INTERNATIONAL JOURNAL OF LATEST TECHNOLOGY IN ENGINEERING, MANAGEMENT & APPLIED SCIENCE (IJLTEMAS)

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue VIII, August 2025

Blue Harvest: Converting the Fish Waste into Wealth

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DOI: https://doi.org/10.51583/IJLTEMAS.2025.1408000178

Abstract: Globally, the fisheries industry produces millions of tonnes of waste each year, consisting of fish heads, bones, skins, viscera, and shells. While this waste is often discarded or used as low-value animal feed, it actually contains many valuable bioactive compounds such as proteins, collagen, chitosan, omega-3 fatty acids, and minerals. In recent years, researchers, entrepreneurs, and fishing communities have begun transforming this waste into useful products for food, nutraceuticals, cosmetics, agriculture, and biodegradable materials. This paper explores how such innovations are being developed, especially in India, where small scale fishers and start-ups are finding affordable solutions to process fish waste into high-value goods. It discusses the challenges of awareness, infrastructure, and market access, and presents the practical solutions being implemented. The results show that these initiatives reduce pollution, generate income, empower women, and contribute to a circular economy in fisheries.

Key words: Fish waste, Value-added Products, Bioactive Compounds, Sustainable Fisheries, Blue Economy Innovations

I. Introduction

The global fishing industry is an important contributor to food security and livelihoods, but it also generates large amounts of waste. Studies estimate that 30–85% of the fish's total body weight becomes waste during processing, especially in commercial fish landing centers and markets. This waste includes heads, skins, bones, scales, fins, viscera, and spoiled fish, which are often dumped into coastal areas, leading to serious environmental and health problems. In India, a major fishing nation with a long coastline, fish waste disposal is a pressing issue, particularly in urban and semi-urban coastal communities. However, fish waste is not simply garbage it is rich in nutrients such as proteins, omega-3 fatty acids, collagen, calcium, and other bioactive compounds. These can be transformed into a wide range of high value products if handled properly. Countries like Norway, Japan, and Iceland already have systems to convert fish waste into nutraceuticals, cosmetics, and fertilizers. Inspired by these models, Indian researchers and innovators are beginning to develop low cost technologies suitable for small fishers and local entrepreneurs. This shift from "waste" to "wealth" offers a sustainable pathway to reduce pollution and increase income in the fisheries sector.

II. Literature Survey

Research studies around the world have confirmed that fish waste contains many valuable bioactive compounds that can be extracted and commercialized. For instance, fish skins and bones are rich in collagen and gelatin, which are used in food, cosmetics, and biomedical products (Coppola et al., 2021; Gaikwad et al., 2024). Fish oils, especially from sardines and mackerel, are an important source of omega-3 fatty acids, which are widely used in nutraceuticals and animal feed. Protein hydrolysates made from fish waste are used in clinical nutrition and functional foods (Espinales et al., 2023). Shrimp and crab shells are rich in chitin, which can be processed into chitosan a biodegradable material with antimicrobial properties useful in agriculture, medicine, and food packaging (Venugopal, 2021; Roy, 2023). Studies in India have shown that women's self-help groups and start-ups are developing fish bone powder as a calcium-rich dietary supplement and are reviving traditional recipes using fish heads and bones. Composting and fermentation techniques are also being used to create organic fertilizers from fish waste, especially in Kerala and Maharashtra. Overall, global and Indian research shows that fish waste valorization is technically feasible and economically beneficial, though infrastructure and market access remain key limitations.

In India, however, fish waste is often left untreated, creating environmental hazards in coastal regions. Recent studies are beginning to document efforts by Indian start-ups and research institutions to process fish waste into useful products tailored for local markets.

Challenges

The utilization of fish waste faces multiple challenges. Despite the promising potential of fish waste utilization, several barriers hinder its widespread adoption. One of the major challenges is the lack of awareness among fishers, vendors, and small scale processors about the economic and nutritional value of fish waste. Most small operators focus only on selling fresh fish and do not have the knowledge or skills to process by-products. Another key issue is the absence of proper infrastructure for waste collection, cold storage, and hygienic processing. Fish waste spoils rapidly in tropical conditions, making timely processing essential. In many coastal markets, there is no system for separating and storing waste. Market access is also a challenge, as consumers are often unaware of the benefits of fish waste derived products, and industries may be hesitant to use them without clear standards. Lack of awareness among fishers and processors means that valuable resources are often discarded. Infrastructure gaps, such as proper collection, cold storage, and hygienic processing units, limit large scale utilization. Market access is also restricted due to poor consumer awareness and lack of standardized supply chains. Together, these challenges prevent fish waste from reaching its full potential as a resource.

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Solutions

To overcome these barriers, in recent years, several innovative actions have been taken to tackle the problem of fish waste and convert it into valuable products. Start-ups and research institutions in India are now extracting omega-3-rich fish oil from sardine and mackerel waste, especially in Kerala and Gujarat. This oil is used in dietary supplements and aquaculture feed. Fish protein hydrolysate (FPH) is being developed by enzymatically breaking down proteins from fish skins and prawn shells. These hydrolysates are used in clinical nutrition, health supplements, and sports foods. Collagen and gelatin are also being extracted from fish skins and bones and are gaining popularity in the cosmetic and pharmaceutical industries as alternatives to animal-based collagen. Chitosan, a versatile biodegradable material derived from shrimp and crab shells, is being developed by researchers in Odisha and Tamil Nadu for use in medicine, biodegradable packaging, and agriculture. Women's self-help groups in coastal areas are also making simple products like fish bone powder, fish pickles, and ready-to-cook curry kits using fish heads and bones. These efforts are creating income opportunities for local women while reducing waste. In addition, fish waste is being composted or fermented to produce organic liquid fertilizers, especially in Kerala and Maharashtra, where these natural fertilizers are used as an alternative to chemical inputs in farming for promoting sustainable agriculture.

Outcomes

The outcomes of these innovations are encouraging both environmentally and economically. Environmental pollution from fish waste has reduced in areas where waste is now being collected and processed instead of being dumped. Fishers and small processors are earning extra income by selling waste or producing value added products. Women's self-help groups, in particular, are benefiting by making and selling products like fish bone powder and pickles, leading to greater financial independence and empowerment. The revival of traditional recipes using fish heads and bones also helps preserve local food culture while reducing waste. The production of organic fertilizers from fish waste supports sustainable agriculture and reduces dependence on synthetic chemicals. Several start-ups working in fish waste valorization have received grants, awards, and recognition from government and development agencies, showing institutional support for such initiatives. These actions also demonstrate that small-scale and community-driven approaches can be effective in addressing the twin challenges of waste management and rural livelihoods.

III. Conclusion

The transformation of fish waste into valuable products is a powerful example of how environmental challenges can be turned into economic opportunities. By extracting useful compounds like protein hydrolysates, collagen, omega-3 oils, chitosan, and calcium, innovators are reducing pollution, improving income, and promoting sustainable practices in the fisheries sector. The key to scaling up these solutions lies in increasing awareness among fishers and processors, investing in affordable and decentralized technologies, and building strong market linkages. Government support in the form of training, infrastructure development, and financial incentives is also essential. As consumer demand for natural supplements, biodegradable materials, and organic fertilizers continues to grow, the market potential for fish waste products will expand. A circular economy in fisheries where every part of the fish is utilized can lead to a more sustainable, profitable, and inclusive future for coastal communities. By promoting innovation and sustainability, the fisheries sector can reduce waste, protect ecosystems, and ensure that nothing in fisheries needs to go to waste; every fish caught can be used to its fullest potential, benefiting both people and the planet.

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