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Assessing the Global Cultivation Practices of Kappaphycus alvarezii: A Comprehensive Review of Growth Dynamics, Nutrient Management, and Biochemical Composition

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ABSTRACT

Kappaphycus alvarezii is a crucial species for carrageenan production, widely used in various industries. This review aims to synthesize global research on the cultivation of K. alvarezii, focusing on growth dynamics, nutrient management, and biochemical composition. Studies show that growth rates are significantly influenced by cultivation methods, such as longline, raft farming, and Integrated Multi-Trophic Aquaculture (IMTA), each offering distinct advantages in terms of yield and ecological sustainability. Nutrient management, particularly nitrogen and phosphorus level, plays a critical role in optimizing both biomass and carrageenan quality. The use of biostimulants and fertilizers has been found to enhance growth and biochemical properties, yet careful nutrient control is essential to prevent negative environmental impacts such as eutrophication. Genetic diversity, particularly through the selection of wild versus cultivated strains, is another important factor in farm resilience. Wild strains provide greater environmental adaptability and disease resistance, while selected strains typically offer faster growth and higher yields. However, the reduced genetic diversity in clonal farming raises concerns about long-term sustainability. Research gaps identified include the need for long-term studies on the sustainability of farming techniques, particularly in the context of climate change, and more extensive investigations into the ecological and economic benefits of IMTA systems. Future research should focus on integrating biological, ecological, and economic aspects to optimize K. alvarezii farming and enhance its contribution to the blue economy.

Keywords: biochemical composition; carrageenan quality; growth dynamics; *Kappaphycus alvarezii*; nutrient management

I. INTRODUCTION

Kappaphycus alvarezii is one of the most commercially significant species of red algae, primarily cultivated for carrageenan production. This hydrocolloid is widely used in the food, pharmaceutical, and cosmetic industries due to its gelling, thickening, and stabilizing properties. Carrageenan derived from *K. alvarezii* is particularly valuable because it is cost-effective and can be produced using relatively simple farming techniques, which has led to its widespread adoption, especially in tropical coastal regions (Tan et al., 2021; Bimasuci et al., 2021; Montúfar-Romero et al., 2023). Its cultivation supports a major segment of the global seaweed market, especially in Southeast Asia, Indonesia, and the Tropical Eastern Pacific, where it contributes significantly to regional economies through both direct revenue from carrageenan and associated industries, such as aquaculture (Zakaria et al., 2019; Shalvina et al., 2022).

Beyond its industrial applications, *K.alvarezii* plays a critical role in supporting livelihoods, particularly in smallholder aquaculture systems. It is often cultivated using low-capital, short-cycle methods, making it an accessible means for coastal communities to generate income. Additionally, K. alvarezii cultivation

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contributes to the blue economy by providing ecosystem services, such as nutrient biofiltration and carbon sequestration, which are increasingly recognized for their potential to mitigate environmental impacts, such as coastal eutrophication and ocean acidification (Nurdin et al., 2023; Heriansah et al., 2025). Through its ability to absorb excess nutrients like nitrogen and phosphorus, *K. alvarezii* acts as a biofilter, improving local water quality and supporting coastal restoration efforts (Montúfar-Romero et al., 2023). However, the expansion of *K. alvarezii* farming is not without its challenges. Environmental stressors, diseases, and the need for improved seed quality and management practices all present significant barriers to its widespread success (Kumar et al., 2020; Soelistyowati, 2023). These challenges underline the need for continuous research into optimizing cultivation practices to enhance sustainability and farm productivity.

This review synthesizes global research on the cultivation practices of *K.alvarezii*, with a particular focus on growth dynamics, nutrient management, and biochemical composition. The aim is to provide an integrated overview of the current state of knowledge, identify best practices, and highlight gaps in research that need to be addressed to further optimize K. alvarezii farming for both economic and environmental benefits.

The primary objective of this review is to synthesize global research on *K. alvarezii* cultivation, focusing on the following aspects: (1). Cultivation Practices and Growth Dynamics: Understanding the various cultivation techniques used worldwide, including raft farming, longline systems, and integrated aquaculture practices, is essential for improving yield and quality. Growth dynamics, influenced by environmental factors such as light, temperature, salinity, and nutrient levels, are critical to predicting the performance of K. alvarezii under different farming conditions. (2). Nutrient Management: Nutrient management plays a crucial role in optimizing growth and biochemical composition, particularly carrageenan yield. Evaluating the impact of different nutrient inputs, such as nitrogen, phosphorus, and organic additives like biostimulants, on *K. alvarezii* will help identify the most efficient and sustainable practices for farming this species. (3). Biochemical Composition and Carrageenan Yield: The biochemical properties of K. alvarezii, particularly its carrageenan content, are influenced by genetic factors and environmental conditions. This review will examine how different cultivation practices and environmental variables affect the biochemical composition of the seaweed, with a focus on optimizing carrageenan yield and quality. (4). Environmental Sustainability and Ecosystem Services: In addition to its economic value, *K. alvarezii* farming provides measurable ecosystem services, including nutrient biofiltration, carbon sequestration, and habitat restoration. The review will explore how these services can be optimized through better cultivation practices, contributing to the broader goals of sustainable aquaculture and blue economy initiatives.

This review will focus on studies published in the last two decades, covering key regions involved in K. alvarezii farming, including Southeast Asia, India, the Pacific Islands, and Africa. These regions are central to the global cultivation of K. alvarezii, and the farming practices in these areas provide valuable insights into the factors that influence productivity and sustainability.

The review will examine multiple cultivation methods, including: (1). Raft farming: A common method in shallow coastal waters, where seaweed is grown on floating rafts. (2). Longline systems: A method used in deeper waters, where seaweed is cultivated on submerged lines. (3). Integrated aquaculture: This system combines seaweed farming with fish or shellfish farming to create a more sustainable, multi-trophic approach.

By analyzing these methods, the review will provide a comprehensive understanding of their respective advantages and limitations, and how they contribute to the overall success of K. alvarezii farming.

To guide the synthesis of the literature, this review will address the following research questions: (1). How do global cultivation practices affect the growth dynamics of K.alvarezii?. This question will explore how different farming systems and environmental conditions influence the growth of K. alvarezii, helping to identify the most effective practices for maximizing yield. (2). What are the optimal nutrient management strategies for the sustainable cultivation of K. alvarezii? This question will focus on evaluating the impact of nutrient inputs on the growth and biochemical composition of K. alvarezii, particularly carrageenan yield. (3). How do

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cultivation techniques influence the biochemical properties of K.alvarezii? This question will examine the relationship between farming methods, environmental factors, and the biochemical composition of K. alvarezii, with a particular emphasis on carrageenan quality. (4). What are the environmental benefits of K.alvarezii farming, and how can these services be optimized for coastal ecosystem restoration and carbon sequestration? This question will explore the ecosystem services provided by K. alvarezii, such as nutrient biofiltration and carbon sequestration, and how these can be maximized through improved farming practices.

This review will be structured as follows: (1). Methods: This section will describe the search strategy, inclusion and exclusion criteria, and the quality assessment tools used to select the studies included in this review. (2). Theoretical Framework and Background: This section will discuss relevant theories and models related to growth dynamics, nutrient management, and biochemical composition of K. alvarezii. It will also highlight the contributions of key researchers and ongoing debates in seaweed farming techniques. (3). Review of Themes/Findings: This section will organize the literature into four key themes: growth dynamics and cultivation techniques, nutrient management and biochemical composition, environmental impact and sustainability, and strain selection and genetic diversity. Each theme will synthesize global research findings, identify key factors influencing outcomes, and highlight the advantages and challenges of various practices. (4). Discussion: This section will provide a critical analysis of the findings, comparing global cultivation practices, nutrient management strategies, and the environmental and biochemical outcomes of different farming systems. (5). Conclusion: This section will summarize the key findings, identify gaps in current research, and suggest areas for future studies aimed at improving the sustainability, productivity, and resilience of K. alvarezii farming practices.

By synthesizing global research on these topics, this review aims to provide actionable recommendations for optimizing K. alvarezii cultivation, contributing to both economic sustainability and environmental restoration in coastal areas.

II. METHODS

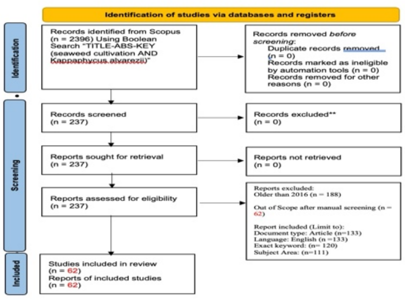
Search Strategy

To ensure a comprehensive synthesis of the global research on K.alvarezii cultivation, a structured search strategy was employed. The primary database used for the search was Scopus, which is renowned for its extensive collection of peer-reviewed journals, conference papers, and research reports related to marine biology and aquaculture. The search strategy employed Boolean operators to combine thematic and exact-phrase terms to capture the most relevant studies. The following key phrases were used in the search: "seaweedcultivation" anda "K.alvarezii"

The search terms were optimized to cover a broad spectrum of studies, ranging from production and product studies to environmental and management research. To refine the search, the following thematic terms were included to target studies related to environmental impact, genetic studies, and specific cultivation methods: (1). Environmental and stress-related keywords: "nitrate," "DIN," "TAN," "biofiltration," "nutrient uptake," "temperature," "salinity," "epiphyte," "ice-ice disease" (Narvarte et al., 2021; Shalvina et al., 2022; Aris, 2020). (2). Genetic studies: "genetic," "COI," "cox2-3," "16S" (Tan et al., 2021; Soelistyowati, 2023). (3). Cultivation method-specific keywords: "long-line," "raft," "tank," "remote sensing" (Rupert et al., 2023; Soelistyowati, 2023).

This approach ensured that the search captured a wide range of studies relevant to the global cultivation practices of K. alvarezii, with particular attention to its growth dynamics, nutrient management, environmental impact, and genetic diversity. The search was limited to English-language studies published within the last 20 years to ensure the inclusion of contemporary research.

Figure 1.
The PRISMA flow diagram detailing the screening and selection process of literature



Source: PRISMA design author

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A flowchart outlining the process of identifying, screening, and selecting relevant studies based on the inclusion and exclusion criteria.

Inclusion and Exclusion Criteria

To ensure that only the most relevant and methodologically rigorous studies were included, strict inclusion and exclusion criteria were applied. The inclusion criteria are as follows: (1). Study Type: Only peer-reviewed articles, reports, and government publications were included, ensuring a high level of methodological rigor and academic credibility. (2). Publication Date: Studies published within the last 10 years (2016–2025) were considered to focus on the most recent developments in K.alvarezii cultivation and related practices. (3). Focus on Cultivation and Biochemical Properties: Studies needed to directly address cultivation techniques, growth dynamics, nutrient management, and biochemical composition of K. alvarezii. This focus ensured that the review remained within its scope of optimizing farming practices and addressing sustainability concerns.

The exclusion criteria included: (1). Non-English Articles: Articles not available in English were excluded due to the linguistic limitations and to maintain consistency in interpretation. (2). Studies with Limited Methodological Rigor: Articles that lacked sufficient methodological detail, such as sample size, experimental design, or data accuracy, were excluded to ensure that only high-quality studies contributed to the review. (3). Irrelevant Topics: Studies not directly addressing K. alvarezii or its cultivation, as well as those focused on unrelated species or unrelated aquaculture practices, were excluded to maintain the relevance of the review.

This rigorous screening process was followed by a review of the titles, abstracts, and full-text articles to ensure that only the most relevant studies were included in the final selection. The final selection included 62 studies, which were assessed based on their contribution to the understanding of cultivation practices, growth dynamics, nutrient management, and biochemical composition of K. alvarezii.

Screening and Selection Process

The screening and selection process followed a step-by-step approach: (1). Identification: The initial step involved searching relevant databases like Scopus using the keywords and inclusion criteria. This search returned 2396 records. (2). Screening: The first round of screening involved reviewing titles and abstracts to filter out irrelevant studies. A total of 237 studies were retained for detailed review. (3). Eligibility Check: Following the title and abstract review, full-text articles were assessed for methodological quality and relevance to the review questions. Studies that did not meet the inclusion criteria were excluded, and only those with sufficient detail on cultivation methods, environmental factors, and biochemical composition were retained. (4). Final Selection: After full-text screening, 62 studies were included in the final review. These studies were rigorously evaluated to ensure that they met the high standards required for systematic reviews, focusing on the various dimensions of *K. alvarezii* farming practices.

This diagram provides a visual representation of the systematic literature review process, showing the number of records identified, excluded, and ultimately included in the review. The methods used to select and assess the literature in this systematic review were designed to ensure comprehensive and high-quality coverage of the relevant studies. The rigorous search strategy, combined with clear inclusion and exclusion criteria, facilitated the identification of studies that provide meaningful insights into the global practices, challenges, and opportunities in *K.alvarezii* cultivation. This methodological approach ensures that the review offers a reliable synthesis of the state-of-the-art research, contributing to the development of best practices for optimizing *K. alvarezii* farming

III. RESULTS AND DISCUSSION

The cultivation of *K.alvarezii* is integral to the seaweed industry, particularly for carrageenan production, which supports a wide array of industries.

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This review has synthesized findings across multiple themes that explore growth dynamics, nutrient management, biochemical composition, and genetic diversity, all of which contribute to the optimization and sustainability of *K. alvarezii* farming. While significant progress has been made in understanding and improving cultivation practices, several challenges remain, particularly regarding long-term sustainability, environmental impact, and genetic management.

The key findings across the four themes of this review provide a holistic understanding of the factors that influence the success of *K. alvarezii* cultivation.

a. Growth Dynamics and Cultivation Techniques: Studies consistently show that the cultivation method employed significantly affects the growth rates and productivity of *K. alvarezii*. Methods such as raft farming and IMTA systems offer advantages in nutrient cycling, while simpler methods like longline systems are more prone to environmental disturbances (Nurdin et al., 2023; Heriansah et al., 2025). The selection of the appropriate cultivation method is thus essential for optimizing yield and minimizing ecological disruption.
b. Nutrient Management and Biochemical Composition: Nutrient management is pivotal in influencing both the growth of *K. alvarezii* and the quality of carrageenan produced. Studies indicate that nitrogen and phosphorus availability, especially in the form of dissolved inorganic nitrogen (DIN), directly influence both biomass production and carrageenan yield (Narvarte et al., 2021; Shalvina et al., 2022). Furthermore, the use of biostimulants has shown promise in enhancing growth and optimizing biochemical properties, suggesting a pathway for improving productivity while reducing environmental stress (Boa Ventura et al., 2025).
c. Environmental Impact and Sustainability of Cultivation: The environmental impacts of *K. alvarezii* farming are mixed. On the one hand, seaweed farming offers significant ecological benefits such as nutrient biofiltration and carbon sequestration (Montúfar-Romero et al., 2023). On the other hand, intensive cultivation methods may contribute to problems such as epiphyte overgrowth, disease outbreaks, and eutrophication (Mulyaningrum et al., 2019; Aris, 2020). Integrated systems like IMTA provide a more sustainable solution, addressing nutrient waste while enhancing overall farm productivity (Narvarte et al., 2021; Heriansah et al., 2025).
d. Strain Selection and Genetic Diversity: Genetic diversity is crucial for the long-term sustainability of *K. alvarezii* farming. Wild strains, although slower-growing, offer greater resilience to environmental stressors, while selected strains often outperform in terms of growth rates and carrageenan yield (Zakaria et al., 2019; Tan et al., 2021). A balanced approach that integrates both wild and cultivated strains is recommended for ensuring sustainable farm operations and reducing vulnerability to disease and environmental stress (Yahya et al., 2024; Dangan-Galon et al., 2024).

Cultivation practices for *K. alvarezii* vary globally, and their impacts on growth and yield depend on local environmental conditions and farm management strategies. The review reveals that while low-input methods like longline systems dominate large-scale production, they often struggle with issues such as disease, epiphyte overgrowth, and poor biomass control (Nurdin et al., 2023; Mulyaningrum et al., 2019). In contrast, controlled systems like raft farming, vertical farming, and IMTA offer better biomass control and higher yields but come with increased capital and management requirements (Montúfar-Romero et al., 2023). The choice between low-cost, extensive methods and more controlled, intensive systems must be

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made based on environmental conditions, financial capacity, and the long-term sustainability goals of the farm.

A significant finding across these studies is the interaction between farming methods and local environmental conditions. Cultivation methods such as vertical farming and IMTA are particularly effective in nutrient-rich or polluted waters, where they can help reduce eutrophication and improve water quality. In contrast, longline farming, although cost-effective, is better suited for calmer, nutrient-limited environments but may not provide the same level of ecological service or biosecurity (Narvarte et al., 2021; Heriansah et al., 2025). These results underscore the need for site-specific approaches when selecting cultivation methods.

Nutrient management remains a critical determinant of the long-term sustainability of K. alvarezii farming. Optimal nutrient inputs not only enhance growth rates but also influence the biochemical properties of the seaweed, such as carrageenan yield and quality. The review highlighted the importance of managing nutrient ratios—particularly nitrogen and phosphorus—since they directly impact both biomass production and the quality of the extracted carrageenan (Narvarte et al., 2021; Kumar et al., 2020).

The challenge lies in ensuring that nutrient management practices are both efficient and sustainable. Integrated systems such as IMTA represent a promising approach to nutrient management, as they reduce nutrient waste while providing valuable ecosystem services like nutrient biofiltration (Narvarte et al., 2021; Heriansah et al., 2025). However, large-scale implementation of IMTA still faces challenges in terms of operational scalability and high initial capital investment. Further research is needed to validate the long-term effectiveness of these systems in different geographical contexts.

Additionally, biostimulants and organic fertilizers have shown potential in enhancing growth and improving biochemical outcomes (Boa Ventura et al., 2025). However, the sustainability of these practices requires further exploration, particularly with regard to their environmental impact and scalability in large-scale farming systems.

Carrageenan yield and quality are key commercial factors influenced by both environmental and genetic factors. The biochemical composition of K. alvarezii varies according to environmental conditions, such as nutrient availability and temperature, and cultivation practices. Studies have shown that nutrient enrichment, particularly through nitrogen and phosphorus management, can enhance biomass but may negatively affect carrageenan gel strength and molecular structure (Shalvina et al., 2022; Bimasuci et al., 2021).

Genetic diversity also plays a crucial role in carrageenan quality. Selected strains, while providing higher yields, may produce carrageenan with inferior gel strength or reduced sulfate content when compared to wild strains (Zakaria et al., 2019; Tan et al., 2021). These findings suggest that strain selection, in conjunction with optimal environmental management, is essential for balancing high yield with high-quality carrageenan production. The interaction between genotype and environmental conditions (genotype × environment) must be carefully considered to achieve the desired biochemical properties and ensure that commercial carrageenan production meets industry standards.

Based on the findings synthesized in this review, several recommendations emerge for improving the productivity and ecological impact of *K.alvarezii* farming.

a. Optimize Cultivation Methods: Farms should adopt cultivation methods that match the environmental conditions of the region. While longline methods are effective in calm waters, more controlled systems such as IMTA and vertical farming should be explored in nutrient-rich environments to improve

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ecological sustainability and farm productivity.

b. Implement Integrated Nutrient Management: Nutrient inputs should be carefully calibrated to ensure that growth is optimized without compromising the quality of carrageenan or contributing to eutrophication. IMTA and controlled nutrient systems, such as bioreactors and recirculating aquaculture systems, should be further investigated for their long-term sustainability and environmental benefits.
c. Enhance Genetic Diversity: Farmers should use a combination of wild and selected strains to ensure genetic resilience and improve disease resistance. The use of micropropagation and genetic monitoring can help maintain genetic diversity and prevent the negative effects of monoculture farming.
d. Promote Precision Farming: The integration of remote sensing and precision farming technologies can help optimize farming operations by providing real-time data on environmental parameters, nutrient levels, and crop health. This will enable more efficient and adaptive management practices.

Despite the progress in understanding *K. alvarezii* cultivation, several gaps in research remain:

a. Long-Term, Multi-Site Genotype × Environment Studies: More research is needed to explore the interactions between genotype, environmental conditions, and farming methods across multiple sites to optimize yield and carrageenan quality (Oort et al., 2025; Tan et al., 2021).
b. Validation of IMTA Systems: While IMTA systems show great promise for nutrient recycling and ecological benefits, further large-scale validation is needed to confirm their effectiveness and sustainability across different geographical and operational contexts (Heriansah et al., 2025; Narvarte et al., 2021).
c. Improvement of Seed Systems and Genetic Monitoring: Research into seed production techniques, such as micropropagation and land-based seedbeds, is crucial for improving seed quality, reducing disease outbreaks, and enhancing genetic resilience (Latip et al., 2025; Rupert et al., 2023).

This discussion synthesizes key findings from the four themes, identifies critical points for improving *K.alvarezii* farming practices, and outlines future research directions necessary to ensure the sustainability and productivity of this important aquaculture species

IV. CONCLUSION

This review has synthesized key findings related to *K.alvarezii* cultivation, focusing on growth dynamics, nutrient management strategies, and biochemical composition. The reviewed literature highlights that *K. alvarezii* growth is influenced by several factors, including cultivation methods, nutrient availability, and environmental conditions such as temperature, salinity, and light intensity. The choice of cultivation technique—whether longline, raft farming, or Integrated Multi-Trophic Aquaculture (IMTA)—has significant implications for farm productivity and ecological sustainability. Moreover, nutrient management plays a crucial role in optimizing growth and biochemical yield, particularly in improving carrageenan quality. Biostimulants and fertilizers have been identified as effective tools for enhancing growth and quality, though the risks of nutrient imbalance and eutrophication remain.

The genetic diversity of *K. alvarezii* strains also emerged as a key factor influencing long-term farm sustainability. Wild strains provide greater resilience to environmental stressors and diseases, while selected strains yield higher biomass and carrageenan yield. However, the reduction in genetic diversity associated with clonal propagation poses risks for long-term farm resilience.

This review identified several research gaps, particularly the need for long-term, multi-site studies to explore genotype-environment interactions and their impact on

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growth, yield, and carrageenan quality. Furthermore, the potential of IMTA systems for sustainable farming warrants further investigation to assess their scalability and environmental benefits.

Future research should focus on integrated studies that combine biological, ecological, and economic aspects of seaweed farming. Developing precision aquaculture models, incorporating genetic monitoring, and advancing seed systems will be essential to optimize *K. alvarezii* farming practices and ensure its sustainability.

V. REFERENCES

Aris, M. (2020). Horizontal Transmission of Ice-Ice Disease in Seaweed Kappaphycus alvarezii (Doty) L. M. Liao (Gigartinales, Rhodophyta). Hidrobiológica, 30(2), 155–161. https://doi.org/10.24275/uam/izt/dcbs/hidro/2020v30n2/muhammad

Bimasuci, H., Adharini, R. I., & Sari, D. W. K. (2021). Characteristics of Semi-Refined Carrageenan From Kappaphycus Seaweed Farmed in Coastal Waters of Northern Java, Indonesia. Asian Fisheries Science, 34(3). https://doi.org/10.33997/j.afs.2021.34.3.002

Cáceres-Farías, L., Montúfar-Romero, M., Lodeiros, C., Espinoza-Vera, M. M., Cáceres-Farias, L. B., Avendaño, U., Ruiz-Chóez, W., & Alfaro-Núñez, A. (2025). Growth Rate Comparison of Three Kappaphycus alvarezii Colour Strains Cultivated Using Tubular Netting and Tie-Tie Methods in the Waters of Ecuador. Journal of Applied Phycology, 37(2), 1139–1152. https://doi.org/10.1007/s10811-025-03465-5

Cokrowati, N., Risjani, Y., Firdaus, M., & Andayani, S. (2021). Accelerated Growth of Kappaphycus alvarezii Using Sargassum Aquifolium Extract and Its Anatomical Characteristics. Biodiversitas Journal of Biological Diversity, 22(11). https://doi.org/10.13057/biodiv/d221158

Dangan-Galon, F., Sabido, V., Dumilag, R. V., Mabuhay-Omar, J. A., & Creencia, L. (2024). Selection of Fast-Growing Seaweed Cultivars in Palawan, Philippines. PalawanSci, 16(2), 10–22. https://doi.org/10.69721/tps.j.2024.16.2.02

Deb, K., & Singh, S. (2022). Effect of Seaweed (Kappaphycus Alvarezii) Extract on Rainfed Aerobic Rice (Oryza Sativa L.). Environment Conservation Journal, 23(3), 260–266. https://doi.org/10.36953/ecj.10072231

Heriansah, H., Syamsuddin, R., Najamuddin, N., Syafiuddin, S., & Hidayani, M. T. (2025). Studying How to Minimize Nutrient Waste While Maximizing Macroalgae Biomass; A Vertical Method Study on an Integrated Aquaculture Recirculating System. Aquaculture Studies, 25(3). https://doi.org/10.4194/aquast1874

Kumar, Y. N., Poong, S., Gachon, C. M. M., Brodie, J., Sade, A., & Lim, P. (2020). Impact of Elevated Temperature on the Physiological and Biochemical Responses of Kappaphycus alvarezii (Rhodophyta). Plos One, 15(9), e0239097. https://doi.org/10.1371/journal.pone.0239097

Latip, M. A. A., Hamzah, S., Nasir, N. M., & Syed Mohamad Azim Syed Mahiyuddin. (2025). Optimising Callus Induction in Kappaphycus alvarezii via Micropropagation Techniques Under Different LED Light Conditions. Asia-Pacific Journal of Molecular Biology and Biotechnology, 119–124. https://doi.org/10.35118/apjmbb.2025.033.1.13

Maradhy, E., Nazriel, R. S., Sutjahjo, S. H., Rusli, M. S., Widiatmaka, W., & Sondita, M. F. A. (2022). Evaluation of Water Suitability for Sustainable Seaweed (Kappaphycus Alvarezii) Cultivation to Support Science Technopark in North Kalimantan. Jurnal Pengelolaan Sumberdaya Alam Dan Lingkungan (Journal of Natural Resources and Environmental Management), 11(3), 490–503. https://doi.org/10.29244/jpsl.11.3.490-503

Montúfar-Romero, M., Rincones-León, R. E., Cáceres-Farias, L. B., Espinoza-Vera, M. M., Avendaño, U., Cruz-Jaime, T., Cubillos, L. A., Ruíz, W., Revelo, W., Lodeiros, C., Alfaro-Núñez, A., & Cáceres-Farías, L. (2023). Feasibility of Aquaculture Cultivation of Elkhorn Sea Moss (Kappaphycus Alvarezii) in a Horizontal Long Line In the Tropical Eastern Pacific.

Scientific Reports, 13(1). https://doi.org/10.1038/s41598-023-41795-x

Mulyaningrum, S. R. H., Suwoyo, H. S., Paena, M., & Tampangallo, B. R. (2019). Epiphyte Identification on Kappaphycus alvarezii Seaweed Farming Area in Arungkeke Waters, Jeneponto and the Effect on Carrageenan Quality. Ilmu Kelautan Indonesian Journal of Marine Sciences, 24(3), 146. https://doi.org/10.14710/ik.ijms.24.3.146-152

Narvarte, B. C. V., Genovia, T. G. T., Hinaloc, L. A. R., & Roleda, M. Y. (2021). Growth, Nitrate Uptake Kinetics, and Biofiltration Potential of Eucheumatoids With Different Thallus Morphologies. Journal of Phycology, 58(1), 12–21. https://doi.org/10.1111/jpy.13229

Nunes, A., Dutra, F. d. S., Santos, L. R. d., Martins, C. P., Schneider, A. R., Oliveira, E. R., Pereira, M. S., Azevedo, G. Z., Barcelos-Oliveira, J. L., Gelli, V. C., Santos, A. A. d., Maraschin, M., & Lima, G. P. P. (2025). A Biostimulant From Kappaphycus alvarezii Enhances the Growth and Development of Basil (Ocimum Basilicum L.) Plants. Horticulturae, 11(4), 424. https://doi.org/10.3390/horticulturae11040424

Nurdin, N., Alevizos, E., Syamsuddin, R., Asis, H., Zainuddin, E. N., Aris, A., Oiry, S., Brunier, G., Komatsu, T., & Barillé, L. (2023). Precision Aquaculture Drone Mapping of the Spatial Distribution of Kappaphycus alvarezii Biomass and Carrageenan. Remote Sensing, 15(14), 3674. https://doi.org/10.3390/rs15143674

Oort, P. A. J. v., Julianto, B., Latama, G., Siradjuddin, I., Rukminasari, N., Walyandra, Z. Z., Ibrahim, I. A., Verhagen, A., & Werf, A. K. v. d. (2025). Yield Determinants of Kappaphycus alvarezii Seaweed in South Sulawesi, Indonesia. Journal of Applied Phycology, 37(2), 1153–1170. https://doi.org/10.1007/s10811-025-03446-8

Ratnawati, P., Simatupang, N. F., Pong-Masak, P. R., Paul, N. A., & Zuccarello, G. C. (2020). Genetic Diversity Analysis of Cultivated Kappaphycus in Indonesian Seaweed Farms Using COI Gene. Squalen Bulletin of Marine and Fisheries Postharvest and Biotechnology, 15(2), 65. https://doi.org/10.15578/squalen.v15i2.466

Rupert, R., Rodrigues, K. F., Chong, H. L. H., Yusof, N. A., & Yong, W. T. L. (2023). Characterization of Persistent Marine Bacterial Community Profiles Isolated From Long-Term Kappaphycus alvarezii Cultures in a Closed Cultivation System Using 16S rDNA Analysis. Malaysian Journal of Microbiology. https://doi.org/10.21161/mjm.230015

Shalvina, A., N'Yeurt, A. D. R., Lako, J. V., & Piovano, S. (2022). Effects of Selected Environmental Conditions on Growth and Carrageenan Quality of Laboratory-Cultured Kappaphycus alvarezii (Rhodophyta) in Fiji, South Pacific. Journal of Applied Phycology, 34(2), 1033–1043. https://doi.org/10.1007/s10811-022-02690-6

Soelistyowati, D. T. (2023). Molecular Assessment of Kappaphycus alvarezii Cultivated in Tarakan Based on Cox2-3 Spacer. Squalen Bulletin of Marine and Fisheries Postharvest and Biotechnology, 18(1), 52–64. https://doi.org/10.15578/squalen.736

Tan, P., Poong, S., Tan, J., Brakel, J., Gachon, C. M. M., Brodie, J., Sade, A., & Lim, P. (2021). Assessment of Genetic Diversity Within Eucheumatoid Cultivars in East Sabah, Malaysia. Journal of Applied Phycology, 34(1), 709–717. https://doi.org/10.1007/s10811-021-02608-8

Yahya, N., Poong, S., Brodie, J., Cook, E., Wilbraham, J., Mallinson, S., Kassim, A., Ku Nor Afiza Asnida Ku Mansor, & Lim, P. (2024). Comparison of Two Cultivation Methods for Domesticating Wild Red Algal Eucheumatoids for Use in the Seaweed Industry. Journal of Applied Phycology, 36(6), 3525–3536. https://doi.org/10.1007/s10811-024-03325-8

Zakaria, A., Rahman, E. N., Rahmani, U. N., Manurung, R., Puad, N. I. M., & Abduh, M. Y. (2019). PRODUCTION OF CARRAGEENAN BY DIFFERENT STRAINS OF Kappaphycus alvarezii CULTIVATED IN SERANG, INDONESIA. Iium Engineering Journal, 20(2), 12–21. https://doi.org/10.31436/iiumej.v20i2.1062

Zuldin, W. H., Yassir, S., & Shapawi, R. (2016). Growth and Biochemical

Jurnal Riset Diwa Bahari
Vol. 3, No. 2, 2025, 100-109
Homepage: https://ejurnal.itbm.ac.id/jbd
E ISSN: 3032-3177

Composition of Kappaphycus (Rhodophyta) in Customized Tank Culture System. Journal of Applied Phycology, 28(4), 2453–2458. https://doi.org/10.1007/s10811-016-0792-9

.