Fish By-Catch ... Bonus From The Sea
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Fish By-Catch... Bonus from the Sea

Report of a Technical Consultation on Shrimp By-Catch Utilization held in Georgetown, Guyana, 27–30 October 1981

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Processing of By-Catch into Frozen Minced Blocks (Surimi) and Jelly Products

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By-catch fish from shrimp trawling were used for pilot-scale production of frozen surimi and fish-jelly products. The technology developed was then transferred to fish processors and fish technologists in Southeast Asia through demonstrations and training courses.

A major portion of the catch by fish and shrimp trawlers operating in the Southeast Asian region comprises fish species classified as by-catch that are discarded at sea or converted to animal feed. A considerable increase in by-catch has been reported from most Southeast Asian countries in recent years, ranging from 40% to 70% of the total fish catch (JICA 1978). An estimated $5 \times 10^6$ t of fish by-catch are discarded at sea in the tropics (Allsopp 1977), and more than $10^6$ t were caught in the South China Sea area alone in 1978 (SEAFDEC 1980).

With the reported increase in the amounts of the by-catch and the alarming estimates of discards at sea, the problem of using this resource for human consumption is of immediate concern for the region and is the basis for a project undertaken by the Marine Fisheries Research Department of the Southeast Asian Fisheries Development Center. The major thrust of the project includes pilot-scale production of frozen minced blocks (surimi), production of traditional fish-jelly products of the region, and basic studies on the gel-forming ability of common species in the by-catch. In addition, nonjellied products such as fish fingers have been investigated.

Method

Fish by-catches from commercial trawlers in the South China Sea were purchased from the local fish market in chilled form and were placed in ice water as soon as they were brought to the laboratory. They would normally have been used for livestock and fish feed and for conversion into fish meal; therefore, much of the material had not been satisfactorily iced, the degree of freshness varying according to whether the fish were caught at the beginning or end of the fishing trip, which usually lasts 3–5 days. The fish were purchased at a contract price of S$0.50/kg, including transport and delivery charges. The market price, however, fluctuates according to the supply, with an average of about S$0.30/kg (without delivery).

Although the by-catch of the area comprises at least 100 species, the major components are goatfish (Mullidae), croaker (Sciaenidae), threadfin breams (Nemipteridae), lizard fish (Synodontidae), silver biddy (Gerridae), ponyfish (Leiognathidae), and Parapercidae, together constituting about 80% of the total weight (Sinoda et al. 1978). Despite the variations in species composition and amount according to season, locality, degree of sorting on the vessel, etc., a significant portion of the fish may be used for human consumption.

One of the limitations on the use of the by-catch is that the fish are small and difficult to head and clean. In countries where labour is cheap, the operations can be done by hand, but, for handling in bulk in other areas, mechanical heading and gutting would be necessary.

The Marine Fisheries Research Department, therefore, tested the use of a modified fish heading–filleting machine. The machine, which can be used for fish ranging from 30 g to 200 g can reduce the time for heading and gutting by half.

The use of a mechanical flesh-and-bone separator appears essential for bulk handling of by-catch as raw material, especially in
areas where labour is costly. With the use of this equipment, a yield of mince at about 35% (by weight of whole fish) can be obtained from the by-catch. The mince, however, is usually dark red because of blood and kidney tissues that have not been completely removed during gutting.

This mince must be treated further. One method to improve it is washing. It was found that, when the mince was washed twice with 4–5 times its volume of iced water (w/w), first with 0.2% salt and then with 0.3% salt, the leaching confers several advantages; it:

- Gives the flesh a higher gel-strength potential, by removing the undesirable components that interfere with gel formation;
- Whitens the product;
- Removes the fishy odour — taste can then be adjusted to suit local preferences through the addition of, for example, monosodium glutamate, spices, taste enhancers, etc.; and
- With addition of sugar, enables the mince to be frozen and stored for an increased period.

When the mince has settled, the excess water is discarded, and further dewatering can be achieved by hydraulic or screw press or by centrifugation. For the hydraulic press, the mince is placed in a nylon mesh bag and subjected to pressure of 14 kg/cm² for about 10 minutes. Basically, the equipment can be a hand-operated press, oil-compression press, lever system, or even a modified car jack. This system is basically a batch process and is usually slow but suitable for small-scale manufacturers. The screw press is more expensive and sophisticated; it forces the mince forward as the water oozes out through the fine mesh along the sides. The mince is finally extruded quite dry at the end. This is a continuous method and is suitable for large-scale production or for surimi manufacturers. Centrifugation is essentially a batch process. Dewatering occurs when the mixture is spun at 2000–3000 rpm for about 10 minutes. This method is efficient and is suitable for small to medium-sized manufacturers. Depending on the method of dewatering and adjustment of the machinery, the moisture of the final material is about 80–82%.

In Japan, the conventional technique to reduce denaturation of surimi during freezing and storage is to add 8–10% sugar and 0.2% polyphosphate to the leached mince (Tanikawa et al. 1969). Under pilot-scale conditions, leached mince from by-catch (with 3% sugar and 0.2% polyphosphate) has been kept for at least 6 months at -25° to -30°C in the Department. It is, therefore, possible to use less sugar (3%) than was previously felt necessary for surimi made from tropical fish species. This finding is important in Southeast Asia where consumers are not familiar with sweet fish-jelly products. For shorter periods of storage, the leached mince can be kept chilled in ice or partially frozen (ice/salt mixture at -3°C).

**Processing of Frozen Surimi into Jelly Products**

The leached mince in either the fresh or the frozen (surimi) form has been used by the Department for making a wide range of jelly products. In the Southeast Asian region, the most popular traditional fish-jelly products are fish balls and fish cakes. With the increase in price of raw materials used traditionally for these products, the fish-jelly product industry has to utilize other fish. The introduction of leached mince from by-catch and low market-value fish as a substitute raw material will provide impetus to the development of the industry in the region, as well as increasing the utilization of an abundant resource for human consumption.

The Department has successfully produced, on a pilot scale, fish balls and fish cakes from surimi made from by-catch. The products are white and of high quality with good ashi (elasticity). Evaluation studies through trial sales at a local supermarket showed that the products were widely accepted by local consumers. In addition, the technology developed has also been transferred to manufacturers, fish technologists, and extension officers in the region. The Department has already received several requests for technical assistance from both commercial and government organizations.

**Processing**

The blocks of frozen surimi were kept overnight in a chilled room and then ground with other ingredients in a cooled mortar-and-pestle grinder for about 25 minutes. The other ingredients included salt (2.5–3%), flour (wheat, potato, or cassava — 3%), monosodium glutamate (0.5%), and water (20–80%, the amount depending on the moisture
and quality of the surimi). The paste was then formed into the products by machines for making fish balls, fish cakes, fish rolls, etc., although these products can also be formed by hand. The products were then “set” in tap water (28–30°C) for 2 hours or 40°C for 20–40 minutes, before finally being cooked at 90–95°C for 20 minutes.

**Basic Concepts of the Project**

In initiating the project on the utilization of by-catch as a raw material for the production of traditional fish-jelly products in Southeast Asia, the Research Department has introduced several basic technological concepts:

- **Leaching of mince**, which is one of the most important steps in the production of fish-jelly products; washing eliminates the components that interfere with gel formation and makes it possible to utilize not only a wider range of fish species but also raw materials that are not fresh. Cheap and abundant fish resources can now be processed into fresh or frozen mince for the production of good quality fish-jelly products (Poon et al. 1981).
- **Use of frozen surimi** as an intermediate product; frozen surimi has been widely used in Japan for the manufacture of fish-jelly products (kamaboko) from an abundant and underutilized fish resource, Alaska pollack (Matsumoto 1978). The production of frozen surimi in Southeast Asia, as an intermediate product, can help stabilize the availability of raw materials for the fish-jelly products industry; provide the basis for centralization of treatment of raw materials (including problems of waste discharge and disposal); increase utilization of by-catch mince, even as meat extenders in sausages, burgers, etc.; aid in the development of new products; be useful in areas where seasonal abundance of some low-value fish species gives rise to problems in utilization and preservation; and give manufacturers greater flexibility in production and process planning.
- **Double-step heating** of the products; determining the optimum conditions (temperature and time) for “setting” are important if the potential gel strength of the raw material is to be realized. This is especially important because the proteins of tropical fish behave rather differently from those of temperate fish species. Traditionally, the products are soaked in tap water (28–30°C) for 2–3 hours before being boiled or fried; however, the time can be reduced to 20–40 minutes at a temperature of 40°C. An understanding of the setting conditions of the different species is, therefore, necessary for greater flexibility in production and process control.

**Training and Transfer of Technology**

One of the primary functions of the Department is to transfer technology to fish technologists and processors in the region. This is done through training and lecture-cum-demonstration courses.

Since August 1980, the Department has conducted four short-term training courses for fish technologists from Southeast Asia. Participants included technologists involved in research in fish processing, product development, and extension services. So far, 24 participants from Thailand, the Philippines, Malaysia, Singapore, and Brunei have completed the courses. The courses covered, among other subjects, the basic principles of processing fish-jelly products, principles of gel formation of fish flesh, and practical sessions on processing of frozen surimi and fish balls and cakes. Assessment of fish-jelly products and fish freshness was also included.

The main objective of other, lecture-cum-demonstration, courses is the extension of the technology suitable for upgrading of the fish-ball and fish-cake industry in the region. The Department organized four such courses, of which one was for processors from Southeast Asian countries. The courses dealt mainly with the technology for utilizing low-value demersal fish for the manufacture of fish-jelly products and their intermediate products, covering:

- The effect of proper leaching of mince to improve the gel strength and colour of the product;
- The effect of double-step heating in production of fish-jelly products and the importance of correct temperature and time;
- The rationale for utilizing surimi (frozen blocks of mince made from underutilized
fish) and its production and preservation;  
- Formulation and production of a range of  
  fish-jelly products from underutilized fish  
  and frozen surimi; and  
- Demonstration of fish-processing equip-  
  ment for the production of surimi and fish-  
  jelly products.

Of the total participants, 116 were local and 17 were from Malaysia, Thailand, and the Philippines. The demonstration provided the manufacturers with the opportunity to compare and discuss processing methods and equipment and to assess the applicability of the technology to local conditions. As a result, the Department has now established close rapport with local manufacturers and has received a number of requests for technical assistance and guidance. Local factories are visited periodically by officers from the Department to deal with specific problems and to monitor and assist in efforts to incorporate the technology. Already, one small producer has successfully begun producing fish-jelly products such as fish balls and cakes from small demersal fish using technology developed by the Department.