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Categories of Seafood Processing Wastes and various effective management strategies of Liquid effluents

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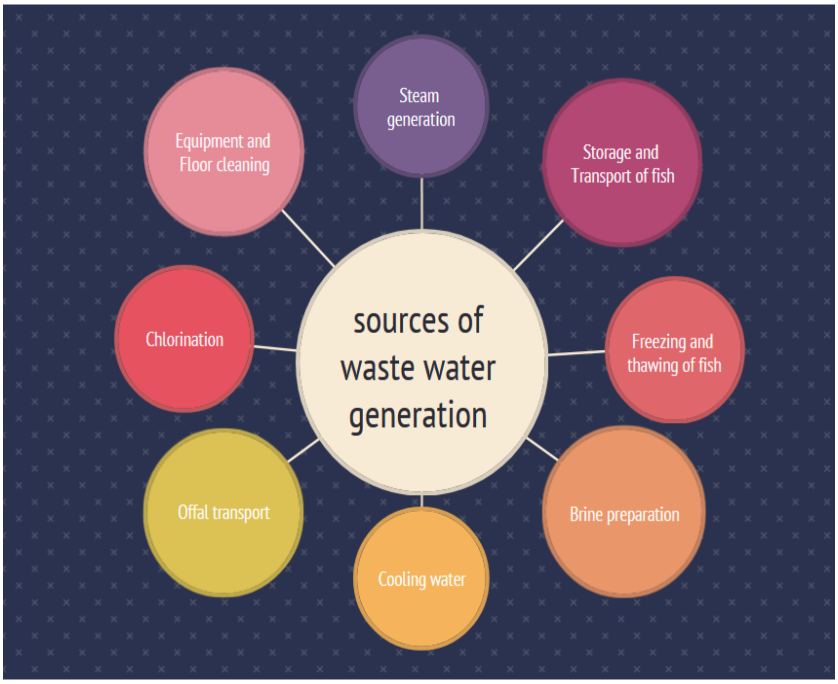
Abstract

Seafood processing waste is one of the major challenges that are faced in Industry and it contains many organic pollutants and nutrients that harm the environment if discharged without treatment. The discards, bycatches and effluents are collectively referred to as Seafood Waste Biomass. It is urgent to search for a solution to treat seafood processing wastewater for sustainable development purposes. The key sources of seafood waste generation include brine, cooling water, chlorination, freezing and thawing, storage and transport, equipment and floor cleaning. The major categories of seafood waste include liquid and solid wastes. The predominant problems occurred due to the waste generation are Nutrient losses and environmental problems. This review discusses the effective management strategies to utilize the liquid effluents and several green processes for the treatment of liquid effluents

Keywords: Seafood Processing Waste, Categories of waste, green processes, Effective management strategies

Introduction



Ocean provide enormous seafood varities such as finfishes (pollock, tuna, herring, mackerel, whiting and others), shellfishes encompassing crustaceans (shrimp, prawn, crab, lobster) and mollusk (mussel, oyster, clam and scallop), cephalopod (squid and cuttlefish), gastropod (abalone and snail). Global seafood production reached **190.6 million metric tonnes in 2022.** Aquaculture played a significant role in the overall production, with farmed shrimp leading the growth. India's seafood exports continued to grow, with a value of **63,969.14 crore in 2022-23.** The demand for seafood is projected to increase by 60% in 2050. Of the total global seafood production, 45% is consumed as fresh fish and the remaining 55% is processed and consumed in frozen (29%), canned (14%) and cured (12%) form.

One of the major concerns with respect to the seafood production is associated with the generation of heavy amounts of waste. The key process which contribute significantly to solid waste generation are evisceration, chopping, slicing and filleting produces heads, tails and scraps. Apart from solid waste, the seafood industry also releases voluminous amounts of process liquid waste, that are discarded during washing, chilling, blanching, filleting, cooking, surimi production, marination and other processing operations. Approximately, 10 to 40 m^3 water is required for processing each ton of raw seafood material. These effluents have high solid contents, denoted as Total Suspended Solids (TSS).

Categories of Seafood waste

Seafood waste can be categorized in to two different types;

Solid Waste	Liquid Waste
Organic Waste: Skin, shells, heads, tails, and other seafood components which are not edible but biodegradable	**Processing Effluents**: A lot of wastewaters are generated during cleaning, scaling, gutting, filleting, and other fish dressing steps. This wastewater may contain blood, chemicals, oils, and fats
Non-organic Waste: In non-organic waste, plastic, metal packing materials and cardboard are considered which may be non-biodegradable	**Cooling Water:** The water used in the chilling process of seafood and equipment might mix with contaminants or be affected by temperature fluctuations

Problems due to seafood waste

Nutritional losses

Types of discards	**Nutritional losses**
Solid discards	49 to 58% protein, 22 to 30% ash and 7 to 19% fat
Shrimp shell discards	65% proteins, 21% ash and 18 to 20% chitin

Environmental pollution

- The ocean dumping of bycatch causes reduced oxygen levels at the ocean bottom, burial or smothering of living organisms and disease to the seafloor ecosystem.

- Putrefaction of seafood discards in landfill can cause climate change due to the formation of methane, ammonia and hydrogen sulphide.

Effective Management Strategies of Seafood Liquid waste

1. The installation of water treatment units in the thawing and gutting stages in the plant reduces water usage by up to 70%
2. The installation of fish oil separator can be used for the removal of fish oil that is further used in the value addition
3. The installation of pressurized hoses and suitable sized capacitor banks could save 70% of the water used for cleaning purposes
4. The wastewater generated during thawing process can be recycled using a closed-circuit water recirculation system and it can be further used for gutting process which saves 45% of water
5. The use of vacuum system for gut removal, usage of gas for deskinning and microwave for boiling can significantly reduce water consumption.
6. The reuse of brine for pickling and adoption of advanced waste water treatment processes such as heat centrifugation, nano filtration and reverse osmosis would result in lesser water consumption
7. In the canned tuna processing industry, fitting of pressure nozzles for spray cooling could reduce water consumption by 66%

Green processes for the treatment of seafood process liquid effluents

S.No.	Processes	Principle	Benefits
1.	**Dissolved Air Floatation (DAF)**	DAF removes suspended solids, oil, and grease by attaching tiny air bubbles to them, causing them to float to the surface for removal.	1. High Removal efficiency 2. Flexibility 3. Compact design 4. Lower Sludge production 5. Rapid separation time 6. Potential for water reuse 7. Effective in treating low density materials 8. Suitable for pretreatment
2.	**Activated Sludge**	It involves blowing oxygen or air into raw, unsettled sewage. This process smashes the solids. The sewage is bubbled, and sewage	1. High quality effluent 2. Reduced BOD 3. Pathogen removal 4. Compliance with

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		liquor is discharged into an activated sludge chamber. Live bacteria settle to the bottom of the tank and dead bacteria float to the top. Clean water is discharged into a soakaway or watercourse while the live bacteria return to the digestion chamber.	environmental standards 5. Flexibility 6. Relatively lower installation cost
3.	**Anaerobic digestion (AD)**	AD uses microorganisms to break down organic matter in the absence of oxygen, producing biogas (primarily methane and carbon dioxide) and a nutrient-rich sludge. This process occurs in stages, beginning with hydrolysis, followed by acidogenesis, acetogenesis, and finally, methanogenesis	1. Lower operating cost of the digester 2. Sludge occupies lesser volume and easier to dry 3. Reduce production of landfill methane 4. Methane – source of biogas 5. Digestate – the content of reactor after completion of digestion which can be used as fertilizer
4.	**Membrane processes**	The process involves microorganisms breaking down organic matter in a bioreactor, and then a semi-permeable membrane separates the treated water from the remaining biomass and solids, producing high-quality effluent	1. High quality effluent 2. Space efficiency 3. Reduced sludge production 4. Effective pathogen removal
5.	**Electrochemical Oxidation**	Electrochemical oxidation (EO) is a wastewater treatment process that uses electrical energy to break down organic pollutants. It works by generating strong oxidizing species, like hydroxyl radicals, at the anode, which then reacts with and degrade the contaminants. This process can effectively mineralize pollutants into harmless substances like water and CO2, or convert them into more biodegradable compounds	1. Effective for difficult to treat pollutants 2. No external chemical addition 3. Environmentally friendly 4. Flexibility and Applicability 5. Potential for Hybrid processes 6. Easy to setup and operate 7. Potential for high efficiency 8. On-site generation of oxidants 9. Versatility 10. High Degradation standards
6.	**Flocculation**	Flocculation is a chemical process that follows coagulation in wastewater treatment. It involves	1. Improved water clarity and purity 2. Efficient contaminant

		adding specific chemicals, known as flocculants, to water containing suspended particles. These flocculants neutralize the electrical charges on the particles, allowing them to come together and form larger, heavier clumps called flocs. The flocs then settle out of the water through sedimentation or can be removed by filtration	removal 3. Cost-effectiveness 4. Supports Sustainable practices **5.** Enhanced Downstream processes

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