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Growth Performance of *Kappaphycus alvarezii* and *Kappaphycus striatus* cultivated in Ekas Bay, East Lombok Regency, West Nusa Tenggara Province

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Abstract

Kappaphycus alvarezii is a superior product of Indonesian fisheries, producing carrageenan which is used as a food, cosmetic, and medicinal ingredient. *K. striatus* is a carrageenan-producing red alga that began to be cultivated in the Ekas waters of East Lombok in 2023. *K. striatus* is more resistant to epiphytes and sudden climate change. The purpose of this study was to analyze the growth of *K. alvarezii* and *K. striatus*. The research was conducted in Ekas Bay, Jerowaru District, East Lombok Regency. The research was conducted from November 8, 2023, to January 8, 2024. This research used an experimental method with T-test analysis. Treatments in this research are the cultivation of *K. alvarezii* and *K. striatus*. Cultivation was carried out at Ekas Bay. Analysis of seaweed carrageenan was carried out in the Laboratory of Fish Production and Reproduction, Aquaculture Study Program, Faculty of Agriculture, Mataram University. The result of this research is *K. striatus* has a higher absolute weight of 154 g compared to *K. alvarezii* seaweed which is 72 g. The specific growth rate of *K. striatus* higher at 2,98 % / day compared to *K. alvarezii* is 1, 98 %/day. The yield of carrageenan of *K. alvarezii* is 1,95% and *K. striatus* 0,88%. Antioxidant of *K. alvarezii* is 5,46 % and *K. striatus* is 7,42%. Chlorophyll *K. alvarezii* is 5,77 mg/l and *K. striatus* is 3,51 mg/l. The conclusion of this study is the growth of *K. striatus* faster than *K. alvarezii*.

INTRODUCTION

Cultivation of *K. alvarezii* has long been practiced in most seaweed farming locations in Indonesia. This type of seaweed is the type that is generally cultivated by seaweed farmers in Indonesia, as well as in Lombok. Based on the RPJMN, seaweed production in 2020 was 12.3 million tons and is targeted to be 20.42 million tons by 2024 (Deputy for Maritime Resources Coordinator, 2020). In 2020 the seaweed export volume was 195,57 tons with a value of USD 279.58 million, the export volume in 2021 increased to 225,612 tons with a value of USD 345.11 million (KKP, 2022). *K. alvarezii* is a superior product of Indonesian fisheries, producing carrageenan which is used as a food, cosmetic, and medicinal ingredient (Satriani *et al*., 2023). Seaweed

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also functions ecologically as an oxygen producer in waters, a carbonate provider, provider of macro and micronutrients. The presence of seaweed is very important in the waters (Annisa *et al.*, 2023).

The production of *K. alvarezii* cultivation is decreasing from year to year. The causes of the decline include the availability of *K. alvarezii* seeds decreasing even though there are seeds from tissue culture production and climate change. It is necessary to develop the cultivation of *K. alvarezii* from other species including *K. striatus* (Hung and Hoa, 2021). *K. striatus* is a carrageenan-producing red alga that is starting to be widely cultivated. *K. striatus* is more resistant to epiphytes and sudden climate change. *K. striatus* began to be cultivated in 2005 in Bohol, Philippines.

K. striatus began to be cultivated in the Ekas waters of East Lombok in 2023 by local farmers. *K. striatus* seedlings were initially taken from cultivation in Bali. *K. alvarezii* seaweed has a rather rough outer skin surface because it has cleats and rough spots. *K. alvarezii* has a smooth surface, dark brown, brown-green, yellow-green, and purple-red, reaching 30 cm in height. *K. striatus* seaweed is a seaweed better known as "sakul" with a morphological shape that is rounded like a ball with colors that tend to be dark or light green. These morphological characteristics distinguish it from other species of carrageenan-producing seaweed (Du *et al.*, 2023). *K. striatus* has a wider habitat than *K. alvarezii* which is more dominant close to the coastline. *K. striatus* has a habitat from the coastline to far from the coastline.

Currently, the main problem often faced by farmers is the low quality of seedlings derived from cultivation with indications of stunted growth, poor environment can also affect the growth of seaweed. To overcome these problems, seed selection is needed to produce superior seaweed seedlings, then the development of *K. striatus* cultivation in Lombok and West Nusa Tenggara requires a lot of research related to growth and location requirements by its habitat. The purpose of this study was to analyze the growth of *K. alvarezii* and *K. striatus*.

METHODOLOGY

Ethical Approval

Ethical approval of the research does not require ethical approval because it is not related to clinical trials on animals.

Place and Time

The research was conducted from November 8, 2023, to January 8, 2024. The location of this study is located in Ekas Bay, Jerowaru District, East Lombok Regency. Analysis of seaweed carrageenan was carried out in the Laboratory, Fish Production and Reproduction, Aquaculture Study Program, Faculty of Agriculture, Mataram University.

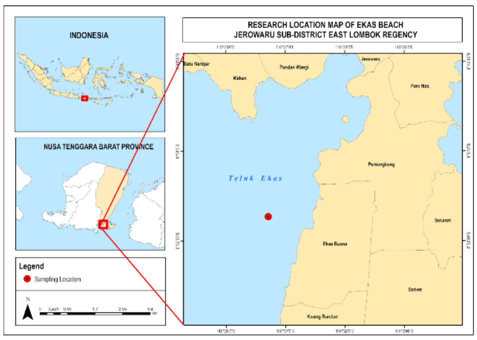

Figure 1. Research location.

Research Materials

The materials and tools used in this study were *K. alvarezii* and *K. striatus* seaweed seeds, a mobile phone camera, pH meter (China), refractometer (ATC, China), lux meter (Fukushima, Japan), Dissolved

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Oxygen (OEM, China), nitrate test kit (HANNA instruments, USA), phosphate test kit (HANNA instruments, USA), ammonia test kit (HANNA instruments, USA), microscope (NOVOCE), razor blade (Tatra, Czech Republik), prep glass (GEA medical, Indonesia), stove (RINNAI, Japan), pot, 96% alcohol, filter cloth, tray, spoon, blender, measuring board, plastic clips, labels, and stationery.

Research Design

his study used a completely randomized design (CRD) consisting of 2 treatments and 10 replicates, with the following details: The first treatment (1) with *K. alvarezii* seaweed and the second treatment (2) with *K. striatum* seaweed. Each treatment consisted of 10 ris, then the number of points per ris rope was 45 clumps.

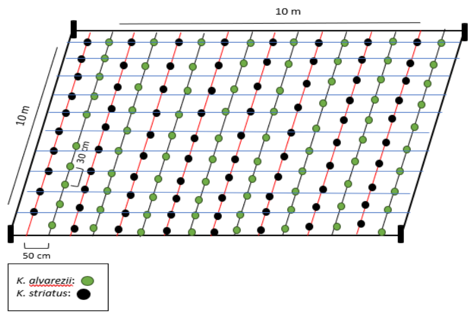

Figure 2. Basic stake method (*K. alvarezii* and *K. striatus*).

Work Procedure

Seedlings of *K. alvarezii* and *K. striatus* are seedlings taken directly from Ekas Bay. Seedlings were selected first, with the criteria of seaweed without wounds, color like the original color, many thallus and not attached to other organisms. The seedlings were weighed with a scale with an initial weight of 50 g per ris, consisting of 2 treatments and each treatment was repeated 10 times. This study was conducted for 45 days. The parameters tested were survival rate, specific growth rate, antioxidant and chlorophyll-a content, and carrageenan content. Further supported by water quality parameters such as temperature, pH, Dissolved oxygen, salinity, ammonia, nitrate, phosphate, brightness, and light intensity.

Carrageenan Analysis Procedure

Getting the carrageenan content in *K. alvarezii* and *K. striatus* is done through several stages, starting from drying the harvested seaweed. Then dry seaweed was soaked back for 24 hours. Seaweed that has been soaked is weighed again and the sample is cut into small pieces to facilitate the process of smoothing with a blender then the sample is put into a blender which is added with water as much as 3 times the wet weight of seaweed that has been soaked. Then cooked for 15 minutes using medium heat, then mixed with an alcohol concentration of 96% as much as 5 ml. The next stage was filtered using filter paper and dried for 3 days in the sun, then weighed and the resulting carrageenan to find the percentage of carrageenan. Calculation of the percentage yield of carrageenan using the following formula:

$$\text{Carrageenan Percentage} = \frac{\text{Carrageenan Weight}}{\text{Dry Weight}} \times 100\%$$

Antioxidant Analysis Procedure

The antioxidant activity of seaweed was tested with the UV-Vis spectrophotometer DPPH method. Samples were used as much as 1 g, the sample used was added 9 ml methanol then vortexed and macerated for 24 hours. After maceration, the sample was filtered using Whatman filter paper to separate the residue from the

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filtrate. The filtered sample was taken 1 mL and then added 2 mL of 0.1 mM DPPH solution. The mixture was shaken until homogeneous and covered with aluminum foil then incubated in a dark room for 30 minutes. Then measure the absorbance at a wavelength of 517 nm and record the absorbance measurement results.

$$\% \text{ Inhibition} = \frac{(\text{Abs blank} - \text{Abs sample})}{\text{Abs blank}} x100\%$$

Chlorophyll Analysis Procedure

Seaweed samples in wet conditions, blended and taken as much as 2 g which has been mashed using a mortar. Then dissolved using 100% acetone. The liquid is taken, if the liquid is cloudy filtered so that the clear filtrate is obtained. The clear filtrate was taken as much as 10 mL, in the room in the cuvette and then measured the absorbance value using a spectrophometer. To determine the chlorophyll content, a standard solution of chlorophyll-a was made and measured with the same wavelength. According to Riyono (2006), chlorophyll-a content was calculated using the formula:

Chlorophyll-a (mg/L) =11.93 (A664) - 1.93 (A647)
Description:
A= Absorbance at each wavelength

Data Analysis

The research method used in this study is an experimental method with a complete randomized design (CRD) with 2 treatments, namely *K. alvarezii* and *K. striatus* using the basic peg method for cultivation activities (Figure 1), then continued with the T-test for the research location map as shown below (Figure 2).

RESULTS AND DISCUSSIONS

Growth

Absolute Weight

Based on the results of the cultivation of *K. alvarezii* and *K. striatus* seaweed cultivated using the basic peg method with a maintenance time of 45 days, the results obtained absolute weight growth. Where *K. striatus* seaweed has a higher absolute weight of 154 g compared to *K. alvarezii* seaweed which is 72 g. Absolute weight growth can be seen in Figure 3.

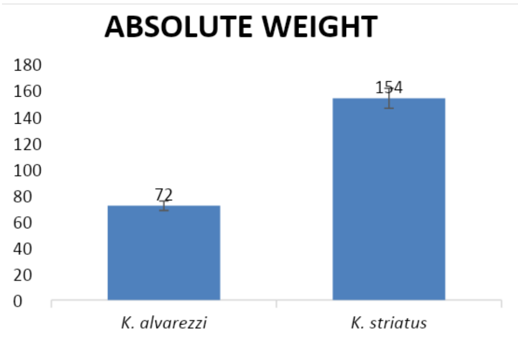

Figure 3. Absolute Weight of *K. alvarezii* and *K. striatus*.

Based on the T-test that has been done, the results obtained differences in the type of *Kappaphycus* seaweed do not have a real influence (P>0.05) on the growth of absolute weight. Where the value of absolute weight growth in *K. striatus* seaweed is higher at 154 g compared to *K. alvarezii* seaweed is 72 g. The growth of seaweed is influenced by the quality of seedlings. Seaweed growth is influenced by the quality of the seeds.

Based on the absolute weight value obtained, the absolute weight of *K. striatus* seaweed is higher allegedly because the seeds used are new seeds that have adaptability and resistance to environmental changes. The increased growth of seaweed is because the seaweed is in the phase of adaptation to its environment that takes place well, thus affecting the daily or weekly growth rate (Halimah *et al*., 2021). While *K. alvarezii* seaweed has a lower absolute

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weight allegedly due to a decrease in the quality of seeds, the seeds used come from picking the tip of the seaweed talus that has been cultivated or the use of seeds that are repeated from the harvest.

This certainly affects the quality of seedlings which in turn affects growth and resistance to environmental changes. This is per the statement of Cokrowati *et al*. (2019), which states that the low quality of seaweed seeds causes seaweed to not grow optimally. Seaweed that has low adaptability and resistance to environmental changes is characterized by whitening of the talus on seaweed which causes the loss of talus which in turn has an impact on suboptimal growth. This is supported by the statement of Gultom *et al*. (2019), which states that seaweed that is not well adapted causes seaweed to experience stress due to changes in environmental conditions.

Specific Growth Rate

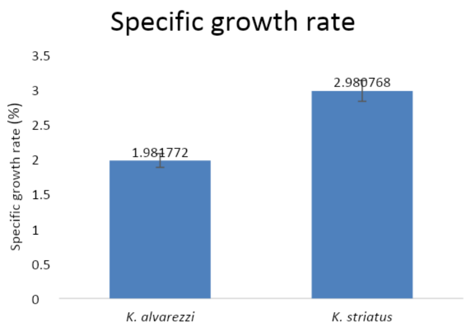

Figure 4. Specific growth rate of *K. alvarezii* and *K. striatus*.

Based on the T-test that has been done, the results obtained differences in the type of *Kappaphycus* seaweed give a real influence (P <0.05) on the specific growth rate. Where the value of the specific growth rate in seaweed *K. striatus* is higher at 2.98 %/day compared to seaweed *K. alvarezii* is 1.98 %/day. The value of specific growth in seaweed *K. striatus* is classified as optimal but inversely proportional to seaweed *K. alvarezii.* According to Putri *et al*. (2022), the daily growth of seaweed above 2% / day has shown the best growth. This is supported by the statement of Raihanun *et al*. (2022) that the daily growth of seaweed is more than 2% including feasible for cultivation.

The difference in specific growth between *K. alvarezii* and *K. alvarezii* seaweed is thought to be due to the different quality of seeds. Where if the seeds used have low quality, it will have an impact on the durability which in turn affects the absorption of nutrients seaweed. According to Gultom *et al*. (2019), good growth will be achieved by seaweed when getting enough nutrients from the environment. When the amount of nutrients in the environment is small or limited then little is also absorbed by seaweed. This is also supported by the statement Cokrowati *et al*. (2020)which states that the growth of seaweed occurs because seaweed performs the process of respiration and photosynthesis as well as the support of water quality and nutrients dissolved therein.

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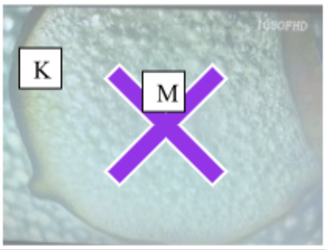
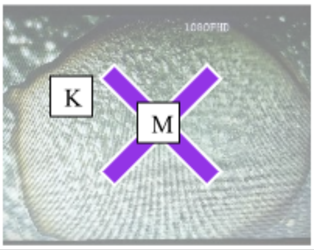
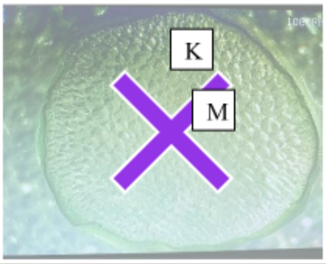
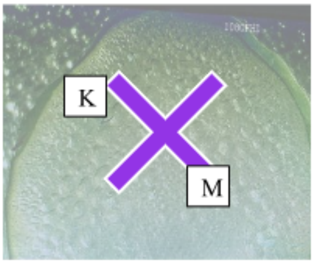
Table 1. Slices of thallus *K. Striatus and K. alvarezii.*

No	Species	Young Thallus	Old Thallus	Description
1.	*K. striatus*			K (Cortical): Small cells located at the edge near the cell wall. M (Medular): Large cells located in the center
2.	*K. alvarezii*			K (Cortical): Small cells located at the edge near the cell wall. M (Medular): Large cells located in the center

Based on the observation of old talus slices on *K. striatus* seaweed, it can be visually seen that the cells in the cortex are elliptical, small in size, and look so dense. While the medullar part of the cells appears larger but not as dense as in the cortical part. The slices of tissue in the young talus showed that the cortical and medullar cells looked the same as the slices of tissue in the old talus.

This is in line with the statement of Cokrowati *et al*. (2021), that in the cross-section of *K. alvarezii*, the medulla contains round or polygonal cells with lenticular thickening on the wall, surrounded by small cells. In line with Maulani *et al*. (2018), the brown variety of *K. alvarezii* seaweed tissue shows a visible cortex section with a healthy cell shape, regular and not tenuous, between tight cell walls. The inner cortex contains polygonal (polygonal-ovoid) cells that get progressively smaller towards the periphery. These outer cells are identical to the cells of the thallus tip (apical), where it is mentioned that the apical part consists of assimilator cells or cells that are actively growing.

Based on the results of observations of slices of *K. alvarezii* seaweed talus tissue visually, it can be seen that the cells in the cortex are elliptical, small in size, and look so dense. While in the medulla the cells appear larger but not as dense as in the cortex. In the cortex is part of the newly formed young cells and medulla cells are cells that are getting to the center of the size is getting bigger. This is in line with the statement of Darmawati (2014), which states that in general shows that cortical cells (K) are smaller in size with an elongated shape with thick and dense cell walls on the surface layer of the talus.

The cortex cells decrease linearly and develop into medular cells (M) that are larger and round, but not too dense when compared to cortical cells. It was clarified by Hariadi *et al*. (2023), that the slices of *K. alvarezii* seaweed tissue showed that the outer cells close to the skin tissue were oval round, small in size, and looked dense. While in the center of the thallus, the cells appear larger. The central tissue of *K. alvarezii* consists of colored filaments surrounded by large cells and coated by a layer of cortex. The filament is a type of thallus consisting of one or more rows of connecting cells, with or without gelatine and adhesive layers.

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Antioxidant and chlorophyll-a levels

Table 2. Antioxidant and chlorophyll-a content.

Seaweed species	Antioxidant content (%)	Chlorophyll-a (mg/l)
K. alvarezii	5.46	5.77
K. striatus	7.42	3.51

Seaweed is considered a natural antioxidant and has high bioactivity. One seaweed that contains natural antioxidants is *Kappaphycus*. *Kappaphycus* is a type of seaweed that has the potential as an antioxidant, based on the results of antioxidant analysis obtained from *K. alvarezii* and *K. striatus* seaweed respectively reached 5.46% and 7.42%. Most seaweeds show high antioxidant properties, which serve as nutraceutical applications (Tanna *et al.*, 2022). The antioxidant content contains active substances such as fucoidan, and phenolic components. According to Gultom *et al.* (2021), antioxidant compounds can prevent or slow down oxidation. Free radicals act as electron acceptors and are also referred to as oxidizing agents because they cause other molecules to donate their electrons and cause cell damage (oxidative stress) which can cause several diseases such as cancer or other degenerative diseases. According to Lalopua (2020), *K. alvarezii* contains some bioactive compounds that have potential as antioxidants including pigments, proteins or peptides, sorbic acid, and carotene.

Based on the results of the analysis of chlorophyll content obtained from seaweed *K. alvarezii* and *K. striatus* amounted to 5.77 mg/l and 3.51 mg/l. The high and low values of chlorophyll are influenced by the high and low values of chlorophyll. High and low chlorophyll value is influenced by the process of photosynthesis. *Kappaphycus* is a plant that lives in the water and has a green leaf substance (chlorophyll) which plays a major role in photosynthesis and growth (Kasran *et al.*, 2021; Cokrowati *et al.*, 2020). Chlorophyll-a is one of the most important parts of the photosynthesis process and is owned by most algae that live in the sea. Then explain the role of phycoerythrin in helping seaweed capture the light that chlorophyll-a uses in the photosynthesis process.

Carrageenan

The results of the analysis of carrageenan both types of seaweed are as in Figure 5.

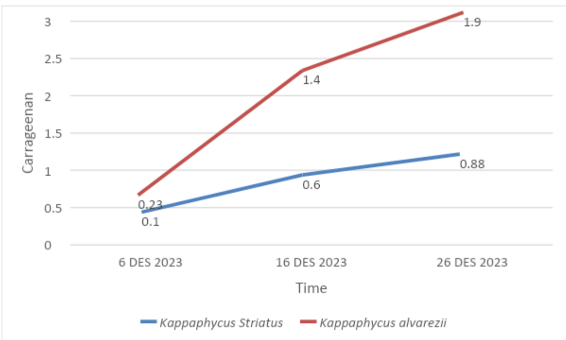

Figure 5. Graph of carrageenan yield results.

Carrageenan is derived from seaweed polysaccharides contained in the cell wall or intracellular matrix and is one of the results of photosynthesis. Carrageenan yield is the weight percentage of carrageenan produced from the extracted dried seaweed. According to Dean *et al.* (2023), *K. alvarezii* also has a high polysaccharide content in its cell wall so it has the potential as a source of carrageenan. Das *et al.* (2021) stated that

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carrageenan is a hydrocolloid compound extracted from red seaweed species, namely *K. alvarezii*, *Chondrus crispus*, and *Eucheuma spinosum*. Based on the results of the study, the yield of carrageenan obtained in the cultivation of *K. alvarezii* on day 0 was around 0.23%, on day 10 was around 1.4%, and on day 20 was around 1.95%. This shows that in this *K. alvarezii* cultivation activity, there is an increase in carrageenan every 10 days of maintenance. This condition can be influenced by the photosynthesis process that occurs within the period/harvest age, the longer the time/harvest age can produce an increase in carrageenan in seaweed talus is also high. In line with the statement of Putri *et al*. (2022), carrageenan is a compound consisting of several elements obtained through the process of photosynthesis of seaweed.

The yield value of carrageenan produced by seaweed *K. striatus* on day 0 ranged from 0.1%, on day 10 ranged from 0.6%, and on day 20 ranged from 0.88%. Carrageenan levels of seaweed continuously increased every 10 days of maintenance. According to Jönsson *et al*. (2020), Carrageenan is a high molecular weight sulfated polysaccharide found in seaweed cell walls, which accounts for most of the marine algae compound market and is used in various industries including food and pharmaceuticals. In addition to the age/time of harvest that can affect carrageenan content, there are several other factors, namely environmental conditions. Rupert *et al*. (2022) believed that environmental conditions (also known as abiotic factors) such as temperature, ammonia, nitrate, phosphate, light, water movement, and nutrients affect the biochemical content of polysaccharides (proteins, carbohydrates, lipids, fiber, ash, and nitrogen) in polysaccharides.

Water Quality

Table 3. Water quality parameters.

Parameters	Value	Eligibility
Temperature (°C)	29.5-32.7	30.3 – 31.7 (Kumar *et al*., 2020)
pH	7.9-8.15	7.0 – 8.2 (Yong *et al*., 2014)
Dissolved Oxygen (ppm)	6.7-8.5	>5 (Oedjoe *et al*., 2022)
Amonia (mg/l)	1.0-1.5	0.1-0 5 (Fitri *et al*., 2023)
Nitrate (mg/l)	10	0.200-0.420 (Sujatmiko *et al*., 2024)
Phosphate mg/l	1	0.200-0.420 (Sujatmiko *et al*., 2024)
Salinity (ppt)	29-31	28 – 35 (Magaña-Gallegos *et al*., 2023)
Light Intensity (lux)	590-772 x100	5000 (Novianti *et al*., 2015)
Brightness (m)	0.7-1.5	1.138-1.3667 (Nikhlani and Kusumaningrum, 2021)

K. alvarezii growth is influenced by environmental factors around the waters. Environmental factors will provide important information related to things that affect the growth of *K. alvarezii*. The temperature obtained in *K. alvarezii* cultivation with the basic peg planting method in ekas waters ranges from 29.5 °C–32.7 °C, including the optimal temperature for *K. alvarezii* growth. This is by the statement of Kumar *et al*. (2020) that the optimal temperature for *K. alvarezii* cultivation growth is 30.3 – 31.7 °C where the water temperature has warmer water conditions. According to Magaña-Gallegos *et al*. (2023), higher seawater temperatures can inhibit the formation of a sizable population of *K. alvarezii* seeds. Temperature plays an important role in *K. alvarezii* growth. Extreme temperature changes can cause death for *K. alvarezii*, disrupt reproduction, and inhibit growth.

Measurements of the pH of the waters around the planting site during *K. alvarezii* cultivation ranged from 7.9 to 8.15. This indicates that the pH around the *K. alvarezii* planting waters is quite optimal for *K. alvarezii* growth. This follows the statement of Yong *et al*. (2014) that the optimal pH of a body of water that can support the growth of seaweed ranges from 7.0 to 8.2. Low pH in waters can cause *K. alvarezii* growth to be inhibited or stopped because the environment is not suitable and metabolic processes in *K. alvarezii* can be disrupted.

The results of measurements of dissolved oxygen in the waters of Ekas get a value that is suitable for the growth of *K. alvarezii* seaweed ranging from 6.7 ppm – to 8.5 ppm. The value is by the natural quality standards for marine biota > 5 mg / L. According to Oedjoe *et al*. (2022), the optimal dissolved oxygen concentration for *K. alvarezii* is 7.37 mg/L. Coastal waters require a minimum of 4,0 mg/L of oxygen, but dissolved oxygen concentrations of more than 5.0 mg/L are preferred for ecosystems with optimal function and carrying capacity.

Ammonia (NH_3) is a chemical compound consisting of one nitrogen atom (N) and three hydrogen atoms (H). It is toxic and can be a problem in some environmental contexts, especially in water. In the context of aquaculture, high ammonia levels can be toxic to living organisms. The ammonia measurement results of the waters around the planting site during *K. alvarezii* cultivation ranged from 1.0 to 1.5 mg/l. These results indicate that ammonia levels are not optimal in these waters. According to Fitri *et al*. (2023), the optimal range of ammonia (NH3) for seaweed cultivation is 0.1-0.5 mg/l. Fadhlullah *et al*. (2022) stated that the higher the content of pH and temperature, the ammonia concentration in these waters will also increase, whereas if the dissolved oxygen content is high then ammonia is rarely obtained otherwise in low oxygen areas ammonia levels are relatively increased.

K. alvarezii requires nitrate as one of the main nutrients for the growth and development process. Nitrate plays a role in helping the formation of proteins, nucleic acids, and various other organic molecules. The results of nitrate content obtained in this study were around 10 mg/l. This indicates that the nitrate content in these waters is not optimal. According to Sujatmiko *et al*. (2024), the optimal nitrate content for *K. alvarezii* growth ranges from 0.200-0.420 ppm. high nitrate content in the cultivation environment can cause several problems. High nitrate content can trigger excessive algae growth, including unwanted algae.

In *K. alvarezii* cultivation, phosphate (PO_4^{3-}) is an important nutrient needed for the growth and development of seaweed. The results of this study obtained a phosphate content value of 1 mg/l. According to Widyartini *et al*. (2017), the optimal phosphate content in water is 0.1-0.2 mg.L-1. This shows that the phosphate content in this study is less than optimal. Excessive phosphate in waters can cause a decrease in water quality, especially algae can grow excessively. This process can reduce oxygen levels in the water and disrupt the balance of the marine ecosystem.

In *K. alvarezii* cultivation, the salinity value obtained is 29 - 31 ppt, where this value is a good salinity for *K. alvarezii* growth According to Magaña-Gallegos *et al*. (2023), the optimal *K. alvarezii* salinity value for growth ranges from 28 ppt to 35 ppt. According to Asmi *et al*. (2013), the effect of high salinity on growth and changes in the structure of algae, among others, is the smaller the size of the stomata, so that the absorption of nutrients and water is reduced, ultimately inhibiting algal growth both at the organ, tissue, and cell levels.

The light intensity obtained in the cultivation of *K. alvarezii*. with the method of planting the base peg in the waters of the ekas ranged from 590x100 Lux - to 772x100 Lux. According to Novianti *et al*. (2015), the good light intensity for cultivation is around 5000 lux. The value of light intensity is influenced by the depth of the water. The deeper the water, the lower the light intensity.

Brightness is an important factor in seaweed cultivation. Seaweed requires sunlight to perform photosynthesis, which is

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the main process for growth and energy production. In the cultivation of *K. alvarezii*, the brightness value obtained is 0.7 – 1.5 m, this is a good brightness value for seaweed growth. According to Nikhlani and Kusumaningrum (2021), the ideal water brightness is more than 100 cm. Turbid water can block the penetration of sunlight in the water so that it can interfere with the photosynthesis process. The optimum range of brightness for seaweed cultivation ranges from 113.8-136.67 cm.

CONCLUSION

The conclusion of this study is the growth of *K. striatus* faster than *K. alvarezii*. The absolute weight of *K. striatus* is 154 g with a growth rate of 2.98%/day.

CONFLICT OF INTEREST

The author declares there is no conflict of interest.

AUTHOR CONTRIBUTION

Nunik Cokrowati as principal researcher and field researcher. Nuryatin and Jayusri contributed to the result, discussion, and field research. Muhammad Jumat contributed to the slice of thallus and field research. Nuri Muahidah as water quality analyzer.

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