Vol-1 Issue-1 2023
Scientific Research Journal of Agriculture and Veterinary Science
ISSN: 2584-1416, Peer Reviewed Journal

A Critical Analysis of Macroalgae Farming Using the Kappaphycus alvarezii Species and Its Impact on the Environment

Alaa Amin

Student of Fisheries Study Program,
BOGOR AGRICULTURAL INSTITUTE, West Java, Indonesia

ABSTRACT

One of the forms of seaweed that is grown in greenhouses at an exceptionally high rate is called Kappaphycus alvarezii. This kind of seaweed may be grown with very inexpensive and straightforward equipment, and the subsequent processing of the collected product needs just a moderate level of expertise. Red algae sometimes referred to as Rhodophyceae, are tiny algae that have the potential to grow to enormous heights. The ingredient particle is responsible for giving algae their recognisable red colour. Other variables, such as the location and the cultivation technique that is used, which in this case may support the growth and production of seaweed, also contribute to the long-term success of the company. Seaweed is an essential component of the business. The development of K. alvarezii seaweed is significantly impacted by both fertilisers and the physicochemical features of the coastal waters. These factors include temperature, saltiness, sunshine, and the directions in which the water is flowing (current). In addition to having uses in the food, beauty product, pharmacological, bacteriological, and medical companies, carrageenan is also a component of fertilisers and an additive for containers in the paper, fabric, photographers, shoe polish, lasagna, and oreochromis niloticus and lamb bottling industries. The primary organism responsible for the production of carrageenan is K. alvarezii.

***Keywords**: Seaweed, aquaculture, mariculture, cultivators, seagrass, ecologically*

---

1. INTRODUCTION

Seagrass is one of the resources that is absolutely necessary for the marine fishing industry (mariculture). One of the types of seaweed that is farmed the most often is the Kappaphycus series. This form of seafood may be produced straightforwardly and cost-effectively, which is one reason for this. In addition, very little processing is required for this sea salt once it has been harvested. That is the reason. K. alvarezii is the primary source of chitosan, which has various uses in nutrition, beauty products, pharmacy, physicochemical and microbiological, and industrial applications, as well as in the fertilizer industry and container additives for the article, fabric, cinematography, Liquid Shoe Polish, frosted flakes, and squid food preservation sectors [1, 2, 3]. K. alvarezii has also been used in the production of fertilisers and container additives for these industries. Additionally, K. alvarezii beach includes hyaluronic acid and kappa tannins, both of which are used in various sectors as agents responsible for gelling and hardening products [4, 5]. It is essential to sustain production by developing ecologically friendly aquaculture methods to meet the ever-increasing demand for seaweed grown on farms in today's market.

2. Genetic Features OF Kappaphycus alvarezii

The term "seaweed" refers to benthic microalgae and is often used in commercial settings. Seaweed and algae are considered low-grade plants since they often grow connected to particular substrates, do not have genuine bases, branches, or leaf but merely have stems that are called thallus [6]. Seaweed and algae may also be referred to collectively as algae. However according, the following is the categorization of Hypnea alvarezii:

- Hallophyta is the relevant taxonomy.
- Category: Rhodophyceae
- Gigartinales is the division, while Solieriaceae is the genus.
- The type species is Kappaphycus.
- Species : Hypnea alvarezii

Smooth, cylindrical, and varying shades of green, yellow, grey, and red are all characteristics that may be used for molecular identification of K. alvarezii [6]. The colour might also be on the spectrum from bright to dark. The thallus might seem straightforward or intricate to the spectator, depending on its development stage. It seems to branch out in many guidelines, with the main divisions reasonably nearby and the hub being in the center (base). The sunlight helps a plant develop a strong primary and secondary roots network. This will expose them to more direct sunlight than usual. Meanwhile, the structure of K. alvarezii is defined as a thallus that is either spherical or flat, with wrinkled (nodules) and protuberances (spine) and two sides that differ. Equal width. [7] Possible manifestations of these features in the cotyledon include: (Figure 1).

Figure 1. *Algae of the genus Kappaphycus* Source: [7]

The diagnostic potential of this seaweed's multicoloured thallus has recently been the subject of much debate. There is a possibility that the cyanobacterial, green algal, allegedly plastic, and cyanophyte kingdoms may find some application for this colouring. The existence of thallus stomata in a wide range of eye-catching hues looks at many types of algae, such as brown algae, green algae, red algae, and blue algae. On the other hand, red algae are famously challenging to detect because of their colorful thallus structures. Red algae may have a thallus that has a variety of colours, ranging from greenish yellow to brown, black, and reddish. There is no guarantee that colour alone will suffice as an adequate identification. Colours can change based on a variety of different things that are present in the environment around them. Changes in climate and ocean conditions, for example, might be among the environmental factors that kickstart a period of rapid morphological and phenotypic change. Algae are primarily single-celled creatures that contain chlorophyll and a thallus. However, there are certain types of algae that have multicellular genitalia. The algal kingdoms are comprised of the following: Outer Euglenophyta, Inner Cyanobacteria, Inner Bacillariophyta, Inner Pyrrophyta, and Inner Elaborate System (inner layer). We will explore the conditions leading up to this and the accompanying courses.

The Rhodophyta are a colossal group of algae that work together. The pigment phycoerythrin is responsible for the vibrant red colour of the seaweed known as K. alvarezii (Rhodophyceae). Because licorice extract was discovered in the kappa-carrageenan fraction, K. alvarezii was reclassified as a separate species from K. cottonii and given the name K. alvarezii. [8] demonstrates this. On the other hand, the regional name "cottonii" is more likely to be accepted by national and international commerce because it is more common and has been used more often.

Because it is a photoautotroph, K. alvarezii grows best on reefs that get much sunlight and are relatively shallow. They do well when placed on plain substrates in deep water (such sand, dead coral, or mollusk shells). It is possible that there is not enough room in the natural environment for this species to reproduce beyond a single society of K. alvarezii, a kind of seaweed that can live through daily temperature variations of a few degrees. K. alvarezii may be found on coral reef flats as short as 20 meters, where it adheres to rocks, shells, and other complex objects. K. alvarezii can also be found on coral reef slopes. According to the source [9], seaweed loves calcium hydroxide because of the material's high fertility, resilience to erosion, and attractive colouring, all of which serve to reflect sunlight. One example of this would be limestone. According to [10], areas with a substrate consisting of coral sand and bits of coral may support the growth of seaweed due to favourable currents. These organisms thrive best at a salinity (salt concentration) that falls somewhere between 28 to 34 parts per thousand. K. alvarezii is most successful when it is progressively pushed away from the mouth of the river. Due to rope culture, it is possible to cultivate this plant even without coral supports or other attachment methods [11].

Seaweeds are capable of reproducing either asexually (via capsules) or sexually (via sperm and eggs) or sexually and asexually simultaneously (by breaking) (through cutting). A process known as vegetative reproduction is something that plants do to ensure that their species will continue to exist. We want to begin by extracting cells and tissues from the plant's growing tip, since this is where we expect to see the greatest results. The thallus of multicellular algae such as K. alvarezii and Gracilaria sp. may be broken into smaller pieces, from which new individuals can develop.

3. Considerations In The Natural Surroundings That Affect Seaweed Culture And Generation

The sustainability of a seaweed farm depends on several physical, chemical, and biological aspects, thus, farmers need to take these requirements into account. Additionally, the choice of site and the technique to be utilised also impacts the performance of the growing company, which may improve the development and output of seaweed. Environmental factors have the greatest impact on seaweed reproduction, as stated in [10]. Things like temperature, saltiness, sunlight, and water flow are some of the environmental elements that have a role in the availability of nutrients and water quality (current).

3.1 Nutrients in Water

The presence of nutrients in the water is one of the most critical factors contributing to seaweed growth. Alterations in the amount of accessible water have an influence, both favourably and adversely, on the quantity and quality of saltwater generated. Two types of minerals are necessary for development: microeconomic minerals, which are required in huge quantities, and segmental and sub-minerals, which are required in much smaller amounts. Both types of minerals are essential for growth. The application of the macroelement, which is more often known as a nutrient, has the potential to hasten the development of a plant (N). The presence of nitrogen (N) is required for sea salt production because nitrogen (N) plays an essential role in the mechanism by which sunlight works. According to the research presented in [12], nitrogen is a component that plays a critical role in the generation of cytoplasmic. About 14 cm3 of nitrogen is present in each and every liter of saltwater. The generation of oxygen and usable energy begins with chloroplasts taking in nitrogen, a critical stage in the process.

Phosphorus and nitrogen are two instances of the many macronutrients that are examples of those in short supply [13]. Seagrass can't develop without certain macronutrients, particularly when exposed to sunshine. In addition, nitrates, a complex made up of nitrogen, can be digested, while phosphodiesterase, which is also a molecule made up of phosphorus and oxygen, is absorbed. Both of these molecules are examples of molecules that consist of carbon dioxide and nitrogen. Phosphate contents in the ocean span a broad range, from 0.021 to 0.201 parts per billion (ppb), with groundwater having the lowest phosphate contents than deeper seas. This vast range of proportions is due to the ocean's complex chemical makeup. In order to get the best results possible from mariculture, the water should have a phosphate concentration of greater than 0.8 ppm [14], and the nitrate concentration should range from 0.9 to 3.9 ppm. In contrast to phosphorus and ammonium, lithium is known as a "macronutrient," which is a term used to describe a nutrient needed by trees in extremely high amounts. According to reference [16], the process of plant cells receiving energy from optical processes requires the utilisation of potassium. Wilting in plants, weakening their thallus structure, and an enhanced susceptibility to disease are all potential side effects of an insufficient intake of magnesium (K). A sluggish metabolism and slower development, in addition to an increase in respiratory rate, maybe the result of a deficiency in K components [17]. In addition to this, it has the potential to quicken the pace at which one breathes.

3.2 Water Quality and Circumstances

3.2.1 Reflectivity of Water

The high quantities of light that are present in coral reef waters are necessary for optimal metabolic function. For seaweed cultivation, the needed light intensity ranges from 0.94 meters to 6.78 meters during the rainy season and from 1.65 meters to 7.35 meters during the dry season [18]. If the water is more transparent, then more sunlight will be able to pass through it. As a result, the photosynthetic activity of the seaweed will be able to continue at a rapid enough pace to keep up with the increasing light intensity. The additional sunlight kicks off the biochemical process, which encourages the seaweed to take up more nutrients so that it may continue to expand. The formation of seaweed requires visibility of between 3.5 and 5.5 meters and a current speed of between twenty and forty centimeters per second [15].

3.2.2 Moving Water:

Because seaweed can get all of the nutrients it requires directly from the ocean, the movement of water, which is more often referred to as currents, helps keep nutrients that promote growth flowing. Vitamins and minerals are the two primary nutrition categories, and their names are used interchangeably. Algae need a wide array of nutrients to grow to their full potential. These nutrients include carbon, hydrocarbons, and micronutrients such as copper, copper, metal, and moly.

3.2.3 Heat or Cold

According to [6], seaweed grows best in temperatures between 22 and 27 degrees Celsius, although seaweed thrives in waters between 24 and 35 degrees Celsius. According to [18], the research found that the optimal temperature range for seaweed development during the rainy season was between 29 and 30.60° C, whereas the dry season temperature range was between 28 and 91° C and 32 and 55° C. In addition, the view of [19] is consistent with this, which claims that K. alvarezii's maximal photosynthetic rate occurs around 30 ° c and that photosynthetic activity is suppressed at temperatures over 32 ° c.

3.2.4 Saltiness

The degree of saline in an environment is one of the factors that have the most significant impact on an organism's capacity to grow and spread. Most macroalgae, often known as seaweeds, are susceptible to changes in salt. Macroalgae will shut down their photosynthesis when subjected to salt levels that are too high [20]. This is accomplished by preventing electron transport inside the reaction center of the photosystem. The samples of algae with a salinity of 30 parts per thousand had the greatest chlorophyll concentration, whereas those with a salinity of 35 parts per thousand had the maximum chlorophyll content. According to [21], the optimum salinity supports good seaweed development because of the harmony of the activities in the cell membrane. The salinity of seaweed and the water in its surrounding environment is affected by salinity, a chemical component that transforms the characteristics of both things. This balance is necessary for healthy seaweed growth because it makes it easier for the seaweed to absorb nutrients, including micronutrients, which are needed for respiration. How salt influences plant growth is very nuanced [22]. Ionic, osmotic, and secondary stress are the three forms that may be caused by salinity. Ionic anxiety is an emotional kind. Ionic stress brought on by high salinity may lead to Na^+ poisoning, which can be fatal. An increase in salt causes electrolyte tension because it affects the excessive hydrostatic potential, which in turn prevents the body from absorbing water and other components via the osmosis process. The presence of an excessive amount of Na ions on the exterior of the cotyledon may make it more difficult for the thallus to absorb K^+ from its local environment. The high salinity causes an increase in ionic pressure as well as osmotic pressure, both of which are harmful to cell functions and monomers such as lipids.

Since the process of modifying osmolality is tightly associated with the function of biological membranes in the movement of nutrition, salinity influences the physiological and biochemical processes [23]. The consequences of excessive salinity, which include the constriction of stomata in order to limit nutrient and water intake, inhibit the formation of algae at the organ, tissues, and subcellular levels. This results in a reduction in the number of algae that may form. In light of this, according to [20], only stolons were duplicated from branches in response to a salt treatment of 20 ppt and 45 ppt, while new branches with ramuli formed in response to a salinity of 30-40 ppt.

4. CONCLUSIONS

According to the findings of a search that was derived from multiple literature reviews, the essential factors that have a significant impact on the production of K. alvarezii microalgae are the underwater environmental components such as minerals and the health complications of the waterbodies such as warmth, moistness, sunshine, and hydraulic gradient (current). Due to the significance of these parameters, we heartily advise cultivators to utilize water temperatures that are compatible with the prerequisites of K. alvarezii seaweed.

5. REFERENCES

[1]. Nurdjana, ML (2005) "Iklim usaha yang Kondusif Bagi Pengembangan Akuakultur di Indonesia" Konferensi nasional Akuakultur, Makassar, 23-25 November 2005. Kerjasama Masyarakat Akuakultur Indonesia, Balai Riset Perikanan Budidaya Laut Makassar, 25 p.
[2]. Neksidin, Utama K, Pengerang and Emiyarti (2013) "Studi Kualitas Air untuk Budidaya Rumput Laut (*Kappaphycus alvarezii*) di perairan Teluk Kolono Kabupaten Konawe selatan" *Jurnal Mina Laut Indonesia*. 3(12), pp 147-155
[3]. Irawati., Badraeni., Abustang and A, Tuwo (2016) "Pengaruh perbedaan Bobot Thallus Terhadap Pertumbuhan Rumput laut *Kappaphycus alvarezii* Strain Coklat yang dikayakan" *Jurnal Rumput laut Indonesia* 1(2), pp 82-87.
[4]. Hayashi L, de Paula E.J, Chow F (2007) "Growth Rate and Carrageenan Analyses in Four Strains of *Kappaphycus alvarezii* (Rhodophyta, Gigartinales) Farmed in the Subtropical Waters of Sao Paulo State" Brazil.
[5]. Knudsen, NR, Tutor AM, Ajaloueian F., Yu, L (2017) "Rheological Properties of Agar and Carrageenan from Ghanaian Red Seaweed" *Journal Food Hydrocolloids*. 63, pp 50-58.
[6]. Parenrengi, A., and Sulaeman, (2010) "Mengenal rumput laut, *Kappaphycus alvarezii*. *Media Akuakultu*r 2 (2), pp 142-146.
[7]. Hitler S. (2011) "Pengaruh Berat Bibit Awal yang Berbeda Terhadap Pertumbuhan dan Kadar Keragenan Rumput Laut (*Kappaphycus alvarezii*) Varietas Cokelat Menggunakan Metode Vertikultur. Fakultas Perikanan dan Ilmu Kelautan Universitas Haluoleo. Kendari.
[8]. Doty MS and Norris JN. (1985) "Biotechnological and Economic Approaches to Industrial Development Based on Marine Algae in Indonesia" Paper in Workshop on Marine Algae in Biotechnology. Jakarta 11-13 Desember 1985. National Academy Press. Washington D.C.
[9]. Dawes, CJ (1981) "Marine Botany" A Willey – Interscience Publication niversity of South Florida USA. 628p
[10]. Kadi, A and Atmadja, WS (1988) "Rumput Laut (Algae) Jenis, Reproduksi, Produksi, Budidaya, dan Pasca Panen" Proyek Studi Potensi Sumber Daya Alam Indonesia. Pusat Penelitian dan Pengembangan Osenologi. LIPI, Jakarta.
[11]. Daniel BA, (2012) "Produktivitas Rumput Laut *Kapaphycus alvarezii* yang dibudidayakan oleh Masyarakat Pesisir. *Bachelor thesis.* Jurusan Perikanan Dan Kelautan Fakultas Pertanian Universitas Nusa Cendana. Kupang.
[12]. Yuniarsih, E., Nirmala, K., Radiata I.N, (2014) "Tingkat Penyerapan Nitrogen dan Fosfor ada Budidaya Rumput laut Berbasis IMTA (Integrated Multi-Trophic Aquaculture) di Teluk Gerupuk, Lombok tengah, Nusa Tenggara Barat" *Jurnal. Ris. Akuakultur*. 9(3), pp 487-500.
[13]. Lapointe, BE. (1987) "Phosporus and Nitrogen Limited Photosintesis and Growth of *Gracilaria ticvahiae* (Rhodophyceae) in the Florida Keys: An Experimental Field Study. *Ma. Biol.*, 93(4), pp 561-568
[14]. Wardoyo, SE. (1992). "Potensi Budidaya Rumput Laut di Sulawesi Utara" *Buletin Penelitian Perikanan* 1.
[15]. Sulistidjo. (2002) "Penelitian Budidaya Rumput Laut (Algae Makro/Seaweed) di Indonesia" Orasi Pengukuhan Ahli Peneliti Utama Bidang Akuakultur. LIPI, Pusat Penelitian Oseanografi, Jakarta.
[16]. Nicholls, RE (1993) "Hidroponik Tanaman Tanpa Tanah" Dahara Prize. Semarang.
[17]. Round. FE. (1977) "The Biology of The Algae" Edward Arnold Publisher. London.

[18]. Asni, A. (2015). "Analisis Produksi Rumput Laut (*K. alvarezii*) Berdasarkan Musim dan Jarak Lokasi Budidaya di Perairan Kabupaten Banteng"

[19]. Soegiarto, AW, Sulistijo, Mubarak H. (1978) "Rumput laut. (Algae). Manfaat, Potensi, dan Usaha Budidayanya" Lembaga Oseanologi Nasional. LIPI, Jakarta.

[20]. Hui, G., Zhongmin S., Delin D. (2014) "Effect of Temperature, Irradiance on the Growth of the Green Algae *Caulerpa lentillifera* (Bryopsidophyceae, Chlorophyta). *Chinese Journal of Applied Phycology*. DOI 10.1007/s10811-014-0358-7 from: http://link.springer.com/article/10.1007%2Fs10811-014-0358-7, (accessed in 10 Desember 2014)

[21]. Izzati, M. (2004) "Kejernihan dan Salinitas Perairan Tambak setelah Penambahan Rumput Laut, *Sargassum plagyophyllum* dan Ekstraknya" Laboratorium Biologi dan Struktur Tumbuhan Jurusan Biologi FMIPA Undip Semarang.

[22]. Arisandi A, Marsoedi, H, Nursyam and A, Sartimbul. (2011) "Pengaruh Salinitas yang Berbeda terhadap Morfologi, Ukuran dan Jumlah Sel, Pertumbuhan serta Rendemen Karaginan *Kappaphycus alvarezii" Jurnal Ilmu Kelautan* 16 (3), pp 143-150.

[23]. Xiong, I and J.K. Zhu. (2002). "Salt Tolerance in The Arabidopsis" American Society of Plant Biologists.