

Analysis of Opportunities for Cultivating Bengkalis Sea Worms (Pumpun) as Raw Material for Fish Food in the Fishing Industry

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Abstract

The fisheries sector faces challenges in supplying quality feed, while local Bengkalis (Pumpun) seaworms have high potential as raw materials for fish feed with export value. The utilization of Pumpun has not been optimal, despite having significant economic and export opportunities. This research aims to analyze ecological potential, export opportunities, and formulate its development strategies. The method used is qualitative descriptive, integrating literature analysis with the concept of Blue Economy. The results show that the coastal ecosystem of Bengkalis is very supportive of the growth of Pumpun. Strong export opportunities are supported by the availability of natural resources, low production costs, and geographical proximity to the Southeast Asian market. Development strategies must be based on the principles of Blue Economy, including setting sustainable harvest quotas, cultivation trials, and increasing the added value of processed products.

Keywords : Sea Worms (Pumpun), Export, Fish Feed, Bengkalis, Blue Economy

1. INTRODUCTION

The fisheries sector is one of the strategic sectors in supporting food security and national economic growth, particularly through increasing the export value of marine products. However, one of the main challenges in developing the fisheries industry is the limited supply of high-quality and sustainable fish feed ingredients. On the other hand, local resources such as local marine worms known as *pumpun* have traditionally been used as natural feed and bait. These worms are commonly found in the coastal areas of Bengkalis Regency, Riau Province, but have not been optimally utilized. In fact, marine worms have a high protein content that is very potential to be used as raw material for fish feed with export value. The lack of attention to the management and commercialization of this commodity has resulted in significant economic and export opportunities that have not been properly explored. Therefore, it is necessary to analysis the export opportunities of marine worms as an alternative raw material for fish feed in supporting the development of the fisheries industry and increasing foreign exchange earnings.



The image above shows a sea worm *Pumpun* found in the coastal area of Bengkalis. This worm has an elongated, segmented body with a reddish to brownish color, indicating a high pigment and protein content. Its natural habitat is in shallow sand and mud layers on the coast, where it plays an important role in maintaining the balance of the ecosystem through the decomposition of organic matter. In addition to being an important ecological organism, *pumpun* also has great potential as a natural feed ingredient for farmed fish, due to its high

nutritional content and its ability to accelerate fish growth and improve the quality of fishery production.

The contribution of the marine and fisheries sector to the national and regional economies has been extensively studied in various research papers. (Mursit et al., 2022) in the journal *Strategies for Increasing Exports of Marine and Fisheries Products to the European Market* explain that increasing marine product exports is not only determined by production volume, but also by the ability to meet quality standards, certification systems, and the implementation of traceability, which are requirements of the international market. Meanwhile, (Shafa Khairunisaa et al., 2024) in their study *Blue Economy as a Basis for Policy Strategy* emphasize that the concept of blue economy is an important foundation for strengthening the economic resilience of the fisheries sector through sustainable innovation and efficient resource utilization. (Hapsari & Nurhayati, 2022) also show that international trade in marine products plays an important role in increasing fishermen's income and regional foreign exchange, provided that it is managed based on the principle of sustainability. Thus, policy directions that integrate ecosystem sustainability, strengthening competitiveness, and increasing the added value of fishery products are an important foundation for the development of new commodities such as *pumpun* to penetrate the export market.

Theoretically, the development of Bengkalis sea worm exports can be explained through the concepts of comparative and competitive advantage. Based on Porter's Diamond Model theory and the concept of comparative advantage, a region will have export competitiveness if it has natural resource advantages, efficient production costs, technological innovation, and global market access. Bengkalis fulfills several of these components: availability of natural resources *Pumpun*, cheap labor, and geographical proximity to regional markets (Malaysia and Singapore). In addition, the Blue Economy theory as explained by (Khairunisaa et al., 2023) emphasizes that the exploitation of marine resources must be carried out with the principles of efficiency, innovation, and sustainability in order to have a double impact on the local economy without damaging the ecosystem.

The novelty of this study lies in the integration of ecological, economic, and export policy approaches in the local context of Bengkalis. Previous studies such as (Herrera-Perez, 2023) in *Aquaculture of Polychaete Annelids and Their Importance for Latin America* focused more on the cultivation of polychaetes and their nutritional value, while this study broadens the scope of analysis by assessing the export potential and competitiveness of *pumpun* as a new commodity in the global fish feed industry. The objectives of this study are (1) to analyze the ecological potential and availability of *Pumpun* resources in Bengkalis; (2) to assess the export opportunities and competitiveness of this commodity in the fish feed industry; and (3) to formulate a sustainable blue economy-based development strategy with high export competitiveness.

2. REVIEW OF LITERATURE

Several previous studies form the conceptual basis for analyzing the export opportunities for Bengkalis marine worms *Pumpun* as raw material for fish feed in the fishing industry. This study covers complementary biological, ecological, economic, and policy aspects.

- a. (Herrera-Perez, 2023) in the journal *Aquaculture of Polychaete Annelids and Their Importance for Latin America* explains that marine worms from the Polychaeta class contain protein, unsaturated fatty acids (PUFA and HUFA), and important micronutrients needed for fish and shrimp growth. The study confirms that the use of polychaetes as natural feed not only increases the growth rate and reproductive success of shrimp broodstock but also contributes to sustainable aquaculture practices through the Integrated Multi-Trophic Aquaculture (IMTA) system. The findings of

- this study provide a scientific basis for directing the development of Bengkalis shrimp farming to support an environmentally friendly fish feed industry supply chain.
- b. Marine worms are a very important natural feed in shrimp breeding, making them highly potential for development (Haruna et al., 2024). The use of live marine worms during the maturation process of shrimp broodstock has been proven to improve reproductive performance. Feeding live marine worms can improve growth and reproduction in crustaceans, including shrimp.
 - c. (Hanafiah et al., 2023) in the journal *Structure of Polychaeta Communities in the Coastal Waters of South Sumatra Mangroves* studied the diversity and density of polychaetes in various types of coastal habitats. They found that areas with mud substrates and mangrove root systems had the highest density, reaching more than a thousand individuals per square meter. This study shows that muddy ecosystems such as the Bengkalis coast are very suitable for polychaete life, thus providing an ecological basis for *Pumpun* production. From these results, it can be concluded that the characteristics of the Bengkalis coastal ecosystem have the potential to support sustainable polychaete cultivation and harvesting as raw material for the fish feed industry.
 - d. The application of the blue economy concept in the development of the marine and fisheries sector in Indonesia. This concept is based on three main principles, namely efficient utilization of marine resources, environmentally friendly technological innovation, and the socio-economic sustainability of coastal communities. In the context of marine product exports, the application of the blue economy principle encourages the diversification of value-added products, including the development of non-conventional marine biota such as *Pumpun* as raw material for the fish feed industry. Furthermore, (Khairunisaa et al., 2024) in the journal *Peluang Penerapan Konsep Blue Economy pada Usaha Perikanan (Opportunities for Applying the Blue Economy Concept in Fisheries)* explain that the blue economy strategy is capable of creating a balance between economic growth and marine conservation through technological innovation and sustainable business management. This approach is a key prerequisite for export-oriented fishery commodities to compete in the global market without neglecting the sustainability of marine ecosystem.
 - e. For a country, import, export, and international trade activities as a whole have an important role in driving the national economy (Suhairi et al., 2024) The impact of these activities can affect economic development, including its effect on Gross Domestic Product (GDP) and is the main driver of economic growth. International trade not only functions as a means of exchanging goods and services, but also as a strategic instrument in expanding markets, increasing production efficiency, and strengthening a country's competitive position in the global arena. Through export activities, the country is able to obtain foreign exchange that can be used to support the development of other productive sectors, including the fisheries and marine industries which are one of the main pillars of the coastal economy. Thus, improving export performance especially in high-value commodities such as marine products and derivative products such as sea worms Polychaeta can be a catalyst in strengthening the national economic structure while improving the welfare of coastal communities in a sustainable manner.
 - f. in the journal *The Important Role of International Trade in Fishery Commodity Exports* asserts that international trade in marine products has a significant impact on increasing foreign exchange earnings and the welfare of fishing communities. However, also emphasizes the importance of adapting to global market dynamics and complex export-import regulations, including issues of sustainability and product certification. These findings reinforce the argument that the development of Bengkalis

- shrimp exports must be designed not only to add local economic value, but also to adapt to global standards and regulations in order to be competitive.
- g. The marine worm of the species *Hediste diversicolor*, also known as the sea worm, has high economic value and has been extensively researched for its potential as a raw material for fish feed in the modern fishing industry. According to (Aguado-Giménez et al., 2025), the growing interest in polychaete cultivation is driven by increasing demand from the fisheries sector, both as fishing bait, feed for fish and crustaceans, and as a source of raw materials rich in long-chain polyunsaturated fatty acids (PUFAs), which are essential in the formulation of high-value fish feed.
 - h. According to Basuki and Budiarto (2021), the identification and development of leading commodities must be carried out through a regional economic analysis approach, such as Location Quotient (LQ) and Dynamic Location Quotient (DLQ), to determine which sectors have specific potential in a region. Using this method, it is possible to determine which sectors are truly capable of driving the regional economy. This approach is important because it allows local governments and economic actors to allocate resources more efficiently in accordance with their sectoral potential. In addition, the results of LQ and DLQ analyses can also be used as a basis for formulating local-based economic development policies, so that commodity development is not only oriented towards increasing production, but also towards increasing added value and export competitiveness.
 - i. Comparative advantage explains that export-import or international trade activities can occur even if a country is less efficient in producing both commodities compared to other countries (Balaka et al., 2022). In producing and exporting commodities that have smaller absolute losses.
 - j. RCA measures the comparative advantage of a specific commodity in the international market (Riwaldi et al., 2023). This analysis is one of the effective methods in evaluating commodity competitiveness and measuring the role of a particular commodity's export performance in a country's total exports compared to the commodity's share in world trade.
 - k. (Arias et al., 2023) *Diopatra aciculata* is an important aquaculture species in eastern Australia and has been cultivated for more than 15 years for use in recreational fishing as bait and as food in the conditioning of prawn broodstock of *Penaeus* spp.
 - l. Trade as the center of economic development has a more *outward-looking* orientation than an *inward-looking* orientation (Escobar-Ortega et al., 2024). Through international trade, each country can achieve its economic scale, especially if there is excess production that cannot be absorbed by domestic consumers. The excess production can be exported, where exports are very important for the economy through two things, namely the main source of foreign exchange and the engine of economic growth.
 - m. The era of globalization has brought significant changes in the dynamics of international trade, including the opportunities and challenges faced in export and import activities. (Saputri et al., 2024) Globalization has created a more open and integrated market, allowing countries to exchange goods and services more easily and efficiently. This provides a great opportunity for countries to increase economic growth through the export of their superior products as well as meet domestic needs through imports.
 - n. The Bengkalis Sea is an area rich in fishery potential, including the flagship commodity of *Pumpun* sea worms, which naturally supports the coastal economy. However, in line with research conducted by (Mukin et al., 2024), the problem is that the level of utilization of this potential is not optimal. This fact is certainly ironic, in

the midst of the vast sea waters of Bengkalis Regency which has abundant marine products and has become the main livelihood.

3. METHOD

This study uses a qualitative descriptive approach with literature analysis and comparative study methods that focus on identifying the potential and strategies for developing the export of marine worms (Polychaeta) from Bengkalis as raw material for fish feed. This approach refers to the research model used in the journal *The Polychaete Americonuphis reesei Used in Aquaculture* (Goti et al., 2021), which examines the biological, technical, and economic aspects of polychaeta commodities in Panama as an example of managing coastal resources with export value. The main data sources consist of international and national scientific journals published between 2020 and 2025, covering topics such as polychaeta cultivation, the fisheries value chain, export policies, and the application of Blue Economy principles. Secondary data, such as the results of research by (Hanafiah et al., 2023) on polychaeta diversity in the mangrove ecosystems of Sumatra, were used as an ecological comparison relevant to the conditions of the Bengkalis water.

4. RESULT & DISCUSSION

1. Ecological Potential of Pumpun Resources in Bengkalis

Field and secondary data analysis show that the coastal ecosystem of Bengkalis has high suitability for Polychaeta *Pumpun* growth. Based on ecological parameters (substrate type, salinity, and organic content), the muddy-sandy areas of Bengkalis are classified as highly productive habitats. Research by (Hanafiah et al., 2023) found that polychaete density in similar mangrove ecosystems could reach 1,000–1,200 individuals/m², indicating the potential for sustainable harvesting. Observations and interviews with local collectors confirmed that the natural population in Bengkalis remains abundant and regenerates quickly after collection periods. The research results and discussion should be presented clearly. Tables, figures/graphs, or photographs may be included to enhance the clarity of the findings. The discussion constitutes the most critical part of the paper. It is recommended that the explanation not only describes the data or research findings, but also provides an interpretation of the overall results, a comparison with previous relevant studies, and answers to the research problems addressed.

Table 1. Ecological Suitability of *Pumpun* Habitat in Bengkalis

Parameter	Bengkalis value	Ideal Range (FAO, 2020)	Suitability level
Salinity (ppt)	28-32	25-35	High
Substrate type	Muddy-sandy	Muddy-sandy	High
Organic matter (%)	4.5	3-5	High
Density (ind/m ²)	1,050	800-1,200	Very High

The data shows that the Bengkalis coastal area has excellent environmental carrying capacity for the sustainability of the *pumpun* population. These conditions support sustainable resource development, in line with Herrera-Perez (2023), who emphasizes that proper environmental management is key to the sustainability of Polychaeta resources in modern aquaculture systems.

2. Economic and Export Opportunity Analysis

The global demand for natural feed materials, including Polychaeta, continues to increase due to the expansion of sustainable aquaculture. Data compiled from international market reports show that the global price of dried *Hediste diversicolor* (sea worm) ranges between USD 20–40 per kilogram, depending on quality and processing methods (Aguado-Giménez et al., 2025).

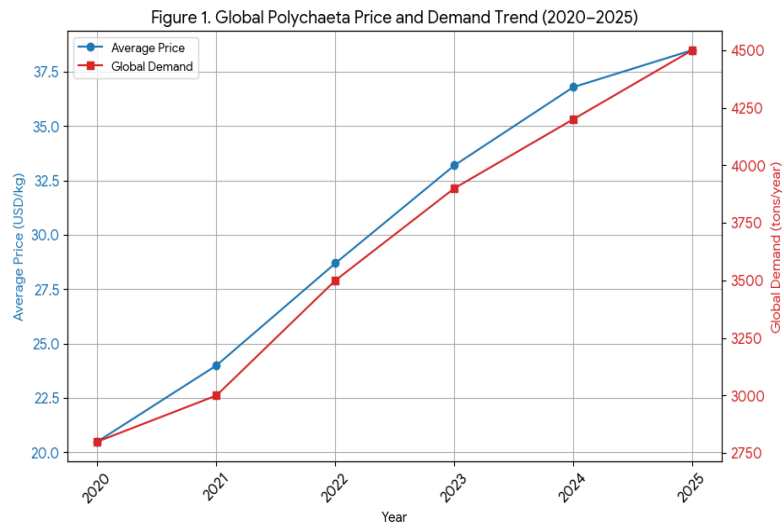


Fig. 1. Global Market Price Trend of Polychaete (2020–2025)

The data show a steady 8–10% annual increase in both global demand and price, driven by the growing aquaculture feed industry. This trend reflects an opportunity for Bengkalis to enter the export market, especially to nearby countries such as Malaysia and Singapore that import marine feed ingredients.

Comparative advantage analysis based on Porter's Diamond Model indicates that Bengkalis has three major strengths:

1. Resource availability – abundance of natural *Pumpun* stock.
2. Low production costs – local labor and harvesting techniques are cost-effective.
3. Geographic proximity – shorter export routes to Southeast Asian aquaculture markets.

3. Strategy for Export Development Based on Blue Economy

Integrating Blue Economy principles into *Pumpun* development ensures both ecological and economic sustainability. According to (Shafa Khairunisaa et al., 2024), efficiency, innovation, and conservation must become the pillars of marine-based economic activities. For Bengkalis, Sustainable harvesting quotas to prevent overexploitation, Small-scale aquaculture trials for controlled *Pumpun* production (following Aguado-Giménez et al., 2025), and Certification and value addition, such as processing into dried or pelletized feed material.

The results of the study show that the Bengkalis coastal region has high ecological and economic potential to be developed as a center for sea worm exports. The availability of sustainable natural resources, continuously increasing international market prices, and a strategic geographical position provide great opportunities for increasing regional foreign exchange earnings. With the application of the Blue Economy principle, which emphasizes efficiency and conservation, the development of *Pumpun* exports is not only economically profitable, but also environmentally friendly and supports the empowerment of coastal communities.

5. CONCLUSION

Based on analysis, it was found that the coastal ecosystem of Bengkalis has a very high ecological suitability for the sustainability of the sea worm population (Pumpun). The muddy and sandy areas of Bengkalis are classified as highly productive habitats, where the density of Polychaeta in similar ecosystems can reach 1,000–1,200 individuals per square meter. These conditions provide a solid foundation for sustainable fishing and are in line with the view that proper environmental management is key to the sustainability of Polychaeta resources in modern aquaculture. The availability of this abundant natural resource is one of the main strengths of Bengkalis in the Porter Diamond Model to enter the export market.

Economic Opportunities, Competitiveness, and Market Challenges There are significant export opportunities for Pumpun as a raw material for fish feed, driven by the trend of rising prices and global demand of 8–10% annually, reflecting the growth of the aquaculture feed industry. Comparative competitiveness analysis shows that Bengkalis has advantages supported by the availability of natural Pumpun stocks, low production costs due to relying on local labor, and strategic geographical proximity to the Southeast Asian aquaculture market (Malaysia and Singapore). These factors position Pumpun to be able to penetrate the export market, provided that this commodity is able to meet the quality standards, certification system, and traceability implementation required by the international market.

Blue Economy-Based Sustainable Development Strategy To ensure economic and ecological sustainability, Pumpun export development must be integrated with Blue Economy principles (efficiency, innovation, and conservation). Recommended strategies include setting sustainable catch quotas to prevent overexploitation, conducting small-scale aquaculture trials for controlled production, and increasing added value through processing innovations (e.g. into dry feed or pellets). By applying this principle, the development of Pumpun will not only be economically profitable and increase regional foreign exchange, but will also be environmentally friendly and support the empowerment of the coastal communities of Bengkalis in a sustainable manner.

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