effectiveness of *Kappaphycus alvarezii* extract and Artificial Nutrient Solution on *Lactuca sativa L.* in terms of the plant height (cm), mass (g), and number of leaves 30 days after the application of treatments

**Hypothesis**

There is no significant difference in the effect of *Kappaphycus alvarezii* extract and artificial nutrient solution on the growth of *Lactuca sativa L.* in terms of plant height (cm). mass (g), and the number of leaves 30 days after the application of treatments.

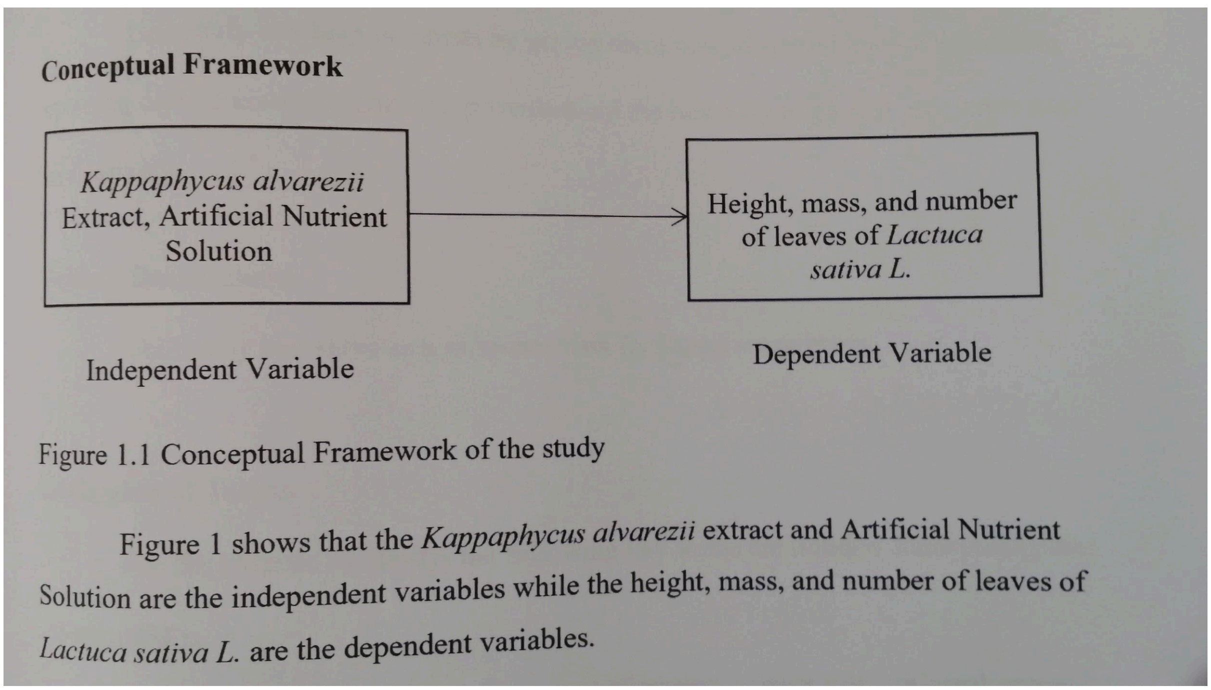



Figure 1.1 Conceptual Framework of the study

Figure 1 shows that the *Kappaphycus alvarezii* extract and Artificial Nutrient Solution are the independent variables, while the height, mass, and number of leaves of *Lactuca sativa L.* are the dependent variables.

## Significance of the Study

The result of the study will benefit the following:

**Consumers.**

This study will serve as a source of information to consumers whether which nutrient solution is better in terms of efficiency, price charge, and convenience: *Kappaphycus alvarezii* Extract or artificial substances.

**Farmers.**

This study can serve as a basis and give details for alternatives in cultivation, providing them a concept for farming with the utilization of hydroponics.

**Botanist**.

This study can help botanists by giving them new ideas and knowledge about growing certain kind of plants and provide them the best way to grow it efficiently and with quality.

**Future Researchers.**

This study can serve as a reference data for future researchers.

## Definition of Terms

For the purpose of clarity, the following key terms are defined conceptually and operationally:

**Hydroponics.** This refers to a method of growing plants using mineral nutrient solution in water without soil (Plant Factory, 2016)

In this study, Hydroponics refers to the cultivation method that will be utilized for growing *Lactuca sativa L*

**Lactuca sativa L.** An annual herb belonging to the Asteraceae family. It exhibits a self-supporting growth structure and is typically found in freshwater environments. This plant features simple, broad leaves and achenes (Encyclopedia of Life, n.d.).

In this study, *Lactuca sativa L.* refers to the plant selected as the experimental subject to assess the effectiveness of seaweed extract and an artificial nutrient solution.

**Kappaphycus alvarezii.** A type of marine red algae, commonly known as red seaweeds. Among Kappaphycus species, particularly *Kappaphycus alvarezii,* these marine organisms are of paramount importance as carrageenophytes. They are extensively cultivated in tropical and subtropical regions worldwide for the production of carrageenan and other valuable substances (Azanza, 2023).

In this study, *Kappaphycus alvarezii* refers to the organic solution and will be used as contrary nutrient solution for hydroponics cultivation of *Lactuca sativa L.*.

**Nutrient solution.** This refers to a liquid containing all the essential nutrients required for plant growth, allowing the plant roots to access these nutrients for their development (Trees.com, 2022).

In this study, nutrient solution refers to the inorganic solution that will be utilized for comparison with the *Kappaphycus alvarezii* Extract.

**Scope and Delimitation of the Study**

The objective of this study was to conduct a comparative analysis between the artificial nutrient solution and *Kappaphycus alvarezii* Extract in the hydroponic cultivation of *Lactuca sativa L.* The researchers aimed to determine which among the artificial nutrient solution and *Kappaphycus alvarezii* Extract is more effective in Hydroponic cultivation of *Lactuca sativa L*. The researchers opted for this study to further explore the hydroponic system and how it could benefit the cultivation of plants, more specifically, the *Lactuca sativa L.* Furthermore, the researchers wanted to have a wide understanding of which among the Artificial nutrient solution and *Kappaphycus alvarezii* Extract would be more effectual in the cultivation of *Lactuca sativa L.* hydroponically. The target of this study will be the successful growth of *Lactuca sativa L.* that is being cultivated hydroponically. The researchers did a comparison between the *Kappaphycus alvarezii* Extract and artificial nutrient solution yields a greater efficacy in enhancing the growth of *Lactuca sativa L.*. in terms of the plant height, mass, and number of leaves after 30 days of application of treatment. This research study will be conducted at Tigbauan Road, Cabatuan, Iloilo. The location is one of the barangays in the Municipality of Cabatuan in the Province of Iloilo, Philippines. This study was conducted during the school year 2023-2024 and for approximately seven weeks. Seven days was allotted for the seedlings to grow in the nursery before transferring them to the sponges, then transferred to the jars following the Kratky method for 30 days. Two days was designated for data collection, and an additional two days will be allocated for data analysis. The researchers employed an Experimental method for this study and will be utilized the Randomized Complete Block Design (RCBD).

# CHAPTER II

## REVIEW OF RELATED LITERATURE

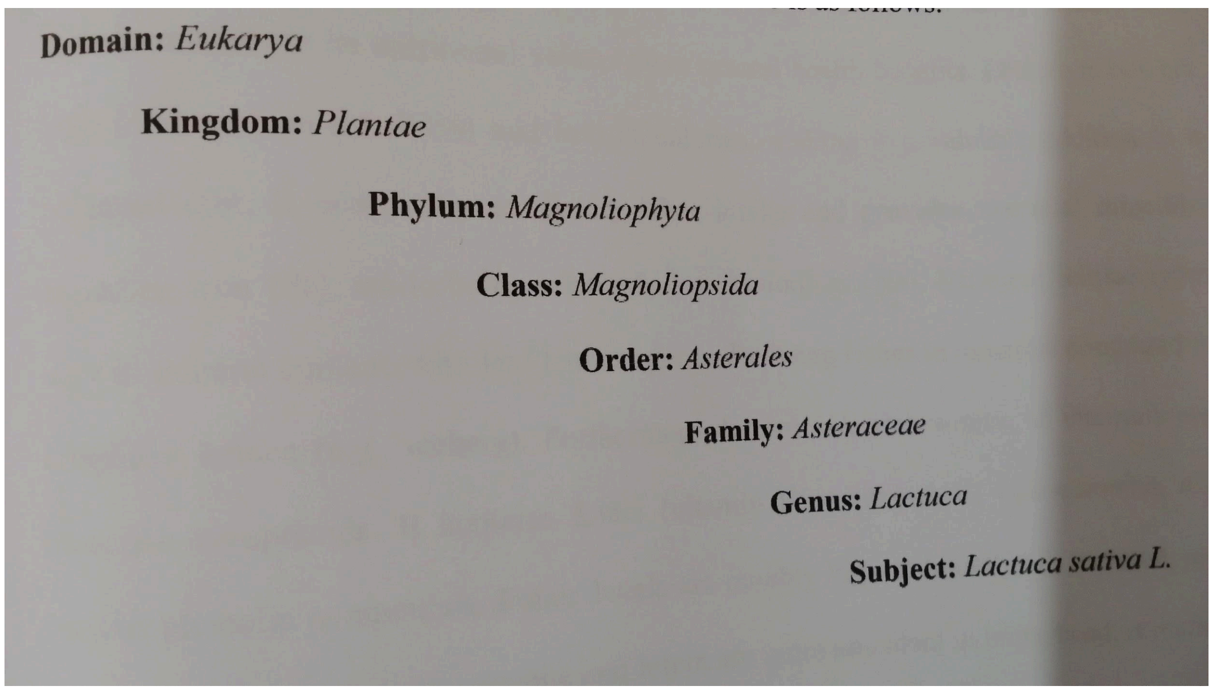
This portion consists of the following parts: Ⅰ) *Lacnica sativa L*., its definition, importance, taxonomical classification, health benefits, and cultivation process were introduced, and; Ⅱ) *Kappaphycus alvarezii* Extract, its definition, importance, Taxonomic Classification, nutrient content, extraction, and concentration were presented, and; III) Nutrient solution, where its importance, concentration and formulation were discussed.

**Lactuca sativa L.**

The Definition and Importance of *Lactuca sativa L.* Lettuce, *(Lactuca sativa L.),* an annual leaf vegetable of the aster family (Asteraceae), Most lettuce varieties are eaten fresh and are commonly served as the base of green salads. Lettuce is generally a rich source of vitamins K and A, though the nutritional quality varies, depending on the variety (Britannica, 2023). This plant also has excellent medicinal properties. Lettuce is cultivated worldwide and is one of the most consumed green leafy vegetables in the raw form for its taste and high nutritional value. It is regarded as an important source of phytonutrients. It is characterized by considerable morphological and genetic variations. Today, it is produced all over the world and is used in forensic medicine for many ailments, including pain, stomach problems, inflammation, and urinary tract infections. Different studies provided the scientific evidence of its pharmacological potential, including antimicrobial, antioxidant, neuroprotective, and hypnotic effects. The chemical composition of the plant revealed the presence of different classes of secondary metabolites, such as terpenoids, flavonoids, and phenols, which should be responsible for its biological activities. The plant also contains essential elements, such as vitamins, minerals, and organic substances (Noumedem et al, 2017)

**Taxonomic Classification and names of Lactuca sativa L...**

The taxonomic classification and names of *Lactuca sativa L.* or lettuce is as follows:



**Domain:** *Eukarya*

**Kingdom:** *Plantae*

**Phylum:** *Magnoliophyta*

**Class:** *Magnoliopsida*

**Order:** *Asterales*

**Family:** *Asteraceae*

**Genus:** *Lactuca*

**Subject:** *Lactuca sativa L.*

**Health Benefits of Lactuca Sativa L.**

Lettuce offers a range of health benefits that encompass bone strength, hydration, improved vision, and potential assistance with sleep. Rich in vitamin K, it aids in fortifying bones and reducing the risk of fractures. Its high-water content contributes to hydration, complementing liquid intake. Additionally, lettuce serves as a source of vitamin A, supporting eye health and lowering the risk of conditions like cataracts and macular degeneration. Although some lettuce extracts have shown promise in promoting sleep, further research is needed to determine its natural form's effectiveness. While nutritional content can vary by variety, lettuce generally provides significant vitamin A, along with smaller amounts of vitamin C and iron. These combined attributes make lettuce a valuable addition to a healthy diet (WebMD Editorial Contributors, 2020).

According to a study conducted by Moo Jung Kim et al. in 2015, lettuce, often underestimated for its nutritional value, offers several health benefits. Lettuce is notably high in water content (95%) and low in calories, making it a valuable addition to a balanced diet. It contributes to dietary fiber intake and provides essential minerals, including iron (Fe), while being relatively low in sodium (Na). Different lettuce types vary in mineral content, with leaf lettuces generally being richer in minerals compared to crisphead lettuce (e.g., iceberg). Furthermore, lettuce is a rich source of vitamins and bioactive compounds. It contains folate (vitamin B9), vitamin C, beta-carotene, and various phenolic compounds. Folate levels are notably high in butterhead, romaine, and red leaf lettuce, while beta-carotene and lutein are more abundant in butterhead, romaine, and leaf lettuces compared to crisphead lettuce. Red lettuce tends to have a higher phenolic content, while green leaf lettuce excels in vitamin C content. Despite common misconceptions about lettuce's nutritional value, research data strongly support its potential to provide significant amounts of essential nutrients, especially folate, carotenoids, and phenolic compounds. Therefore, incorporating lettuce into one's diet can contribute to overall health and well-being.

**Hydroponic Cultivation of Lactuca sativa L..**

According to the experiment conducted by Peter Stanley, to grow a lettuce hydroponically using Kratky method the roots must have enough space to grow. The sponges containing fully germinated lettuce seed will be transferred on net cups and will be put in jars. Clay pebbles will be added to fill the space of the net cups. Artificial nutrient solution and *Kappaphycus alvarezii* with specific concentration will be added to the water of the jar.

The water must reach the first line of the net cups, just enough for the roots to touch the water. To avoid the production of algae the jar must be covered by paper to block the water from light. For artificial source of light LED light (6500 kelvin) will be utilized. *Lactuca sativa L..* will be cultivated for three weeks to see result.

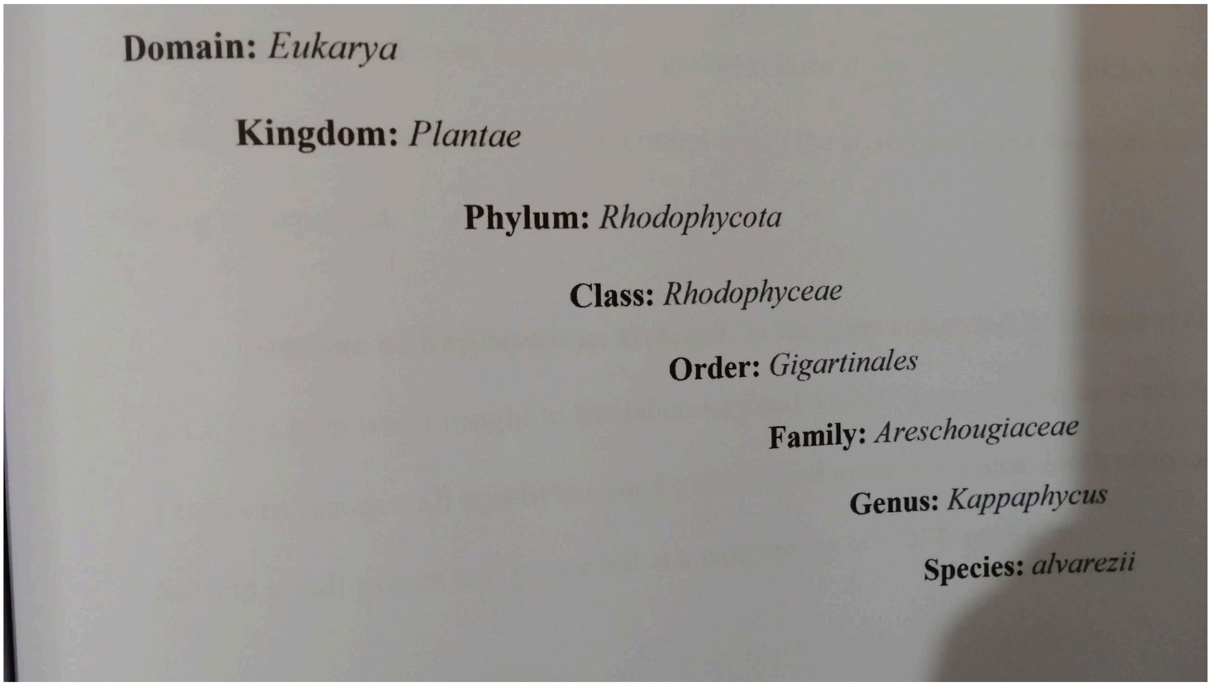
*Lactuca sativa L.,* commonly known as lettuce, undergoes global hydroponic cultivation with genetic and morphological variations. The cultivation process involves seed germination in tissue papers and sponges, transplantation into net cups with clay pebbles, and exposure to artificial light under LED, specifically utilizing a light source with a color temperature of 6500 kelvin, for three weeks. Lettuce's nutritional richness, especially in vitamins K and A, contributes to health benefits like bone strength and a potential sleep aid.

**Kappaphycus alvarezii**

The Definition and Importance of *Kappaphycus alvarezii.* Kappaphycus is a tough, fleshy, firm; algae that can grow up to 2m tall. The thalli are coarse, with axes and branches 1-2cm in diameter and heavy major axes that are relatively straight, but lacking secondary branches near the apices. These algae frequently and irregularly branch, with most branches, both primary and secondary branches, intercalated between primary branches. The algae is shiny green to yellow-orange (University of Hawai'i, ND). Seaweed *(Kappaphycus alvarezii)* is one of the primary commodities in the fisheries sector of the Southeast Sulawesi government. Hence, its cultivation areas can be found along the coastal waters of the province. Apart from carrageenan production, its biomass can also store a significant amount of nutrients and growth regulators, which are highly useful in various crop cultivation systems (G.G. Selvam & K. Sivakumar, 2014; D. Chen et al., 2021).

**Taxonomic Classification and names of Kappaphycus alvarezii.**

The taxonomic classification and names of Kappaphycus alvarezii is as follows.



**Domain:** *Eukarya*

**Kingdom:** *Plantae*

**Phylum:** *Rhodophycota*

**Class:** *Rhodophyceae*

**Order:** *Gigartinales*

**Family:** *Areschougiaceae*

**Genus:** *Kappaphycus*

**Species:** *alvarezii*

Nutrient Content of *Kappaphycus alvarezii.* Seaweed extract contains various plant growth-promoting substances, such as Indole 3-acetic acid (IAA), gibberellins (GA3), kinetin, and zeatin (K. Prasad et al., 2010; K. Chojnacka, A. Saeid, Z. Witkowska, & L. Tuhy, 2012), as well as macro- and micro-nutrients, including N. P. K. Na, Ca, Mg S, Cu, Fe, Mn, and Zn (S.S. Rathore, D.R. Chaudhary, G.N. Boricha, A. Ghosh, B.P. Bhatt, S.T. Zodape, & J.S. Patolia, 2009). The application of seaweed liquid extract to leaves has been shown to improve seed germination performance, growth, yield, and nutrient uptake (S.S. Rathore & D.R. Chaudhary, 2009).

Transportation of *Kappaphycus alvarezii.* According to the study of Tahiluddin et al. in 2021, samples of Ulva lactuca were taken separately from three distinct farmed seaweeds, including E. denticulatum, *K. alvarezii*, and K. striatus. Twenty milliliters of filtered saltwater were used to hold nearly five grams of samples in various sterile containers. Every sample was gathered three times. These were quickly placed in the study site's freezer after being cooled inside the styrofoam using seawater ice while being transported.

Storage of *Kappaphycus alvarezii*. In the study conducted by Latique et al. in 2013, the alga was brought to the laboratory and washed thoroughly in tap water for 3 or 4 times to remove all epiphytes, sand particles and associated fauna. Fresh material was cut into small pieces and preserved at a temperature of -20°C until uses.

Extraction of *Kappaphycus alvarezii.* In the study conducted by Kilowasid. L..et al. in 2022, the researchers obtained the mineral fertilizer AB mix from a farm supply store. Fertilizer A, weighing 1,250 g, was diluted in 5 L of water to form stock solution A. Fertilizer B underwent the same treatment and became stock nutrient solution B. After 35 days, they processed fresh seaweed *(K. alvarezii),* chopping it into 2-3 cm pieces and blending it to create a slurry. The resulting sap droplets were filtered using a cotton cloth. preserving them as a 100% concentrated stock solution.

**Concentration of Kappaphycus alvarezil**

In the study conducted by Zodape et al. (2010), different concentrations of *Kappaphycus alvarezii Extract* (5.00%, 10.0%, 15.0%) mixed in water were used as a fertilizer in growing Phaseolus radiata L. Results showed that the 10% extract yielded the highest increase in yield over the control group, with a significant increase of 30.11%.

This increase surpassed the yield increases observed with the 5.0% and 15.0% concentrations, which were 16.78% and 26.30%, respectively.

A research study by Turco et al. (2022) was conducted to explore the efficacy of various concentrations of seaweed extracts in cultivating different types of lettuce. The experiment focused on assessing the impact of seaweed extracts on seed germination and subsequent growth. Results indicated that the 10% concentration of seaweed extract yielded significant and noteworthy outcomes across different lettuce varieties. Specifically, for the lettuce variety Maravilha Das Quatro Estações, the 10% concentration of Gracilaria sp. extract demonstrated remarkable stimulation of seed germination, with an 86% germination rate compared to the control group at 88%. Similarly, for the Bionda degli Ortolani lettuce variety, the 10% concentration of *Ascophyllum nodosum* extract exhibited a substantial enhancement in seed germination. achieving a germination rate of 62.5% as opposed to 40% in the control group. These results highlight the potential of seaweed extracts, especially when utilized at a 10% concentration, as beneficial additives for improving the cultivation of particular lettuce varieties.

**Nutrient Solution**

Importance of Nutrient Solution. Hydroponic nutrient solutions are crucial for plant growth, delivering a balanced mix of nutrients like nitrogen, phosphorus, and potassium, along with trace minerals such as iron, calcium, and magnesium. These solutions act as a direct source of nourishment for plant roots, ensuring efficient absorption and faster growth in hydroponic systems. Essentially, the nutrient solution serves as a complete meal, providing all essential elements for plants to thrive (AtlasScientific, 2023). In hydroponics, a nutrient solution is akin to soil fertilizers. It is a liquid containing all the essential nutrients required for plant growth, allowing the roots to directly access the necessary elements. This liquid medium plays a vital role in supporting and facilitating the growth of plants in hydroponic systems (Tress.com, 2022).

**Concentration and Formulation of Nutrient Solution.**

Based on the experiment conducted by Peter Stanley (2018), the hydroponic plant food MasterBlend, commonly referred to as 4-18-38 tomato fertilizer, is incredibly affordable and productive. It works best when paired with calcium nitrate and magnesium sulfate (Epsom salt). To prepare a nutrient solution for your hydroponic pepper plants, start by filling the container halfway with your chosen water source, such as tap water. Next, measure 1.6 grams of Masterblend and carefully add it to the container. Seal the container with the lid, and then shake it thoroughly to ensure proper mixing. Afterwards, measure 0.8 grams of Epsom Salt (Magnesium Sulfate), introduce it into the container, re-seal with the lid, and shake it again for even distribution. To further dilute the mixture, add a bit more water until the container is filled to about 2/3 full. Now, measure 1.6 grams/gallon of Calcium Nitrate, mix it into the container, seal it, and shake vigorously. Top up the container with additional water as needed. It's essential to check the pH level and make adjustments if necessary to reach a pH reading around 6.0, with an acceptable range of +/- 0.2; this may vary depending on your water source. Additionally, it's advisable to assess the EC/ppm strength for this batch, providing a useful reference for future nutrient solutions. Typically, it's recommended not to exceed 2.0 EC for pepper plants in hydroponics.

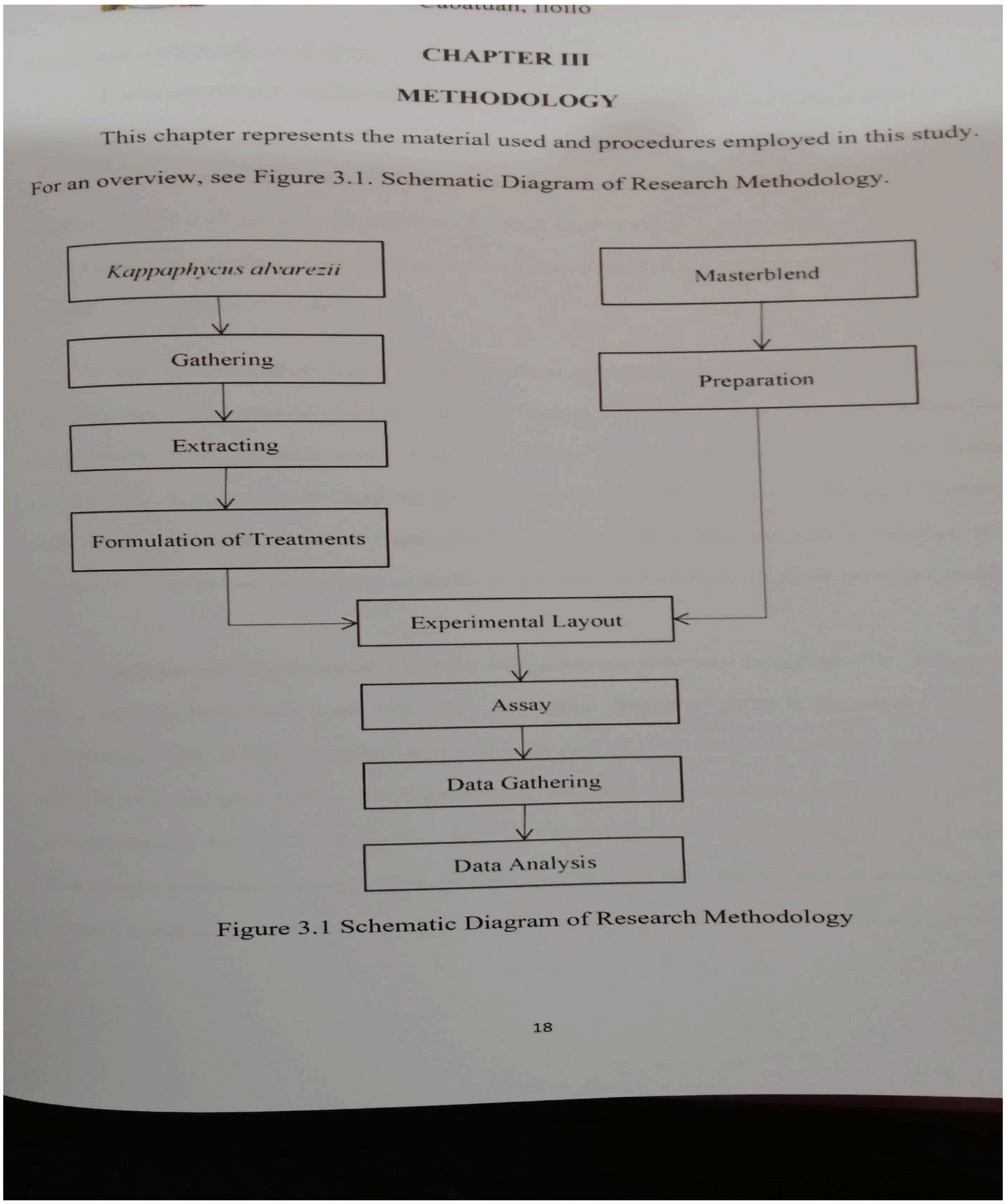
Following these steps will ensure that you have a well-prepared nutrient solution tailored to your hydroponic pepper plants' needs.

Hydroponic Nutrient Solution plays a crucial role in fostering plant growth by delivering a balanced blend of essential nutrients directly to the roots. The formulation process includes using MasterBlend (4-18-38 tomato fertilizer) at an appropriate amount, calcium nitrate, and Epsom salt with specific proportions. The amount of MasterBlend utilized is 1.6 grams per gallon of water. The procedural steps involve filling a container halfway with water, adding MasterBlend and shaking for mixing, introducing Epsom salt and shaking for distribution, diluting with additional water, measuring and adding Calcium Nitrate, vigorous shaking, topping up the container as needed, adjusting the pH to around 6.0, and assessing the EC/ppm strength for optimal plant growth.

**CHAPTER III**

**METHODOLOGY**

This chapter represents the material used and procedures employed in this study. For an overview, see Figure 3.1. Schematic Diagram of Research Methodology


CHAPTER III

METHODOLOGY

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Figure 3.1 Schematic Diagram of Research Methodology

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## Description of Study Variables

**Lactuca sativa L**. Lettuce *(Lactuca sativa L.)* is commonly cultivated as a leaf vegetable, typically as a temperate annual or biennial plant. It served as an excellent provider of minerals, fiber, and bioactive compounds like folate, B-carotene, and lutein, contributing to a healthful and nutrient-rich diet. In this study, lettuce served as the subject for investigating the effects of the treatments, aiming to further optimize its growth and nutritional content.

**Nutrient Solution**. Hydroponic nutrient solutions are formulated to achieve an optimal blend of essential elements, encompassing nitrogen, phosphorus, and potassium. along with trace minerals such as iron, calcium, and magnesium. Through the direct application of these nutrients to the plant roots, hydroponic systems enhance absorption efficiency, resulting in accelerated growth. In this study, this inorganic solution was employed for comparative purposes with an extract derived from Kappaphycus alvarezu.

**Kappaphycus alvarezii.**

Extract of *Kappaphycus alvarezii* is commonly recognized as a robust, flesh-like, and firm type of algae. Seaweed extract comprises diverse substances that foster plant growth, such as Indole 3-acetic acid (IAA), gibberellins (GA3), kinetin, and zeatin. Additionally, it contains both macro- and micro-nutrients, encompassing N, P, K, Na, Ca, Mg, S, Cu, Fe, Mn, and Zn. In this research, *Kappaphycus alvarezii* is denoted as the organic solution and served as an alternative nutrient solution in contrast to the synthetic hydroponic cultivation of *Lactuca sativa L.*.

**Gathering of Study Variable**

**Lactuca sativa L.** seeds. Packed seeds of *Lactuca sativa L.* were bought in a local

**Kappaphycus alvarezii.** 20 kilograms of *Kappaphycus alvarezii* were bought in a local market.

**Artificial Nutrient Solution.** 250 grams of Master Blend (4-18-38 tomato fertilizer), 250 grams of magnesium sulfate, and 250-500 grams of calcium nitrate were bought in an online store via Shopee.

Glass Jar, Net Cups, Sponges, Clay pebbles, and Light Bulb. Nine glass jars, nine net cups, a pack of sponge, a pack of clay pebbles (500 grams), and a 6500K of LED light bulb was bought in a local store.

**Preparation of Study Variable**

**Preparation of Kappaphycus alvarezii**

The frozen seaweed was thawed using water, then soaked to defrost it. Afterward, it was washed to ensure there were no other debris that could be included in the extraction. It was then filtered using a strainer and left to dry at room temperature.

## Formulation of Artificial Nutrient Solution

A clean container was filled with water half the container size. 1.6 grams of MasterBlend Nutrient Solution was added to the container. Then, 0.8 grams of epsom salt was measured and diluted with the mixture. It was checked if the mixture has an even distribution of substances. Afterwards, 1.6 grams of calcium nitrate was mixed. The container was sealed and shaken vigorously. A pH meter was used to make sure that the mixture has a 6.0 pH reading with an acceptable reading of +/-0.2. Lastly the mixture was labeled with its corresponding name.

## Preparation of Lactuca sativa L.

Seeds of *Lactuca sativa L.* were placed in a microwavable container with a water-sprayed tissue lining on its bed and surface. These seeds were arranged in a linear position, placed equidistant from one another, and covered on top with another layer of wet tissue to start the imbibition process. Once it starts growing its roots it were transferred to a net cup with a sponge and filled with clay pebbles and be placed on a jar. The nine pots were placed one inch away from each other.

## Plant Extraction Method

The fresh seaweed *(Kappaphycus alvarezii)* was processed by chopping it into 2-3 cm pieces and subsequently blended to produce a slurry. The resulting sap droplets has underwent filtration using a cotton cloth, ensuring the preservation of the concentrated stock solution at a 100% concentration.

**Experimental Layout**

The experimental layout that was used is the Randomized Complete Block Design (RCBD). The treatments are as follows: Treatment A- 100% *Kappaphycus alvarezii* extract; Treatment B- Artificial Nutrient Solution; Control treatment C- No Application.

| I | II | III |
|---|---|---|
| A | C | B |
| B | A | C |
| C | B | A |

Table 3.1 Experimental layout of the study

Legend:

A- *Kappaphycus alvarezii* extract

B- Artificial Nutrient Solution

C- No Application

**Experimental Proper (Assay)**

Seeds of *Lactuca sativa L.* were placed in a microwavable container with a water-sprayed tissue lining on its bed and surface. These seeds were arranged in a linear position, placed equidistant from one another, and covered on top with another layer of wet tissue to start the inhibition process for three days. After three days, the seeds were transferred to the sponge with minimum amount of water in a microwavable container and an additional seven days were allotted for its continuous germination totaling 10 days.

After 10 days, once the seedlings begin to have a root system and form about 3-5 leaves, it was then transplanted into a hydroponic setup.

A total of nine germinated seeds were used for testing the commercial nutrient solutions and *Kappaphycus alvarezii* Extract. The germinated seeds were placed in a net pot together with a sponge that served as its growing media, the empty space of the net pots was filled by the clay pebbles, then later placed on a jar. The jars with a volume of et 250 ml were utilized for the Kratky method. One germinated seed was put in each jar, one inch away from the other.

The solutions were prepared at the same time. The mass of MasterBlend (1.6 grams/gallon), magnesium sulfate (0.8 grams/gallon) and calcium nitrate (1.6 grams/gallon) were mixed and was used as nutrient solution. Simultaneously, the seaweed extract was used in another container, and the third container has not received any nutrient solution. They were labeled according to the name of the treatment respectively. The pH level was checked if it is 5.5 or 6 using a pH meter, pest control was done manually without using pesticides so that the plants were not contaminated with other chemicals.

After 30 days, the harvest was done in the morning to maintain moisture and freshness content of the lettuce.

**Data Analysis**

Using Microsoft Excel, the following statistical analysis was used to represent the Data:

**Mean.** This was used to summarize the data in the study.

**Standard Deviation.** This was used to tell the homogeneity of the study.

**ANOVA**. This was used to determine if there is a significant difference in the effectiveness of *Kappaphycus alvarezii* extract and the artificial nutrient solution and no application to *Lactuca sativa L.* in terms of number of leaves, plant height, and mass.

**Duncan's Multiple Range Test.** This was used to identify specific differences among treatments.

The selected significance level was set at 0.05%, ensuring a thorough evaluation of pairwise comparison.

# CHAPTER IV

## RESULTS AND DISCUSSION

This study was conducted to compare the effectiveness of *Kappaphycus alvarezii* Extract and Artificial Nutrient Solution in the hydroponic cultivation of *Lactuca sativa 1.*

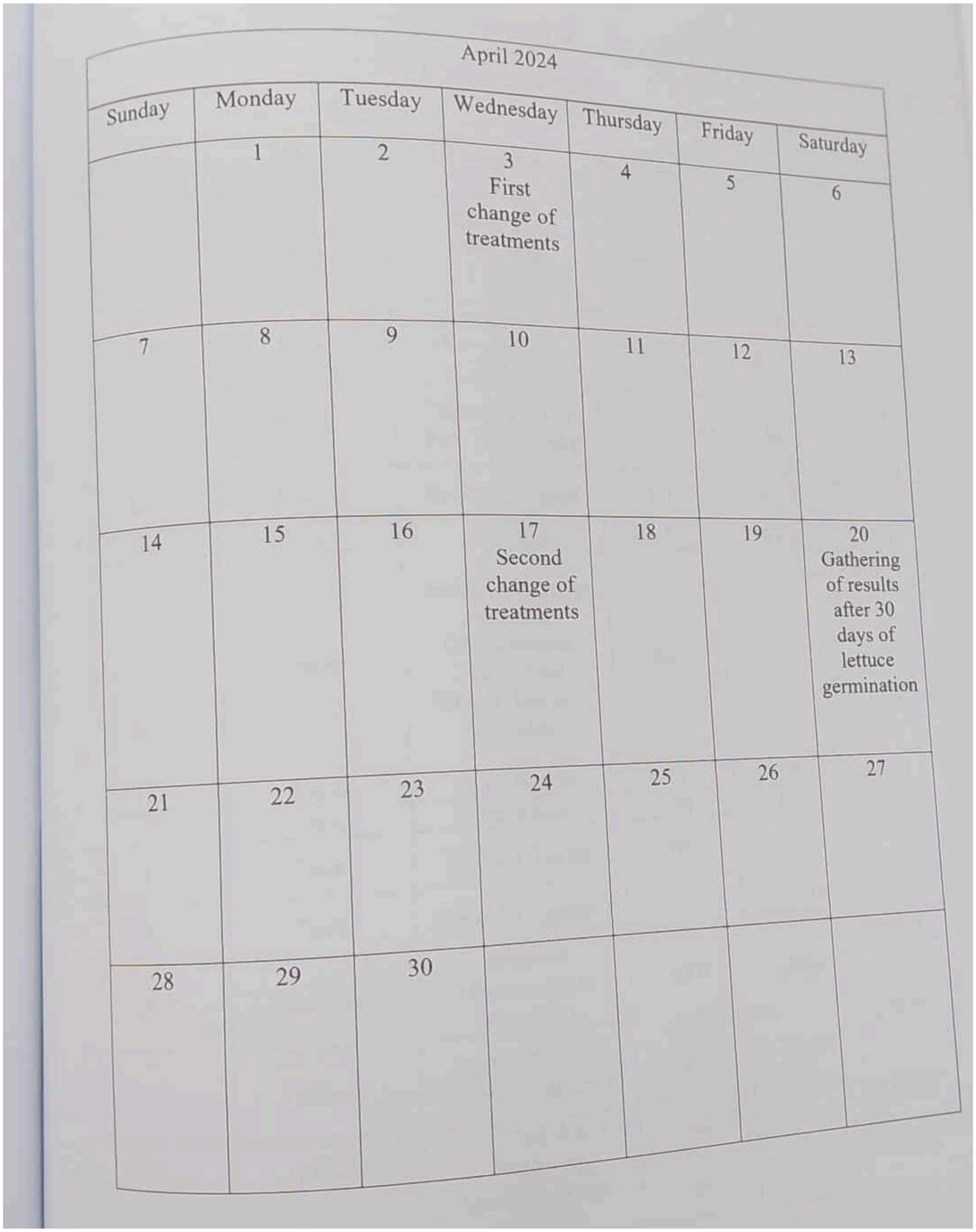
The results showed that both the experimental and positive treatments influenced *Lactuca sativa L.* and were higher than those of the negative control. This implies that both the experimental and positive treatments can affect the growth of *Lactuca sativa L.* in terms of plant height, mass, and number of leaves after 30 days of application.

The results revealed that the efficacy of treatments A and B was higher than that of the Negative Control (water) in terms of mass and height. However, in terms of the number of leaves, only Treatment B (Artificial Nutrient Solution) yielded a higher count than the negative control. The results also showed that the efficiency of Treatment A *(Kappaphycus alvarezii* extract) and Treatment B (Artificial Nutrient Solution) did not exhibit a significant difference, indicating that both treatments are comparable to each other.

Table 4.3 number of leaves of *Lactuca sativa L.* (Lettuce) affected by the different treatments 30 days after application.

| Number of Leaves | | | | | | |
|---|---|---|---|---|---|---|
| Treatment | Replication | | | Total | Treatment Mean ($\bar{x}$) | Standard Deviation (s) |
| | I | II | II | | | |
| *Kappaphycus alvarezii* Extract | 7 | 7 | 7 | 21 | 7.0000 | 0.00000 |
| Artificial Nutrient Solution | 7 | 5 | 5 | 17 | 5.6667 | 1.15470 |
| Water (Negative Control) | 5 | 7 | 6 | 18 | 6.0000 | 1.00000 |
| Grand Total | | | | 56 | | |
| Grand Mean | | | | | 6.2222 | |

Table 4.1 displays the efficacy of the experimental treatment, positive control, and the negative control on hydroponic cultivation of *Lactuca sativa L.* in terms of mass (in grams) 30 days after the application of different treatments. The results reveal that themean mass of Treatment B (Artificial Nutrient Solution) yields the highest, followed by Treatment A (Kappaphycus alvarezii extract) and the Negative Control.



| April 2024 | | | | | | |
|---|---|---|---|---|---|---|
| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
| | 1 | 2 | 3<br>First change of treatments | 4 | 5 | 6 |
| 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 14 | 15 | 16 | 17<br>Second change of treatments | 18 | 19 | 20<br>Gathering of results after 30 days of lettuce germination |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| 28 | 29 | 30 | | | | |

Table 4.2 displays the efficacy of the experimental treatment, positive control, and the negative control on hydroponic cultivation of *Lactuca sativa L.* in terms of height (in centimeters) 30 days after the application of different treatments. The results reveal that

the mean height of Treatment B (Artificial Nutrient Solution) yields the highest, followed by Treatment A (*Kappaphycus alvarezii* extract) and the Negative Control.

Table 4.3: Number of leaves of *Lactuca sativa L.* (Lettuce) affected by the different treatments 30 days after application.

(Lettuce) as affected by the different treatments 30 days after application.

| Mass | | | | | | |
|---|---|---|---|---|---|---|
| Treatment | Replication | | | Total | Treatment Mean ($\bar{x}$) | Standard Deviation (s) |
| | I | II | II | | | |
| *Kappaphycus alvarezii* Extract | 0.5 | 0.5 | 0.4 | 1.4 | 0.4667 | 0.05774 |
| Artificial Nutrient Solution | 0.6 | 0.6 | 0.5 | 1.7 | 0.5667 | 0.05774 |
| Water (Negative Control) | 0.3 | 0.4 | 0.3 | 1 | 0.3333 | 0.05774 |
| Grand Total | | | | 4.1 | | |
| Grand Mean | | | | | 0.4556 | |

Table 4.3 displays the effects of the experimental treatment, positive control, and the negative control on hydroponic cultivation of *Lactuca sativa L.* in terms of the number of leaves 30 days after the application of different treatments. The results reveal

that the mean number of leaves for Treatment A (*Kappaphycus alvarezii* extract) yields the highest, followed by the Negative Control (water), and then Treatment B (Artificial Nutrient Solution).

Table 4.4 One-way ANOVA of the treatments.

**ANOVA**

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Mass | Between Groups | .082 | 2 | .041 | 12.333 | .007 |
| | Within Groups | .020 | 6 | .003 | | |
| | Total | .102 | 8 | | | |
| Height | Between Groups | 7.829 | 2 | 3.914 | .613 | .572 |
| | Within Groups | 38.293 | 6 | 6.382 | | |
| | Total | 46.122 | 8 | | | |
| Leaves | Between Groups | 2.889 | 2 | 1.444 | 1.857 | .236 |
| | Within Groups | 4.667 | 6 | .778 | | |
| | Total | 7.556 | 8 | | | |

P > a=0.05*not significant

Table 4.4 shows that in terms of height and number of leaves there is no significant difference in height and number of leaves among the treatments. However, there is a significant difference in term of mass.

Table 4.5 shows the comparison to assess whether there is a significant difference between treatments.

Table 4.5 shows the comparison to assess whether there is a significant difference between treatment.

| Dependent Variable | | (I) Treatments | (J) Treatments | Mean Difference (I-J) | Std. Error | Sig. |
|---|---|---|---|---|---|---|
| Mass | Scheffe | *Kappaphycus alvarezii* Extract | Artificial Nutrient Solution | -.10000 | .04714 | .187 |
| | | | Negative Control | .13333 | .04714 | .079 |
| | | Artificial Nutrient Solution | *Kappaphycus alvarezii* Extract | .10000 | .04714 | .187 |
| | | | Negative Control | .23333* | .04714 | .008 |
| | | Negative Control | *Kappaphycus alvarezii* Extract | -.13333 | .04714 | .079 |
| | | | Artificial Nutrient Solution | -.23333* | .04714 | .008 |

Table 4.5 shows that there is a significant difference between Treatment B (Artificial Nutrient Solution) and to the Negative Control in terms of the mass 30 days after application of treatments.

# CHAPTER V

# SUMMARY, CONCLUSION, AND RECOMMENDATIONS

This study aimed to compare the efficacy of *Kappaphycus alvarezii* Extract and Artificial Nutrient Solution in the hydroponic cultivation of *Lactuca sativa L.* This study was conducted at Tigbauan Road, Cabatuan, Iloilo, from March 2 to April 20, 2024.

*Lactuca sativa L.* and *Kappaphycus alvarezii* were purchased from a local store, while the Artificial Nutrient Solution was acquired from an online shop via Shopee. Three experimental treatments were utilized in the study: *Kappaphycus alvarezii* Extract, Artificial Nutrient Solution, and the Negative Control (water). Randomized Complete Block Design (RCBD) was employed as the experimental layout. The weight of the plants was measured using a weighing scale, their height was measured using a tape measure, and the number of leaves was counted manually. To assess efficacy, researchers employed statistical tools including the mean, standard deviation, and one-way ANOVA.

## Conclusion

The *Kappaphycus alvarezii* extract and Artificial Nutrient Solution both enhance the growth of *Lactuca sativa L.*. in terms of plant height, mass, and number of leaves. The Artificial Nutrient Solution, in terms of mass and heigh,t yields the highes,t and the Kappaphycus alvarezii extract yields the highest in terms of number of leaves; however, there were no significant differences between Treatment A (Kappaphycus alvarezii extract) and Treatment B (Artificial Nutrient Solution).

**Recommendation**

Considering its abundance in the surrounding environment, ease of access, and potential cost-effectiveness, *Kappaphycus alvarezii* could be a viable alternative nutrient solution for *Lactuca sativa L.* cultivation, especially for growers in regions where it's readily available.

The researchers recommend exploring the use of *Kappaphycus alvarezii* Extract in various concentrations alongside Artificial Nutrient Solution for growing lettuce *(Lactuca sativa L.)* hydroponically.

The researchers suggest investigating different hydroponic techniques and methods to optimize lettuce cultivation in this system. They also propose applying these findings to explore the potential of hydroponics for cultivating other vegetables as well.

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phycus_alvarezii_extract

# APPENDICES

## APPENDIX A

## CALENDAR OF EVENTS

| February 2024 | | | | | | |
|---|---|---|---|---|---|---|
| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
| | | | | 1 | 2 | 3 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 Bought artificial light, clay pebbles and germination container |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 Bought lettuce seeds, glass jars, and ziplocks | 26 | 27 | 28 Went to Tagbak, Jaro to buy seaweeed from a local seaweed farmer, and additional ziplocks | 29 | | |

March 2024

| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|---|---|---|---|---|---|---|
| | | | | | 1 | 2 First day of Germination using Rockwool |
| 3 | 4 | 5 | 6 | 7 | 8 Alternative germination using tissue | 9 |
| 10 | 11 Revision of Related Literature | 12 Transferring of Lettuce to Sponges | 13 | 14 | 15 | 16 Formulation of treatments |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |

| | | | | | |
|---|---|---|---|---|---|
| 1.5 | Litters | Distilled Water (Natures Spring) | 25.55 | 25.55 | 2/28/24 |
| 1 | Pack | Microwavable Tupperware | 36.15 | 36.15 | 2/28/24 |
| 4 | Pieces | Sponge | 15 | 60 | 2/28/24 |
| 1 | Piece | Plug | 45 | 45 | 3/16/24 |
| ½ | Meter | Cotton Cloth | 35 | 35 | 3/16/24 |
| ½ | Meter | Cotton Cloth | 45 | 45 | 3/16/24 |
| 1 | Pack | Tissue | 26 | 26 | 3/16/24 |
| 1 | Piece | TDS (Total Dissolved Solids Meter) | 159 | 159 | 3/21/24 |
| 4 | Pieces | Ice | 3 | 12 | 3/19/24 |
| Fare | | | 2257 | | |
| Total Cost | | | 9183.60 | | |

## APPPENDIX D

## PICTORIAL

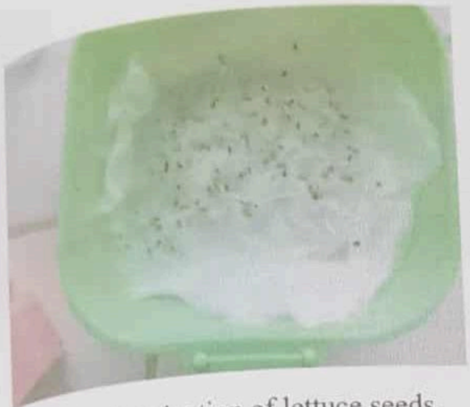

Plate 1. Germination of lettuce seeds.

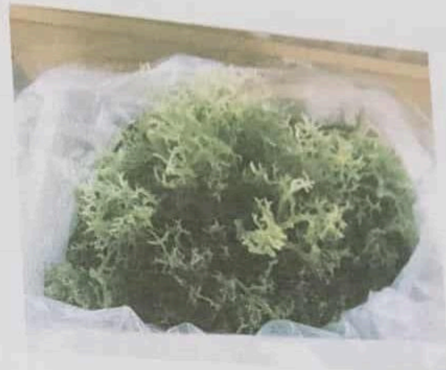

Plate 2. Seaweeds


Plate 3. Artificial nutrient solution

Plate 4. Preparation for seaweeds preservation

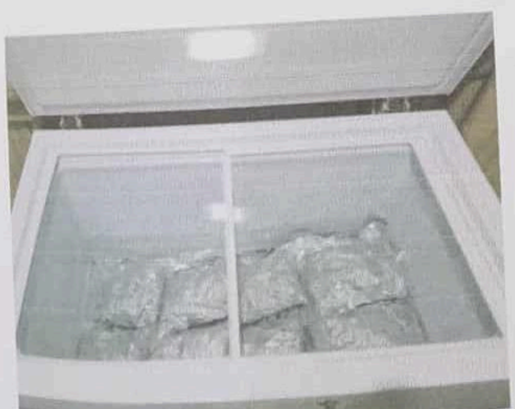

Plate 5. Preservation of seaweeds

Plate 6. Blending of seaweeds

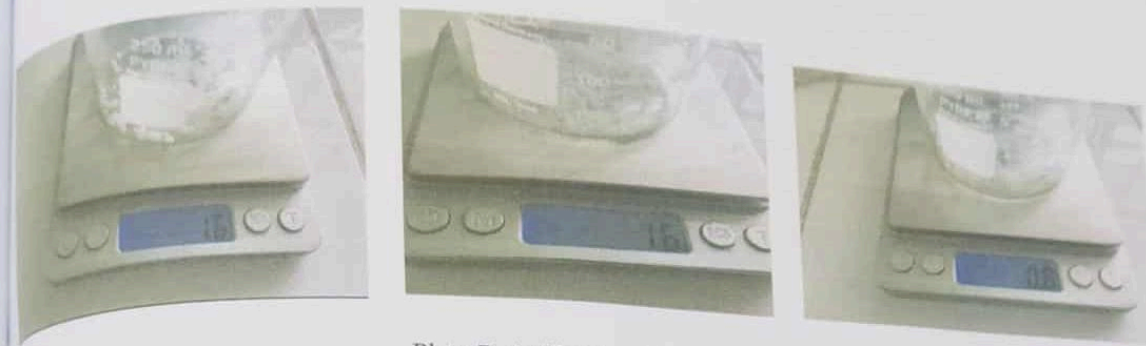

Plate 7. Artificial nutrient solution

Plate 8. Filtration of the extract

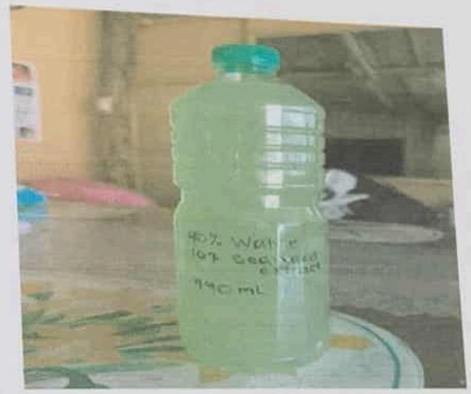

Plate 9. *Kappaphycus alvarezii* Extract

Plate 10. Hydroponics set up of *Lactuca sativa L.*