

Sustainable Fertilizer Production from Fish Processing Waste: A Waste-to-Value Approach

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Abstract

Fish processing generates enormous amounts of both liquid and solid waste, including fish heads, viscera, skin, and carcasses. Both the ecosystem and the people who live nearby are at risk when these wastes are left unattended. Fish waste has a high amount of organic matter, which raises the efficiency of water bodies and creates pollution. This raises concerns about environmental degradation, especially in aquatic habitats. However, if these materials remain left over or improperly disposed of, they create an unpleasant stench that makes it difficult for people to live nearby. Fish waste can however, be used in a successful substitute approach that reduces ecological strain and allows for proper disposal. Conversion of fish processing waste to organic fertilizer and manure. Manure and fertilizer can be produced using fish bodily waste. Fish waste is a major source of potassium, phosphorus and nitrogen, which are essential elements for crop growth. Also, for soils having low calcium levels, they might be a valuable supply of calcium. High levels of nitrogen, phosphorus and Calcium as well as important minerals are commonly found in fish-based fertilizers.

Key words – Fish Waste, Manure, Fertilizer, Composting, Environment pollution.

Introduction

Fish processing generates significant amounts of waste, including scales, roe/eggs, heads, flesh trimmings, viscera, skin and fats. It has been estimated that only 45% of the total fish weight constitutes edible meat, while the remaining 55% consists of non-edible parts: head (22%), bones (12%), skin (3%), trimmings (4%) and viscera (12%), which includes organs such as the liver, eggs, and milt (DoF, 2014). The industry that processes fish produces a lot of solid waste, by-catch and wastewater, which increases the risk of environmental problems. Microorganisms have played a crucial role in the decomposition and stabilization of organic materials since the origin of life on Earth. Composting is a natural biological process that facilitates the proper management, recycling and safe disposal of organic waste. The final

product of this process known as compost. Compost is a nutrient-rich material that can be utilized in agriculture (Pradip, 2016).

Fish waste contains essential nutrients, including calcium, potassium and nitrogen, which can be repurposed for organic farming. Composting fish waste is a cost-effective and environmentally friendly waste management strategy that prevents the spread of pathogens transmitted by insect larvae and vectors. Fish waste is highly biodegradable and serves as an excellent raw material for composting due to its rich organic content. However, improper handling of fish waste can result in strong Odors, attracting insects and potentially leading to health hazards. This waste includes fish heads, flesh remnants, intestines, fins and tails, all of which decompose rapidly and require proper management to minimize environmental impact. (Dhar *et al.* 2024)

Globally, approximately 20 million tons of fish representing 25% of the marine fishery production are discarded annually (Kim and Mendis, 2006). Additionally, the fish processing industry contributes significantly to waste generation, with estimates indicating that up to 75% of the total processed fish volume is discarded as waste (Olsen *et al.*, 2014). In shrimp processing, waste is composed of 28.6% shell and 71.4% head (Meyers, 1986). Despite having a protein content comparable to that of fish meat, fish waste is primarily used for fishmeal production (Mo *et al.*, 2018).

Compared to other disposal methods, composting presents a sustainable and economically viable solution for fish waste management. Fish waste-based fertilizers enhance soil fertility by enriching it with organic matter and essential nutrients, controlling certain plant diseases, suppressing parasites, and eliminating weed seeds. The application of fish compost in agriculture improves soil moisture retention and enhances crop productivity in fields, farms, gardens and tree plantations. (Jaies *et al.*, 2024) Additionally fish-based fertilizers facilitate nutrient recycling from aquatic to terrestrial ecosystems. Several commercially available fishmeal-based fertilizers have been developed, many of which are suitable for organic farming practices. Composting fish waste not only reduces environmental pollution but also promotes sustainable waste management practices in the fishing industry.

Recycling of Fish Waste to Produce Organic Fertilizer

Recycling of fish processing waste to development of organic fertilizer following procedure is describe in briefly below:

Fish dealers can prepare a single pit to allow this garbage to break down; all you have to do is pay attention until the process begins. The first layer should be prepared with fish waste,

it includes waste organs such as the liver, kidneys, air bladder, testicular tissue, ovary, scales, fins, gills and digestive system. The following layer should be sawdust or another wood product as a carbon source. Since the microorganisms that carry out the breakdown process require humidity, watering is one of the most crucial composition process requirements. A shade Temperature is another important consideration in the decomposition process and the pit requires shade to prevent dry. It is necessary to prevent the pit from becoming dry and temperature is another important aspect in the decomposition process. The breakdown process also requires proper aeration. Phosphate- solubilizing bacteria (PSB), *Bacillus*, *Azotobacter* and *Rhizobium* are a few examples of useful bacteria for a quick breakdown process. Other garden garbage and food refuse can be thrown out in a pit. To ensure proper aeration, all layers should be mixed after a month. Until the fertilizer is ready. this procedure should be carried out every fifteen days. You have to watch the pit once a month. A high-quality fertilizer could be produced in 180 days (Balkhande, 2020). After fertilizer manufacturing, a sample should be sent to any laboratory for examination of NPK and other micronutrients after being filtered through mesh.

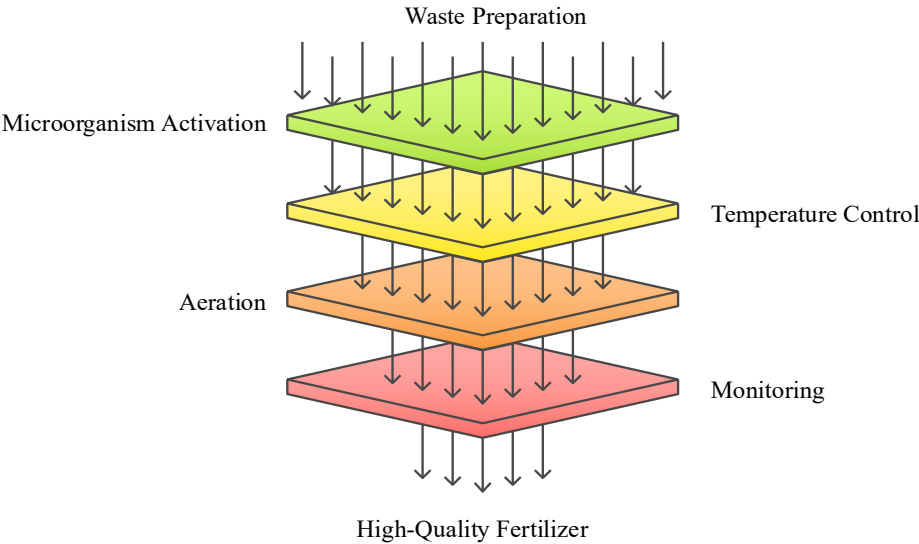
In poultry industries alternative method (vermicomposting) is use for conversion of poultry waste as organic fertilizer development. Vermicomposting is a process uses earthworm, particularly *Eisenia fetida* to break down organic waste. worms are fed poultry dung that has been pre- composted. (Garg *et al.*,2006).

Fish Processing Waste



Fig.1 Fish compost

Composting Process Funnel



Proximate Composition of Fish Waste

The ingredients of protein from crude protein, the moisture, ether the extract, crude ash-like material crude fibre and nitrogen -free extract are used in the food sector. Will be referred to as the "proximate composition" and are represented as the feed's percentages.

Table 1. Proximate composition of fish waste

S.No.	Component	Percentage
1	Nitrogen-free extract	0.38 ± 0.06%
2	Moisture	77.09 ± 0.14%
3	Ash	3.30 ± 0.11%
4	Fat	4.03 ± 0.07%
5	Protein	15.20 ± 0.15%

Source - (palkar *et al.*, 2018)

Application of Fish Waste as Manure or Fertilizer

Fish manure has many types of nutrients like nitrogen, phosphorus, calcium that nutrient help to the growth of crop in different stage. The three main techniques are seed treatment, foliar spraying, and soil application (Devi *et al.*, 2024).

Use as increasing biological component: Fish waste is aerobically broken-down carbon -rich

material like sawdust, straw, or leaves during the composting process. This process lessens pathogen and odor while stabilizing the organic, matter. A soil change that enhances soil fertility, structure, and microbial activity serves as the resultant fish compost. According to studies, compost made from fish waste can enhance soil biological content and greatly boost crop yield (Tiwari,2023). Fish waste can be digested by enzyme or acids to create fish hydrolysate a from fertilizer that is high in peptides that amino acids, and micronutrient. Because of its quick absorption and ability to promote plant growth, this product is frequently used in organic farming. Additionally, fish hydrolysate increases soil microbial activity, leading to in stronger and healthier plants (Bhuimbar, 2023).

Fertilizer use as enhancing soil fertility: Applying fish fertilizer directly into the soil can be done by fertilization (watering system), broadcasting, or soaking. Long -term soil health is achieved by increasing the number of bacteria and gradually increasing nutrients. Application rate: Usually mixed in water ,2-4 liters per acre. it is best to use it before flowering and early stage of growth. (Devi *et al.*,2024).

Use of fish processing compost for seed treatment: After being planted, seed are immersed in a dilute solution of fish fertilizer. This improves seedling vigor, germination, and early root formation. The quantity of organic matter generated by processing fish, which includes heads, the bones, viscera, skin and scale, can vary from fifty to seventy percent of the fish total weight, depending on the species and processing methods (Ghaly *et al.*, 2013). While this trash has traditionally been thought of as a disposal problem, its high nutrient content makes it a valuable resource that can be used again. Especially in agriculture as fertilizer or compost.

The parts that remain from fish can be reused as basic materials to make organic fertilizer. compost based on fish waste like calcium, magnesium, and potassium. this assures sure the waste product if hygienic, clean, and completely devoid of contamination such phytotoxic chemical and heavy metal (Kinnunen *et al.*,2005). After being composted with crushed grass, fish waste from tilapia beneficiation was investigated as humic acid source to encourage vegetable plant development (Busato *et al.*, 2018).

Table: Fish waste-based fertilizer and bioactive compound

Fish waste type	Source	Bioactive compound	Application in fertilizer	Trade Name /Company
Fish Bones	leftover skeletons after	Calcium, phosphorus,	Processed into bone meal for phosphorus	@ Fish bone meal, @Down

	filleting	collagen	rich fertilizer	to earth fertilizer (USA)
Fish offal	Internal organ (viscera, liver, roe)	Nitrogen, lipid, amino acids	Used in compost or fish emulsion rich in nitrogen	@Neptunes harvest (USA)
Fish scales and skin	Cleaning byproduct	Collagen, trace mineral, Gelatin	Added to compost for texture and collagen enhancement	@Agri Gro (USA)
Fish Head	Whole fish heads after filleting	Protein, omega-3 oils, enzyme	Used in compost and hydrolysate, slow- release organic fertilizer	@Pacific Gro (USA), @Ocenic hydrolyte
Fish sludge	Sediment from fish processing waste water	Organic nitrogen, carbon, trace elements	Dried and pelletized used as slow-release fertilizer	@OMRI-listed Organic Fertilizer
Whole waste fish	Non edible or unsellable fish	Protein, nitrogen, micronutrients	Ground or fermented into liquid fertilizer (emulsion/hydrolysate)	@Bio Fishency Ltd. (Isreal)
Fish oil By- product	Extracted oil remnants from processing	Omega -3 fatty acid, vitamins A and D	Combined with compost with compost or hydrolysate to boost microbial activity	@Fertrell Compony (USA), @ Fish Emulsion 2-4-1

Advantages of Fish Waste as Fertilizer

- The disposal problem is resolved and a workable product is produced by composting.
- Composting reduces contamination at ground and surface water and causes no pollutants.
- Through composting, disease-causing bacteria and fly larvae are reduced.
- One economical method of disposal of fish waste is to compost it.
- There was no unpleasant smell from the fertilizer made from fish excrement.
- Organic manure can be made from fish waste; it may be advantageous to fish vendor and fish farmer who dispose of fish waste.

- When dumping is done correctly, sales can generate income. For organic farmers, one significant source of NPK generation is waste materials.

Some Problems to Using Fish Waste as Manure or Fertilizer:

Since organic fertilizer frequently has low nutritional value, applying it becomes more of a process than an event and a lot of fertilizer is needed to obtain the right dosage of nutrients. Additionally, the mixture is different. Fish waste is an unpleasant and time-consuming operation. Mineralization and the release of nutrients, particularly nitrogen, are examples of slow processes.

Conclusion

The greatest method for getting rid of fish waste and solving the environmental issue is composting. Fish waste is produced in enormous quantities by fish processing facilities. This trash has the power to drastically change an ecosystem's biodiversity and community structure if it is not solved. The fertilizer may easily be converted into fish excrement and fertilizer due to its naturally occurring structure and high levels of phosphorous, nitrogen, and potassium.

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