THE USE OF SILAGE TECHNOLOGY TO REDUCE FISH WASTES AND PROVIDE ADDITIONAL LIVELIHOODS

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A significant amount of raw material is produced as a byproduct of fish processing, much of which is used as low-value fertilisers, animal feed, or simply discarded. In searching for ways to maximise utilisation of fish resources, a simple and inexpensive alternative is to render these fish wastes into nutritious silage. This article[1] discusses studies conducted in Bangladesh, Philippines and Thailand, outlining existing good practices in the production and utilisation of fish silage, thereby providing promising insights in terms of increasing the productivity of the fisheries sector, reducing post-harvest waste, increasing economic value and improving environment sustainability.

Gills and other 'non-utilisable' parts of fresh tuna

Fish processing involves several steps: stunning, grading, slime removal, de-heading, washing, scaling, gutting, cutting of fins, filleting and meat bone separation. During processing, the amount of waste generated ranges from 20 - 80%, depending on the level of processing and type of fish. The residual raw material or processing by-product should not be looked upon as waste but as the raw material for a range of other, new products. With looming food shortages, limited fisheries resources and an increased awareness of sustainability, the full utilisation of all resources is a moral and economic imperative. Some by-products containing meat can be used for human consumption, such as the heads, frames and belly flaps, along with some parts of the viscera, such as the liver and roe. They are good sources of high-quality proteins and lipids, with long-chain omega-3 fatty acids. Furthermore, they are also rich in micronutrients such as vitamin A, vitamin D, several B vitamins, and minerals like iron, zinc, selenium and iodine.

However, as a result of fish processing, a significant amount of the original raw material is not used for direct human consumption and all too often the by-products are regarded as low-value items best used as feed for farmed animals, as fertiliser, or to be discarded.

This unutilised portion can be converted into a variety of products including fishmeal and oil, hydrolysates, fish collagen, fish sauce, fish biodiesel and fish leather. In bigger industrial fish processing units, by-products are usually processed into fishmeal and oil. However, investing in a fishmeal plant is not economically viable in small-scale processing units, unless at least eight tonnes of raw material are available on a daily basis. When this is not the case, preservation of the raw material by acid silage is a simple and inexpensive alternative to ensure that more of the material is utilised as a component in local diets or indirectly as a feed ingredient.

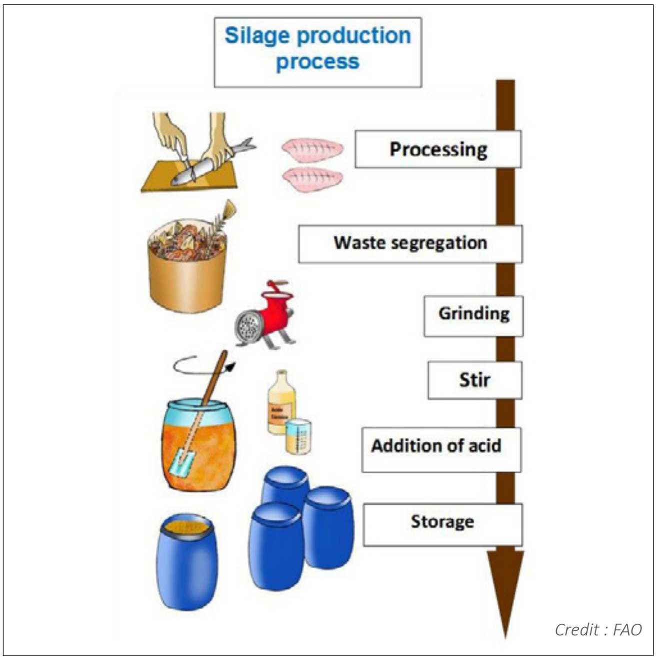
Simple and affordable technology

Fish silage is a liquid product produced from whole fish, or parts thereof. Acids or lactic acid-producing bacteria added to the fish results in the hydrolysis of the mass through the action of natural proteolytic enzymes from the fish itself, especially its viscera. In the process, the fish waste is converted into a liquid mix of hydrolysed proteins, lipids, minerals and other nutrients which is easily digested and absorbed by terrestrial and aquatic animals. The production of fish silage offers economic advantages because it requires simple technology and affordable materials. The silage can be preserved for long periods, even years and since it is liquid, it

[1] *This article is extracted from the recently published FAO Circular report: Islam, J., Yap, E.E.S., Krongpong, L., Toppe, J. and Peñarubia, O.R. 2021. Fish waste management – An assessment of the potential production and utilization of fish silage in Bangladesh, Philippines and Thailand. FAO Fisheries and Aquaculture Circular No. 1216. Rome. (https://doi.org/10.4060/cb3694en)*

can easily be pumped into storage tanks or tanks for transport by road or sea.

There are two known methods of fish silage production, using either fermentation or by adding acid. Fish silage can be produced by fermentation using lactic acid bacteria like *Lactobacillus plantarum* as a starter culture. Acid preservation is a simple and inexpensive way to preserve by-products from processing. Formic acid (typically 2-3% w/w) is considered a good choice since the silage made with it is not excessively acidic (ideally 3.5) and therefore does not require neutralisation before being used. Furthermore, organic acids have antimicrobial and antifungal properties, acting both as bacteriostats and bacteriocides. Temperatures should optimally be between 5 and 40 degrees Celsius.



Fish silage production

Useful as feed or fertiliser

Fish silage is a nutrient-dense product ideal for feed purposes, or for eventual use as a fertiliser. The nutrient composition is, in practice, the same as the raw material used for silage production, and comparable to the nutrient composition of fishmeal on a dry matter basis.

Fish silage could be a valuable feed input for aquaculture, or for chicken, pork and other livestock production. Its use as a feed ingredient or as a protein source has resulted in improved feed intake, better growth and the improvement of some performance indicators in livestock industries. Furthermore, due to its relatively low acidity, fish silage can be fed directly without any prior mixing and treatment; or it can be mixed with dry feed ingredients such as grains and then be given directly to livestock as wet feed. The silage can also be used in pellet production and extruded feeds; in fact, the inclusion of silage often results in extruded pellets being stronger and more resistant than without silage.

Fish silage also reduces the spread of pathogenic microorganisms found in dead fish or fish killed for disease control, owing to the antimicrobial properties of the organic acids. Moreover, the process has been assessed for its potential to reduce Category 2 and Category 3[2] microbial risks for animal by-products of fish origin (as per Regulation (EC) No 1069/2009) when converted into silage.

In addition, the silage may be used as a fertiliser if it does not meet the quality requirements for feed purposes. It is a good source of nitrogen (from the protein), phosphorus, potassium, calcium, and magnesium (particularly from the bone structure) and most trace elements needed for plants.

Studies carried out in three Asian countries

Feasibility studies on the potential production and utilisation of fish silage in selected countries were conducted as a follow-up activity of the FAO Fish Product Safety and Quality project, "Strengthening capacities, policies and national action plans on prudent and responsible use of antimicrobials in fisheries". Data and information were gathered on the following parameters:

- Volume (in tonnes) and value (in USD) of fish waste generated in the country;
- Existing technology used in fish waste processing and utilisation;
- Social, economic, environmental and technical impact of existing fish waste utilisation;
- Presence of fish silage technology;
- Awareness of fish silage technology;
- Potential for the production and utilisation of fish silage technology;
- Potential locations for a pilot testing scheme; and
- Information on how to further improve fish waste management and utilisation.

[2] *Category 2 includes dead and clinically ill fish with outer signs of disease and fish killed for disease control purposes. Category 3 includes animal by-products originating from the slaughtering of fish for human consumption.*

The results provide data that can be used as supporting information when developing future projects and building fish waste management capacity in the fisheries sector.

Bangladesh

In Bangladesh, fish and shrimp are the second most valuable agricultural crop, contributing significantly to the country's gross domestic product (GDP) and total export earnings. Seafood processing industries in Bangladesh produce an estimated 40 796 tonnes of fish and shrimp waste per year. Generally, the seafood waste is sold to local contractors at prices ranging from US$312 to US$1 800 per tonne for shrimp, and from US$250 to US$750 per tonne for fish. Raw and fresh shrimp carapace, as well as the heads and gills of large fish, are sold to local retail markets for consumption while parts of the shrimp shell, appendages, fish scales, air bladders and fins are exported to some Asian countries. A proportion of solid seafood waste is used to feed aquaculture species.


Credit: M Jakiul Islam

Women processing shrimp head meat for household consumption

The prospect of fish silage production constitutes a promising new development for animal feed production in Bangladesh, given that the availability of waste materials from seafood processors – and the demand from feed millers – favour the conditions for silage production. However, in order to flourish, silage industry supply chains, both for seafood waste and its end product (silage) must be established. Moreover, studies on animals' growth performance, muscle quality, and the digestibility of silage-based feeds should be conducted for local farmed species. This will provide the scientific grounds for production, as well as give confidence to silage users.

The Philippines

The total volume of fish production in the Philippines has been decreasing in recent years; however, the value of fishery products still looks promising. There is no reported total amount of fish waste in the Philippines, but it is estimated that approximately 25–30% of the country's total fish production is lost or wasted due to improper post-harvesting.


Credit: Emilia Yap

Tuna bycatch (locally known as ipit) in the General Santos City Fish Port Complex

Fish silage technology can be used in the Philippines to increase the productivity of the fisheries sector, reduce post-harvest waste, promote environment sustainability and reduce pressure on limited wild fisheries. As an efficient way to maximise the utilisation of waste, it would be especially useful in coastal areas of the country, where there are currently no existing waste utilisation facilities. However, critical adjustments have to be made, since the small-scale processors are the targeted beneficiaries in these communities. Batch fish silage processing should be considered for study for these processors, wherein multiple tanks can be filled up with waste and processed one at a time. Careful, detailed planning is therefore required on how to set up the fish silage facility and its processing schedule. The results from these studies may help to enhance the awareness of fish silage technology in the communities concerned, increase the marketability of fish silage in fishing communities and elsewhere, and encourage the maximum utilisation of waste in the country.

Thailand

Thailand has successfully developed its fishery industry and become one of the world's largest fishery exporters, with fish products currently making up about 20% of total Thai food product exports. Major seafood exports in 2017 included canned tuna, processed shrimp/prawns, processed squid/cuttlefish and canned sardines.

There are two major categories in the processed fish industry in Thailand, namely: frozen seafood factories and processed (cooked/canned) seafood factories. During the processing of fishery products, waste occurs in the form of wastewater and solid waste. The solid waste consists primarily of the head and guts, bone and meat scraps, blood, and whole rejected fish; these make up 75%, 16%, 6% and 3% of the total, respectively. The process of tuna canning in Thailand is able to turn waste into fishmeal, fish and bone meal, fish hydrolysate and fish solubles. Surimi processing companies can process large amounts of trimming waste into fishmeal as its main product.

Therefore generally, fish waste management from the seafood industry is well organised in Thailand; unfortunately, its implementation and utilisation in the small-scale sector is more limited.

The highest proportion of waste is snakehead fish waste, made up of the heads and bones, followed by the viscera and scales. Heads, bones, viscera and gonads are sold for local consumption. Tilapia waste is usually composed of fresh heads and bones, the viscera and scales; while the viscera are normally discarded, the heads and bones are utilised as fresh animal feed and the scales are collected and sold for collagen production. Catfish waste is mainly utilised as a liquid fertiliser for vegetable and paddy fields. Fish oil is also produced from the catfish viscera.

Direct disposal of fish and shrimp wastes negatively affects water quality and creates visual pollution

Small communities are interested in fish silage production for animal feed as it constitutes a highly valuable product with no harmful and foul odours, and requires reduced labour and operation periods. However, sufficient hands-on training covering the main principles of fish silage production as well as the storage of fish silage and its utilisation, is needed as a further activity.

Conclusion and recommendations

The studies conducted in Bangladesh, the Philippines and Thailand have identified the types of processing waste and by-products generated in each country. Fish waste management is particularly being practised by large and industrial processors, where the waste is often converted into fish oil and fishmeal. However, it is rarely practised in the small-scale sector due to a lack of economic resources, knowledge and skills, as well as the necessary facilities to convert processing waste into valuable products. Aside from the missed economic opportunities, the improper discarding of fish waste can also result in environment pollution.

The use of fish silage technology and the role of organic acids has not been documented in these countries but the results of the above studies reveal an interest among the fishing communities selected to further explore this technology. However, before it is introduced, a more detailed study should be conducted, including the availability of raw materials; collection and storage of raw materials; availability and use of the acid required; availability of facilities and equipment; and the potential market and demand for the produced fish silage. These factors play an important role in developing a pilot scheme and introducing fish silage technology in these countries. The success of the pilot will provide the basis for the technology to be replicated in other communities across the three countries.

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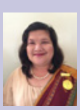

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