Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 29(2): 1221 – 1234 (2025)
www.ejabf.journals.ekb.eg

Innovations in Shrimp Aquaculture: Optimizing Seaweed Biostimulants as an Integrated Approach to Disease Prevention

Yuni Kilawati[1], Mohamad Fadjar[1,2], Yunita Maimunah[1], Riski Agung Lestariadi[3], Hefti Salis Yufidasari[4], Tian Nur Ma`Rifat[3], Syaifullah[1,2], Lutfi Ni`Matus Salamah[1], Attabik Mukhammad Amrillah[1], Angga Wira Perdana[4], Rizky Fadilla Agustin Rangkuti[2], R Adharyan Islamy[1,2]

[1]Department of Fisheries and Marine Resources Management, Faculty of Fisheries and Marine Sciences, Brawijaya University, Jl. Veteran No.16, Malang 65145, East Java, Indonesia
[2]Aquaculture (Kediri City Kampus), Department of Fisheries and Marine Resources Management, Faculty of Fisheries and Marine Sciences, Brawijaya University, Jl. Pringgodani, Kediri City 64111, Indonesia
[3]Department of Department of Socio-Economy Fisheries and Marine, Faculty of Fisheries and Marine Sciences, Brawijaya University, Jl. Veteran No.16, Malang 65145, East Java, Indonesia
[4]Department of Fishery Product Technology, Faculty of Fisheries and Marine Sciences, Brawijaya University, Jl. Pringgodani, Kediri City 64111, East Java, Indonesia

[*]**Corresponding Author:** yuniqla@ub.ac.id

ARTICLE INFO

Article History:
Received: Dec. 3, 2024
Accepted: Feb. 10, 2025
Online: March 26, 2025

Keywords:
Aquaculture,
Biostimulant,
Lipid metabolism,
Microbial dynamics,
Shrimp health

ABSTRACT

This study investigated the use of seaweed-derived biostimulants as a natural, sustainable solution to enhance shrimp health and resilience. The research was conducted over 12 days, during which shrimp were stocked at a density of 150 individuals per treatment. Biostimulants were applied in dosages ranging from 29 to 3,013 gs, adjusted to match shrimp growth stages and metabolic requirements. Microbial parameters, including total *Vibrio* count (TVC), total bacterial count (TBC), and TVC/TBC ratio, were assessed to evaluate microbial community dynamics. Lipid droplet coverage in shrimp hepatopancreas tissue was examined microscopically to determine metabolic health. The results revealed significant changes in microbial and metabolic parameters in response to biostimulant application. On Day 3, TVC was high (9.2×103 CFU) with a low TVC/TBC ratio (3.54%), indicating a less dominant role of *Vibrio* spp. By Day 9, the TVC/TBC ratio increased to 67.11%, suggesting a shift in microbial dominance influenced by biostimulant application. Lipid droplet coverage improved from 0–30% on Day 3 to 40–70% from Day 6 onwards, reflecting enhanced metabolic health. The findings demonstrate that seaweed biostimulants not only promote lipid metabolism but also influence microbial population dynamics, potentially reducing disease risks. These dual benefits position seaweed biostimulants as a promising, eco-friendly tool for sustainable shrimp aquaculture. Further research is recommended to explore long-term applications and the interaction with environmental factors. This study highlights the potential of integrating biostimulants into aquaculture practices to mitigate disease challenges and to enhance shrimp productivity in an environmentally sustainable manner.

INTRODUCTION

Shrimp aquaculture is a critical component of global seafood production, significantly contributing to food security and economic development. However, the

Indexed in Scopus ELSEVIER DOAJ IUCAT

industry faces numerous challenges, particularly disease outbreaks caused by pathogenic bacteria such as *Vibrio* spp., which can lead to substantial economic losses **(Hellequin *et al.*, 2020; Islam *et al.*, 2021; Raj *et al.*, 2022)**. The prevalence of these bacterial infections necessitates innovative approaches to enhance shrimp health and resilience against such threats.

Recent advancements in aquaculture management have underscored the potential of natural compounds, particularly seaweed-derived biostimulants, to bolster shrimp health. These biostimulants are rich in bioactive compounds, including polysaccharides, polyphenols, and essential nutrients, which have been shown to improve immune responses, promote metabolic health, and modulate microbial communities **(Mannino *et al.*, 2020; Campobenedetto *et al.*, 2021; Patkowska *et al.*, 2022)**. For instance, seaweed extracts from species like *Ascophyllum nodosum* have demonstrated significant benefits in enhancing plant growth and resilience under stress conditions, suggesting similar potential applications in aquaculture **(Yakhin *et al.*, 2017; Staropoli, 2024)**. Despite these promising findings, the optimal application strategies and the underlying mechanisms through which these biostimulants exert their effects on shrimp health remain inadequately explored **(D'Addabbo *et al.*, 2019; Xing *et al.*, 2023)**.

This study aimed to evaluate the efficacy of seaweed biostimulants as an integrated approach to disease prevention in shrimp aquaculture. Specifically, it focused on their impact on microbial dynamics, lipid metabolism, and overall shrimp health. Understanding these interactions is crucial for developing sustainable and practical solutions to enhance shrimp productivity while minimizing reliance on chemical treatments **(Calvo *et al.*, 2014; El-Nakhel, 2023; Arun *et al.*, 2024)**. The application of seaweed biostimulants not only promises to improve shrimp health but also aligns with the growing demand for sustainable aquaculture practices that mitigate environmental impacts **(Galambos *et al.*, 2020; Deolu-Ajayi *et al.*, 2022; Han *et al.*, 2022)**.

The integration of seaweed-derived biostimulants in shrimp aquaculture presents a viable strategy for enhancing shrimp health and productivity. As research continues to uncover the complex interactions between these biostimulants and shrimp physiology, it is anticipated that such innovations will play a pivotal role in addressing the challenges faced by the aquaculture industry **(Sandepogu *et al.*, 2019; Caradonia *et al.*, 2021; Ma *et al.*, 2022)**.

MATERIALS AND METHODS

Study period and location

This research was conducted in October 2024, focusing on shrimp aquaculture systems. The study aimed to evaluate the effect of seaweed biostimulants on shrimp health parameters, including total *Vibrio* count, total bacterial count, TVC/TBC ratio, and lipid droplet percentages.

The experimental design

The experimental design was structured to evaluate the effects of seaweed biostimulants on shrimp health. A uniform stocking density of 150 shrimp per treatment was maintained throughout the study. Observations were carried out at intervals of 3, 6, 9, and 12 days after stocking. The application of biostimulants was adjusted based on the growth stages and metabolic requirements of the shrimp, with dosages ranging from 29 to 3,013g per treatment.

Biostimulant preparation

The preparation of biostimulants from seaweed involves extracting bioactive compounds using a water-based solvent extraction method, which is crucial for ensuring the quality and effectiveness of the final product. This method allows for the retention of essential bioactive compounds, such as phenolic compounds, which are known for their antioxidant properties and beneficial effects on plant health **(Campobenedetto *et al.*, 2021)**. Following extraction, the solution is filtered to remove impurities, and it is stored at 4°C to maintain its stability until application, ensuring that the biostimulant retains its efficacy **(Spann & Little, 2011)**. The significance of using a water-based extraction method lies in its ability to preserve the bioactive compounds that contribute to the biostimulant's effectiveness. Seaweed extracts, particularly from species like *Ascophyllum nodosum*, are rich in growth-promoting substances such as auxins, cytokinins, and betaines, which play a vital role in enhancing plant growth and stress tolerance **(Kocira *et al.*, 2019; El-Nakhel, 2023)**. The careful preparation and storage of these extracts are essential for maximizing their potential benefits in agricultural applications **(Kocira *et al.*, 2020)**.

Moreover, the application of biostimulants derived from seaweed has been shown to improve various physiological aspects of plants, including root development and nutrient absorption, which are critical for plant health and productivity **(Banakar *et al.*, 2022; Han *et al.*, 2022)**. The stability of the biostimulant during storage is particularly important, as it ensures that the bioactive compounds remain effective when applied to crops, thereby enhancing their resilience to environmental stressors **(Ertani *et al.*, 2018)**. In conclusion, the method of preparation and storage of seaweed-derived biostimulants is integral to their success in agricultural applications. By employing a water-based solvent extraction method and maintaining proper storage conditions, the quality and effectiveness of these biostimulants can be preserved, leading to improved plant health and productivity **(Arafa *et al.*, 2013; Krawczuk *et al.*, 2023)**.

Shrimp sampling

Shrimp samples were collected systematically at each observation interval. Representative specimens were taken from the culture tank to ensure consistent analysis across treatments. The samples were handled carefully to minimize stress and were promptly processed for microbial and lipid droplet analyses.

Microbial culture and count

Microbial analysis in aquaculture, particularly for shrimp, is essential for monitoring the health and safety of the cultured organisms. In this study, shrimp samples were aseptically collected, and bacterial counts were obtained through standard laboratory procedures involving serial dilution and plating on agar media. Selective agar was employed for the quantification of *Vibrio* spp., while non-selective agar was utilized for determining the total bacterial count (TBC) **(Kriem *et al*., 2015; Silva *et al*., 2018)**. The plates were incubated at 28°C for 24–48 hours, allowing for the growth of bacterial colonies, which were then enumerated as colony-forming units (CFUs) **(Kim & Lee, 2017)**.

The microbial counts obtained from these analyses were crucial for evaluating the bacterial community composition within the shrimp culture system. The total *Vibrio* count (TVC) was quantified using selective media specifically designed for *Vibrio* spp., ensuring accurate detection and enumeration of these bacteria, which are known to be pathogenic and can significantly impact shrimp health **(Lara-Anguiano *et al*., 2013; Chumpol *et al*., 2016)**. The TBC was determined through standard plate count methods, where samples were serially diluted and plated on non-selective agar to capture a broad range of bacterial species **(Manan *et al*., 2022; Tarh *et al*., 2023)**. The ratio of TVC to TBC was calculated as a percentage, providing a measure of the dominance of *Vibrio* spp. relative to the overall bacterial population. This assessment is vital for monitoring microbial dynamics and their potential impact on shrimp health, as high levels of *Vibrio* spp. can lead to diseases such as vibriosis, which is associated with significant mortality in shrimp populations **(Costa *et al*., 2015; Hirshfeld, 2023)**. The methodologies employed in this microbial analysis, including the use of selective and non-selective media, are critical for understanding the microbial dynamics within shrimp aquaculture systems. By accurately quantifying *Vibrio* spp. and total bacterial counts, this study aimed to provide insights into the health status of shrimp and the potential risks posed by pathogenic bacteria **(Yen *et al*., 2020; Kabiraj *et al*., 2020)**.

Lipid droplet examination

Lipid droplet examination in shrimp hepatopancreas tissues is a critical method for assessing metabolic health. In this study, hepatopancreas tissues were fixed in formalin to preserve their structure, followed by staining with Sudan Black, which enhances lipid visualization **(Takeungwongtrakul *et al*., 2013)**. The prepared samples were then examined under a microscope to analyze lipid droplet size and distribution. This methodology is well-established in the field of aquaculture research, providing insights into the physiological state of shrimp and their metabolic processes **(Zhou, 2023)**.

The use of Sudan Black staining is particularly effective for highlighting lipid droplets, allowing researchers to quantify and assess the size and distribution of these droplets within the hepatopancreas **(Li *et al.*, 2022)**. This is crucial because the hepatopancreas plays a significant role in lipid metabolism, including the synthesis and storage of lipids, which are essential for energy production and overall health in shrimp **(Huang *et al.*, 2020)**. For instance, studies have shown that alterations in lipid accumulation can indicate changes in shrimp health status, particularly in response to dietary modifications or environmental stressors **(Xu *et al.*, 2017; Li *et al.*, 2022)**.

Moreover, the examination of lipid droplets can reveal the impact of various factors, such as dietary composition and stress conditions, on shrimp physiology. For example, research has demonstrated that specific dietary components can influence lipid droplet formation and distribution in the hepatopancreas, thereby affecting the shrimp's growth and immune response **(Yu *et al.*, 2022; Loya-Rodríguez *et al.*, 2023)**. The analysis of lipid droplet characteristics, including their size and abundance, provides valuable information regarding the metabolic health of shrimp and can serve as a biomarker for assessing their overall well-being in aquaculture systems **(Colombo *et al.*, 2020; Shi *et al.*, 2020)**. The examination of lipid droplets in the hepatopancreas of shrimp using formalin fixation and Sudan Black staining is a robust approach for evaluating metabolic health. This process not only enhances our understanding of lipid metabolism in shrimp but also aids in monitoring their physiological status in aquaculture settings **(Xie *et al.*, 2019; Xie *et al.*, 2020)**.

Data analysis

All collected data were analyzed and presented as mean values accompanied by their standard deviations to indicate variability within the treatments. The relationship between biostimulant dosage, microbial counts, and lipid droplet coverage was evaluated using regression analysis to determine trends and potential causal links. Correlation techniques were applied to assess the strength and direction of associations among the variables, providing insights into the effectiveness of biostimulant application in influencing microbial dynamics and shrimp metabolic health.

RESULTS AND DISCUSSION

The results of the study are summarized in Table (1), highlighting the effects of seaweed biostimulants on microbial counts and lipid droplet coverage in shrimp.

The application of seaweed biostimulants has been shown to have significant effects on microbial populations and lipid droplet distribution in shrimp. Research indicates that total *Vibrio* counts (TVC) and total bacterial counts (TBC) can vary across culture days, reflecting dynamic microbial interactions influenced by biostimulant dosage **(Sudaryono *et al.*, 2018; Abbas *et al.*, 2023)**. For instance, on Day 3, a high TVC of 9.2×10^3 CFU was recorded alongside a low TVC/TBC ratio of 3.54%, suggesting that *Vibrio* spp. played a less dominant role in the bacterial community at that time. However, by Day 9, the TVC/TBC ratio increased to 67.11%, coinciding with a higher biostimulant dose of 3.0×10^3g. This shift may indicate a change in microbial dominance driven by nutrient availability or competitive exclusion effects induced by the biostimulant **(Immanuel *et al.*, 2010)**.

Table 1. Effect of biostimulant on microbial counts and lipid droplet coverage

Culture days	Biostimulant (gs)	Total Vibrio count (TVC)	Total bacterial vount (TBC)	TVC/TBC ratio (%)	Lipid droplet coverage (%)
3	29	9.2×10^3	36.77%	3.54	0–30
6	2.8×10^3	12.9×10^3	1.79%	10.00	40–70
9	3.0×10^3	1.8×10^3	67.11%	3.10	40–70
12	3.0×10^3	2.0×10^3	35.50%	4.04	40–70

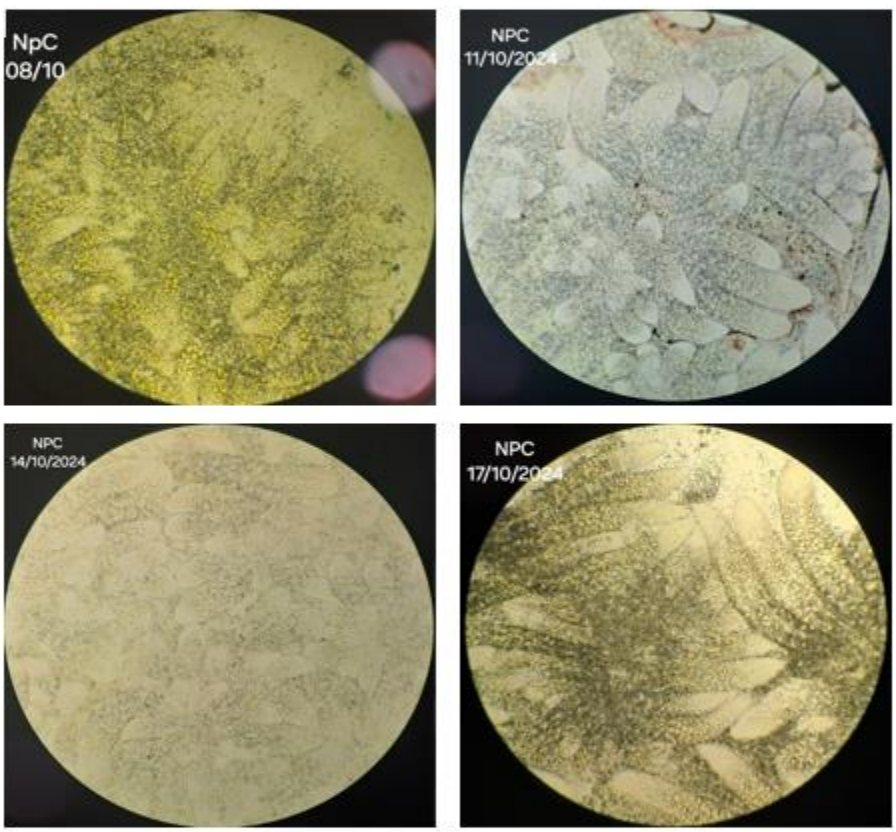

Fig. 1. Lipid droplet coverage in the hepatopancreas of shrimp during the reseach

Furthermore, lipid droplet coverage in the hepatopancreas of shrimp increased significantly from 0–30% on Day 3 to 40–70% from Day 6 onwards (Table 1 & Fig. 1). This enhanced lipid accumulation correlates with higher biostimulant dosages, suggesting that the bioactive compounds in the seaweed extract support improved metabolic health in shrimp **(Sivagnanavelmurugan *et al.*, 2012)**. The stable lipid droplet coverage observed from Day 6 to Day 12 implies a sustained positive impact of biostimulant application on energy storage and utilization, which is critical for shrimp health and growth **(Sirirustananun *et al.*, 2011)**.

Indonesia has a variety of plants that contain numerous bioactive compounds beneficial for health **(Islamy *et al.*, 2024a, b, c; Serdiati *et al.*, 2024)**. The biostimulant used in this study was derived from seaweed, which is known for its rich composition of bioactive compounds, including polysaccharides, polyphenols, vitamins, and minerals **(Islamy *et al.*, 2024d)**. These compounds have been recognized for their ability to enhance plant and animal growth by stimulating biological processes. In shrimp aquaculture, seaweed biostimulants are applied to improve metabolic health, boost immune responses, and promote overall well-being. The bioactive compounds within the biostimulant function by modulating cellular pathways that regulate stress responses, immune function, and lipid metabolism. Additionally, they are believed to help in the modulation of microbial communities in the aquaculture environment, contributing to disease prevention **(Kilawati *et al.*, 2024)**. The application of seaweed biostimulants has been shown to reduce bacterial populations, particularly *Vibrio* spp., which are commonly associated with disease outbreaks in shrimp. By improving shrimp resilience to environmental stressors and pathogens, the biostimulant supports the sustainable and healthy growth of shrimp in aquaculture systems.

The increasing dosage of biostimulants, ranging from 29 to 3013g, demonstrated a clear relationship with microbial count dynamics and shrimp metabolic indicators. While higher doses supported lipid metabolism, they also appeared to influence the microbial community structure, particularly the dominance of *Vibrio* spp. **(Muahiddah & Diamahesa, 2022)**. These findings indicate that seaweed-based biostimulants can act as dual-function agents, promoting shrimp health through enhanced metabolism while potentially modulating microbial populations to prevent disease outbreaks **(Rudi *et al.*, 2019)**. Further studies are warranted to explore the long-term effects of these biostimulants and their interactions with additional environmental factors **(Tinte *et al.*, 2022)**.

CONCLUSION

This study demonstrated the potential of seaweed-derived biostimulants as an effective and sustainable tool for improving shrimp health in aquaculture systems. The application of biostimulants significantly influenced microbial dynamics, as indicated by changes in total *Vibrio* count (TVC), total bacterial count (TBC), and TVC/TBC ratios, which showed a modulation of the bacterial community. Additionally, lipid droplet coverage in shrimp hepatopancreas tissues increased, reflecting enhanced metabolic health and energy storage. The results highlight the dual benefits of biostimulants in reducing disease risk through microbial regulation and improving shrimp physiology. These findings suggest that integrating biostimulants into aquaculture practices could mitigate the dependency on chemical treatments, thus promoting environmental sustainability. Further research is recommended to explore the long-term effects of biostimulants and their interactions with different environmental and management conditions to optimize their application in shrimp aquaculture.

REFERENCES

Abbas, E.; Al-Souti, A.; Sharawy, Z.; El-Haroun, E. and Ashour, M. (2023). Impact of dietary administration of seaweed polysaccharide on growth, microbial abundance, and growth and immune-related genes expression of the pacific whiteleg shrimp (Litopenaeus vannamei). Life., 13(2): 344. https://doi.org/10.3390/life13020344

Arafa, A.; Hussin, S. and Mohamed, H. (2013). Effect of potassium fertilizer, biostimulants and effective microorganisms on growth, carbohydrates concentration and ion percentage in the shoots of potato plants. J. Plant Prod., 4(1): 15-32. https://doi.org/10.21608/jpp.2013.68605

Arun, M.; Kumar, R.; Nori, S.; Sreedevi, B.; Padmavathi, G.; Revathi, P. and Sundaram, R. (2024). Biostimulant properties of marine bioactive extracts in plants: incrimination toward sustainable crop production in rice. https://doi.org/10.5772/intechopen.108640

Banakar, S.; Prasannakumar, M.; Mahesh, H.; Parivallal, P.; Puneeth, M.; Gautam, C. and Narayan, S. (2022). Red-seaweed biostimulants differentially alleviate the impact of fungicidal stress in rice (oryza sativa l.). Sci. Rep., 12(1). https://doi.org/10.1038/s41598-022-10010-8

Calvo, P.; Nelson, L. and Kloepper, J. (2014). Agricultural uses of plant biostimulants. Plant Soil., 383(1-2): 3-41. https://doi.org/10.1007/s11104-014-2131-8

Campobenedetto, C.; Agliassa, C.; Mannino, G.; Vigliante, I.; Contartese, V.; Secchi, F. and Bertea, C. (2021). A biostimulant based on seaweed (ascophyllum nodosum and laminaria digitata) and yeast extracts mitigates water stress effects on tomato (solanum lycopersicum l.). Agriculture., 11(6): 557. https://doi.org/10.3390/agriculture11060557

Caradonia, F.; Ronga, D.; Tava, A. and Francia, E. (2021). Plant biostimulants in sustainable potato production: an overview. Potato Res., 65(1): 83-104. https://doi.org/10.1007/s11540-021-09510-3

Chumpol, S.; Kantachote, D.; Rattanachuay, P.; Vuddhakul, V.; Nitoda, T. and Kanzaki, H. (2016). in vitro and in vivo selection of probiotic purple nonsulphur bacteria with an ability to inhibit shrimp pathogens: acute hepatopancreatic necrosis disease-causing vibrio parahaemolyticus and other vibrios. Aquac. Res., 48(6): 3182-3197. https://doi.org/10.1111/are.13149

Colombo, G.; Simião, C.; Schmitz, M.; Pedrosa, V.; Romano, L.; Tesser, M. and Monserrat, J. (2020). The role of açaí (euterpe oleracea mart. 1824) as a chemoprotective agent in the evaluation of antioxidant defence, oxidative damage and histology of juvenile shrimp Litopenaeus vannamei (boone, 1931) exposed to ammonia. Aquac. Res., 51(4): 1551-1566. https://doi.org/10.1111/are.14503

Costa, R.; Araújo, R.; Souza, O. and Vieira, R. (2015). Antibiotic-resistant vibrios in farmed shrimp. Biomed Res. Int., 2015: 1-5. https://doi.org/10.1155/2015/505914

D'Addabbo, T.; Laquale, S.; Perniola, M. and Candido, V. (2019). Biostimulants for plant growth promotion and sustainable management of phytoparasitic nematodes in vegetable crops. Agronomy, 9(10): 616. https://doi.org/10.3390/agronomy9100616

Deolu-Ajayi, A.; Meer, I.; Werf, A. and Karlova, R. (2022). The power of seaweeds as plant biostimulants to boost crop production under abiotic stress. Plant. Cell. Environ., 45(9): 2537-2553. https://doi.org/10.1111/pce.14391

El-Nakhel, C. (2023). Biostimulants as ecological horizon for a sustainable agriculture. Acta Hortic., (1377): 831-836. https://doi.org/10.17660/actahortic.2023.1377.103

Ertani, A.; Francioso, O.; Tinti, A.; Schiavon, M.; Pizzeghello, D. and Nardi, S. (2018). Evaluation of seaweed extracts from laminaria and ascophyllum nodosum spp. as biostimulants in zea mays l. using a combination of chemical, biochemical and morphological approaches. Front. Plant Sci., 9. https://doi.org/10.3389/fpls.2018.00428

Galambos, N.; Compant, S.; Moretto, M.; Sicher, C.; Puopolo, G.; Wäckers, F. and Perazzolli, M. (2020). Humic acid enhances the growth of tomato promoted by endophytic bacterial strains through the activation of hormone-, growth-, and transcription-related processes. Front. Plant Sci., 11. https://doi.org/10.3389/fpls.2020.582267

Han, S.; Park, J.; Umanzor, S.; Yarish, C. and Kim, J. (2022). Effects of extraction methods for a new source of biostimulant from sargassum horneri on the growth of economically important red algae, neopyropia yezoensis. Sci. Rep., 12(1). https://doi.org/10.1038/s41598-022-16197-0

Hellequin, E.; Monard, C.; Chorin, M.; Bris, N.; Daburon, V.; Klarzynski, O. and Binet, F. (2020). Responses of active soil microorganisms facing to a soil biostimulant input compared to plant legacy effects. Sci. Rep., 10(1). https://doi.org/10.1038/s41598-020-70695-7

Hirshfeld, B. (2023). Prevalence and antimicrobial resistance profiles of Vibrio spp. and enterococcus spp. in retail shrimp in northern california. Front. Microbiol., 14. https://doi.org/10.3389/fmicb.2023.1192769

Huang, M.; Lin, H.; Xu, C.; Yu, Q.; Wang, X.; Qin, J. and Li, E. (2020). Growth, metabolite, antioxidative capacity, transcriptome, and the metabolome response to dietary choline chloride in pacific white shrimp Litopenaeus vannamei. Animals., 10(12): 2246. https://doi.org/10.3390/ani10122246

Immanuel, G.; Sivagnanavelmurugan, M.; Balasubramanian, V. and Palavesam, A. (2010). Effect of hot water extracts of brown seaweeds sargassum spp. on growth and resistance to white spot syndrome virus in shrimp penaeus monodon postlarvae. Aquac. Res., 41(10): e545 - e553. https://doi.org/10.1111/j.1365-2109.2010.02526.x

Islam, T.; Arioli, T. and Cahill, D. (2021). Seaweed extract-stimulated priming in arabidopsis thaliana and solanum lycopersicum. Plants., 10(11): 2476. https://doi.org/10.3390/plants10112476

Islamy, R. A.; Hasan, V. and Mamat, N. B. (2024). Checklist of Non-Native aquatic plants in up, middle and downstream of Brantas River, East Java, Indonesia. Egypt. J. Aquat. Biol. Fish. 28(4): 415–435. https://doi.org/10.21608/ejabf.2024.368384

Islamy, R. A.; Hasan, V.; Mamat, N. B.; Kilawati, Y. and Maimunah, Y. (2024a). Immunostimulant evaluation of neem leaves againts non-specific immune of tilapia infected by A. hydrophila. Iraqi J. Agric. Sci., 55(3): 1194-1208. https://doi.org/10.36103/dywdqs57

Islamy, R. A.; Hasan, V.; Mamat, N. B.; Kilawati, Y. and Maimunah, Y. (2024b). Various solvent extracts of Ipomoea pes-caprae: a promising source of natural bioactive compounds compare with vitamin C. Iraqi J. Agric. Sci., 55(5); 1602-1611. https://doi.org/10.36103/5vd4j587

Islamy, R. A.; Senas, P.; Isroni, W.; Mamat, N. B. and Kilawati, Y. (2024). Sea moss flour (E. cottonii) as an ingredient of pasta: The analysis of organoleptic, proximate and antioxidant. Iraqi J. Agric. Sci., 55(4): 1521-1533. https://doi.org/10.36103/kzmmxc09

Kabiraj, M.; Das, P.; Sultana, S. and Banu, G. (2020). Antagonistic effect of lactobacillus spp. on experimentally Vibrio spp. infected penaeus monodon. Asian J. Med. Biol. Res., 6(2): 311-315. https://doi.org/10.3329/ajmbr.v6i2.48077

Kilawati, Y.; Maimunah, Y.; Widyarti, S.; Amrillah, A. M.; Islamy, R. A.; Amanda, T.; Atriskya, F. and Subagio, F. R. (2024). Molecular identification and hemocyanin gene (HMC) characterization of the shrimp Litopenaeus vannamei infected by acute hepatopancreatic necrosis disease (AHPND). Egypt. J. Aquat. Biol. Fish., 28(5): 1807-1820. https://doi.org/10.21608/ejabf.2024.387024

Kim, J. and Lee, J. (2017). Correlation of total bacterial and Vibrio spp. populations between fish and water in the aquaculture system. Front. Mar. Sci., 4. https://doi.org/10.3389/fmars.2017.00147

Kocira, S.; Szparaga, A.; Kuboń, M.; Czerwińska, E. and Piskier, T. (2019). Morphological and biochemical responses of glycine max (l.) merr. to the use of seaweed extract. Agronomy., 9(2): 93. https://doi.org/10.3390/agronomy9020093

Kocira, S.; Szparaga, A.; Treder, K.; Findura, P.; Bartoš, P. and Filip, M. (2020). Biochemical and economical effect of application biostimulants containing seaweed extracts and amino acids as an element of agroecological management of bean cultivation. Sci. Rep., 10(1). https://doi.org/10.1038/s41598-020-74959-0

Krawczuk, A.; Huyghebaert, B.; Rabier, F.; Parafiniuk, S.; Przywara, A.; Koszel, M. and Kocira, S. (2023). The technical parameters of seaweed biostimulant spray application as a factor in the economic viability of soybean production. Appl. Sci., 13(2): 1051. https://doi.org/10.3390/app13021051

Kriem, M.; Banni, B.; Bouchtaoui, H.; Hamama, A.; Marrakchi, A.; Chaouqy, N. and Quilici, M. (2015). Prevalence of Vibrio spp. in raw shrimps (parapenaeus longirostris) and performance of a chromogenic medium for the isolation of vibrio strains. Lett. Appl. Microbiol., 61(3): 224-230. https://doi.org/10.1111/lam.12455

Lara-Anguiano, G.; Esparza-Leal, H.; Sainz-Hernández, J.; Palafox, J.; Valenzuela-Quiñónez, W.; Apún-Molina, J. and Klanian, M. (2013). Effects of inorganic and organic fertilization on physicochemical parameters, bacterial concentrations, and shrimp growth in Litopenaeus vannamei cultures with zero water exchange. J. World Aquac. Soc., 44(4): 499-510. https://doi.org/10.1111/jwas.12058

Li, Y.; Ji, D.; Jiang, Q.; Yang, Y.; Xu, W.; Du, X. and Zhao, Y. (2022). Comparison of lipid metabolism between broodstock and hybrid offspring in the hepatopancreas of juvenile shrimp (macrobrachium nipponense): response to chronic ammonia stress. Anim. Genet., 53(3): 393-404. https://doi.org/10.1111/age.13194

Li, Y.; Ying, X.; Jiang, Q.; Yang, Y.; Huang, Y.; Fan, W. and Zhao, Y. (2022). Comparison of immune defense and antioxidant capacity between broodstock and hybrid offspring of juvenile shrimp (macrobrachium nipponense): response to acute ammonia stress. Anim. Genet., 53(3): 380-392. https://doi.org/10.1111/age.13182

Loya-Rodríguez, M.; Palacios-Gonzalez, D.; Lozano-Olvera, R.; Martínez-Rodríguez, I. and Puello-Cruz, A. (2023). Benzoic acid inclusion effects on health status and growth performance of juvenile pacific white shrimp penaeus vannamei. North Am. J. Aquac., 85(2): 188-199. https://doi.org/10.1002/naaq.10286

Ma, Y.; Freitas, H. and Dias, M. (2022). Strategies and prospects for biostimulants to alleviate abiotic stress in plants. Front. Plant Sci., 13. https://doi.org/10.3389/fpls.2022.1024243

Manan, H.; Rosland, N.; Deris, Z.; Hashim, N.; Kasan, N.; Ikhwanuddin, M. and Suloma, A. (2022). 16s rrna sequences of exiguobacterium spp. bacteria dominant in a biofloc pond cultured with whiteleg shrimp, penaeus vannamei. Aquac. Res., 53(5): 2029-2041. https://doi.org/10.1111/are.15731

Mannino, G.; Campobenedetto, C.; Vigliante, I.; Contartese, V.; Gentile, C. and Bertea, C. (2020). The application of a plant biostimulant based on seaweed and yeast extract improved tomato fruit development and quality. Biomolecules., 10(12): 1662. https://doi.org/10.3390/biom10121662

Muahiddah, N. and Diamahesa, W. (2022). Potential use of brown algae as an immunostimulant material in the aquaculture field to increase non-specific immunity and fight disease. J. Fish Health., 2(2): 109-115. https://doi.org/10.29303/jfh.v2i2.2075

Patkowska, E.; Jamiołkowska, A.; Mielniczuk, E. and Skwaryło-Bednarz, B. (2022). Biodiversity of fungi colonizing scorzonera (scorzonera hispanica l.) cultivated with the use of biostimulants. Acta Sci. Pol. Hortorum Cultus., 21(3): 99-111. https://doi.org/10.24326/asphc.2022.3.9

Raj, Y.; Ali, N.; Pati, A. and Kumar, R. (2022). Cleaner production technologies for the amelioration of soil health, biomass and secondary metabolites in ocimum basilicum l. under indian western himalaya. Front. Plant Sci., 13. https://doi.org/10.3389/fpls.2022.976295

Rudi, M.; Sukenda, S.; Wahjuningrum, D.; Pasaribu, W. and Hidayatullah, D. (2019). Seaweed extract of gracilaria verrucosa as an antibacterial and treatment against vibrio harveyi infection of Litopenaeus vannamei. J. Akuakultur Indones., 18(2): 120-129. https://doi.org/10.19027/jai.18.2.11-20

Sandepogu, M.; Shukla, P.; Asiedu, S.; Yurgel, S. and Prithiviraj, B. (2019). Combination of ascophyllum nodosum extract and humic acid improve early growth and reduces post-harvest loss of lettuce and spinach. Agriculture., 9(11): 240. https://doi.org/10.3390/agriculture9110240

Serdiati, N.; Islamy, R. A.; Mamat, N. B.; Hasan, V. and Valen, F. S. (2024). Nutritional value of alligator weed (Alternanthera philoxeroides) and its application for herbivorous aquaculture feed. Int. J. Agric. Biosci., 13(3): 318–324. https://doi.org/10.47278/journal.ijab/2024.124

Shi, B.; Jin, M.; Betancor, M.; Tocher, D. and Zhou, Q. (2020). Effects of dietary zinc level on growth performance, lipolysis and expression of genes involved in the calcium/calmodulin-dependent protein kinase kinase-β/amp-activated protein kinase pathway in juvenile pacific white shrimp. Br. J. Nutr., 124(8): 773-784. https://doi.org/10.1017/s0007114520001725

Silva, B.; Hossain, S.; Dahanayake, P.; Zoysa, M. and Heo, G. (2018). Comparative prevalence and characterization of Vibrio spp. isolated from live and frozen white-leg shrimp (Litopenaeus vannamei) in korean markets. J. Food Saf., 38(5). https://doi.org/10.1111/jfs.12487

Sirirustananun, N.; Chen, J.; Lin, Y.; Yeh, S.; Liou, C.; Chen, L. and Chiew, S. (2011). Dietary administration of a gracilaria tenuistipitata extract enhances the immune response and resistance against vibrio alginolyticus and white spot syndrome virus in the white shrimp Litopenaeus vannamei. Fish Shellfish Immunol., 31(6): 848-855. https://doi.org/10.1016/j.fsi.2011.07.025

Sivagnanavelmurugan, M.; Marudhupandi, T.; Palavesam, A. and Immanuel, G. (2012). Antiviral effect of fucoidan extracted from the brown seaweed, sargassum wightii, on shrimp penaeus monodon postlarvae against white spot syndrome virus. J. World Aquac. Soc., 43(5): 697-706. https://doi.org/10.1111/j.1749-7345.2012.00596.x

Spann, T. and Little, H. (2011). Applications of a commercial extract of the brown seaweed ascophyllum nodosum increases drought tolerance in container-grown 'hamlin' sweet orange nursery trees. Hortscience., 46(4): 577-582. https://doi.org/10.21273/hortsci.46.4.577

Staropoli, A. (2024). Biodegradable mulch films and bioformulations based on trichoderma sp. and seaweed extract differentially affect the metabolome of industrial tomato plants. J. Fungi., 10(2): 97. https://doi.org/10.3390/jof10020097

Sudaryono, A.; Chilmawati, D. and Susilowati, T. (2018). Oral administration of hot-water extract of tropical brown seaweed, sargassum cristaefolium, to enhance immune response, stress tolerance, and resistance of white shrimp, Litopenaeus vannamei, to vibrio parahaemolyticus. World Aquac. Soc., 49(5): 877-888. https://doi.org/10.1111/jwas.12527

Takeungwongtrakul, S.; Benjakul, S.; Santoso, J.; Trilaksani, W. and Nurilmala, M. (2013). Extraction and stability of carotenoid-containing lipids from hepatopancreas of pacific white shrimp (litopenaeus vannamei). J. Food Process. Preserv., 39(1): 10-18. https://doi.org/10.1111/jfpp.12203

Tarh, J.; Bassey, E.; Mbah, M.; Solomon, E. and Upula, S. (2023). Bacteriological assessment of smoked-dried white shrimp (nematopalaemon hastatus aurivillius, 1898) sold in calabar, nigeria. Eur. J. Nutr. Food Saf., 15(4): 23-29. https://doi.org/10.9734/ejnfs/2023/v15i41304

Tinte, M.; Masike, K.; Steenkamp, P.; Huyser, J.; Hooft, J. and Tugizimana, F. (2022). Computational metabolomics tools reveal metabolic reconfigurations underlying the effects of biostimulant seaweed extracts on maize plants under drought stress conditions. Metabolites., 12(6): 487. https://doi.org/10.3390/metabo12060487

Xie, S.; Wei, D.; Chen, S.; Zhuang, Z.; Yin, P.; Liu, Y. and Niu, J. (2020). Dietary fishmeal levels affect anti-oxidative ability and metabolomics profile of juvenile pacific white shrimp, Litopenaeus vannamei. Aquac. Nutr., 26(3): 978-989. https://doi.org/10.1111/anu.13055

Xie, S.; Wei, D.; Fang, W.; Wan, M.; Guo, T.; Liu, Y. and Niu, J. (2019). Optimal dietary lipid requirement of postlarval white shrimp, Litopenaeus vannamei in relation to growth performance, stress tolerance and immune response. Aquac. Nutr., 25(6): 1231-1240. https://doi.org/10.1111/anu.12937

Xing, Q.; Han, S.; Park, J.; Yarish, C. and Kim, J. (2023). Comparative transcriptome analysis reveals the molecular mechanism of heat-tolerance in neopyropia yezoensis induced by sargassum horneri extract. Front. Mar. Sci., 10. https://doi.org/10.3389/fmars.2023.1142483

Xu, C.; Li, E.; Liu, Y.; Wang, S.; Wang, X.; Chen, K. and Chen, L. (2017). Effect of dietary lipid level on growth, lipid metabolism and health status of the pacific white shrimpLitopenaeus vannameiat two salinities. Aquac. Nutr., 24(1): 204-214. https://doi.org/10.1111/anu.12548

Yakhin, O.; Lubyanov, A.; Yakhin, I. and Brown, P. (2017). Biostimulants in plant science: a global perspective. Front. Plant Sci., 7. https://doi.org/10.3389/fpls.2016.02049

Yen, N.; Nhung, N.; Vân, N.; Cương, N.; Chau, L.; Trinh, H. and Carrique-Mas, J. (2020). Antimicrobial residues, non-typhoidal salmonella, Vibrio spp. and associated microbiological hazards in retail shrimps purchased in ho chi minh city (vietnam). Food Control., 107: 106756. https://doi.org/10.1016/j.foodcont.2019.106756

Yu, D.; Zhai, Y.; He, P. and Jia, R. (2022). Comprehensive transcriptomic and metabolomic analysis of the Litopenaeus vannamei hepatopancreas after wssv challenge. Front. Immunol., 13. https://doi.org/10.3389/fimmu.2022.826794

Zhou, Z. (2023). Three types of enteromorpha prolifera bio-products based on different processing procedures as feed additives in the diets of pacific white shrimp (Litopenaeus vannamei). Fishes., 8(12): 587. https://doi.org/10.3390/fishes8120587