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*Head and gut fish, separate flesh from the skeletons, wash and dewater, strain, and add flavoring. That is the simplified recipe for . . .*

# Surimi—A Semi-Processed Wet Fish Protein

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## ABSTRACT

*The development of the technology for preparing surimi, a semi-processed wet fish protein, was responsible for the rapid increase in the production of "Kamaboko"-type products in Japan. By being processed into surimi, the fish muscle proteins retain for a longer time the functional properties required for making good "Kāmaboko" and fish sausages. The preparation procedure and factors affecting the quality of surimi are described.*


## INTRODUCTION

In the preceding paper on "Kamaboko", the rapid increase in the production of "Kamaboko"-type products in Japan to over 1 million metric tons in 1970 was cited. This increase was made possible to a large extent by Japanese fishery scientists who developed the technology for preparing surimi, a semi-processed wet fish protein. In preparing surimi, the initial process steps are identical to those for preparing "Kamaboko": heading, gutting, and washing the flesh; separating the fish muscle from skin and bones; washing and dewatering the minced muscle; and straining. In the final process step, the strained muscle is mixed with various additives to stabilize the fish proteins during frozen storage. This mixture is packaged and frozen into rectangular surimi blocks.

The muscle proteins of many species of fish lose their "Kamaboko"-forming properties very rapidly once they are frozen. However, when the muscle is processed into surimi before freezing, the muscle proteins retain for a significantly longer time the functional properties required for making high quality "Kamaboko" and fish sausages. Until the procedure for making surimi was developed, the production of each "Kamaboko" processing plant was limited by the amount of fish muscle it could obtain from fresh fish. Now, "Kamaboko" processing plants can stockpile their raw material to assure full-scale production throughout the year. The surimi plants, which have been built in ports close to the fishing grounds, are mechanized for the efficient handling and processing of the fish into surimi. The compact frozen surimi block as a ready-to-use intermediate raw material is more economical for shipping to and storing at the "Kamaboko" plants in the larger cities than are whole fish.

The frozen surimi industry started in the northern Japanese island of Hokkaido on a small scale in 1960 but expanded greatly when equipment to produce surimi was installed aboard factory ships operating in the North Pacific and Bering Sea (Sakai, 1969). The production of surimi was 87,000 metric tons in 1967 and increased to 292,000 metric tons by 1970 (Zaidan Hojin Norin Tokei Kyokai, 1971). Of the 1970 production, the shore plants in Hokkaido and the Tohoku district in northern Honshu produced 153,000 metric tons of surimi and factory ships produced 139,000 metric tons, primarily in the Bering Sea.

## PROCEDURE FOR MAKING SURIMI

The procedure for making surimi from Alaska pollock in a typical modern processing plant is described below.

### Heading and Gutting Fish

Alaska pollock are headed and gutted by machine. Complete removal of the viscera, spine, and black peritoneum is required to produce a high quality finished product. The fish are taken by conveyor to a drum-type washer to remove slime, scales, blood, bits of viscera, and other extraneous material.

### Separation of Flesh

From the washer, the headed-and-gutted fish are taken by conveyor to the first flesh-separator machine. There the fish pass between a press and a perforated drum. The relatively soft muscle is forced through the holes to the

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inside of the drum. The bones, skin, and adhering flesh remain on the outside of the drum and are scraped off onto a conveyor belt. This "waste" material from the first flesh separator is conveyed to the second flesh-separator machine, which effectively completes the separation of muscle from skin and bones. The minced flesh from the flesh separators is conveyed to a slurry tank where it is mixed with about an equal weight of water and pumped to flesh-washing tanks.

### Washing and Dewatering the Minced Flesh

At the washing tanks, chilled water is added to the slurry at a ratio of five to ten parts of water to one part, by weight, of flesh and gently stirred to leach out blood, flesh pigments, and other water-soluble constituents as well as to float out much of the oil. The flesh is partially dewatered as it is conveyed through a rotary sieve. The washing step may be repeated several times as required. Because of the limited supply of fresh water, on factory ships the flesh-water ratio is 1:4 and only a single wash is used. The time of immersion and of stirring is automatically controlled. The washed minced flesh is then passed through a screw press for final dewatering. The pitch of the flights progressively increases toward the discharge end to increase pressure, and thus the water is gradually pressed from the minced flesh and passes through small holes in the jacket of the press. The desired water content of the dewatered flesh is about 84-86 percent.

### Straining the Flesh

The minced flesh is then fed through a flesh strainer which removes small bones, connective tissue, black skin particles, scales, and tendons.

### Mixing With Additives

The strained flesh is mixed in a food mixer or silent cutter with additives that retard denaturation of the fish protein during frozen storage. Nishiya (1963) showed that leaching the flesh with water to remove inorganic substances and water-soluble proteins, followed by the addition of sodium tripolyphosphate and sugars (sucrose, glucose, or sorbitol) inhibits the rate of denaturation of the proteins. Sucrose or sorbitol is added to surimi used in high-quality "Kamaboko" that requires white color. Glucose, which is less expensive, is added to lower grade surimi, which is used in fish sausage because the browning owing to the amino-carbonyl reaction is not an important factor in sausages. Thus, 5 percent sugar and 0.2 percent tripolyphosphate by weight of the minced flesh are added and mixed for 5-10 minutes until uniformly distributed. The temperature of the mixture must be kept below 50°F (10°C).

**Table 1.—Grades for Alaska pollock (*Theragra chalcogramma*) surimi established by the Hokkaido Surimi Association in 1965.**

| Grades | Freshness of fish | Moisture content of washed flesh | Additives used: Sugar (sucrose) | Sorbitol | Glucose | Poly-phosphate | Amount of starch used in "Kamaboko" prepared for folding test[1] |
|---|---|---|---|---|---|---|---|
| | | Percent | | | | | |
| SA (Special Grade A) | Day boat fish in rigor | 79 | — | 5 | — | 0.2 | 0 |
| A | Day boat fish post rigor | 80 | 5 | — | — | 0.2 | 3 |
| | | | — | 5 | — | 0.2 | |
| | | | — | — | 5 | 0.2 | |
| B | 1- to 3-day iced fish | 82 | 5 | — | — | 0.2 | 7 |
| | | | — | — | 5 | 0.2 | |
| C | 3- to 4-day iced fish | 83 | 5 | — | — | 0.2 | 10 |
| | | | — | — | 5 | 0.2 | |

[1] Folding test: Surimi is processed into kamaboko with 3 percent NaCl and the indicated amount of starch; no cracks or breaks are permitted when pieces of kamaboko 30 mm diameter by 3 mm thick are folded into quarters.

### Packaging and Freezing

Surimi is packed in 10-kg units in both polyethylene bags and in frozen food cartons and frozen in horizontal plate freezers. After freezing, they are packed two blocks per master carton. Surimi should be stored at 0°F or lower since its storage life depends on storage temperatures. For example, the storage life of Alaska pollock surimi at 14°F (−10°C) is about 2 months but at −4°F (−20°C) is about 1 year (Iwata et al., 1971).

## DIFFERENT GRADES OF SURIMI

Processors have formed associations that establish quality standards for the various commercial grades of surimi and issue grade certificates for products meeting these standards.

There are three grades for surimi processed at sea and four grades for surimi processed by the shore plants. For example, the four grades for Alaska pollock surimi established by the Hokkaido Surimi Association in 1965 are given in Table 1. The grade of surimi is dependent upon the freshness of the fish used. In addition, the surimi must make a "Kamaboko" that passes the folding test (see Table 1) in order to qualify for a grade certificate. In making the "Kamaboko" for the folding tests, varying amounts of starch are added (see Table 1). These amounts depend upon the potential grade of the surimi, which in turn depends on the freshness of the fish. Also, a higher moisture content for the washed flesh is permitted as the amount of starch used is increased. Other objective quality tests that may be used include measurement for resilience, pH, and whiteness.

## U.S. INTEREST IN PRODUCING SURIMI

In view of the continuing high Japanese demand for surimi to be used in "Kamaboko", fish sausage and ham, and the prospects of relaxation of import restrictions by Japan, interest has been expressed by some fisheries groups in the potential of producing surimi in the United States for export. Some of the factors that should be considered by interested groups from the technical aspects of producing surimi have been given in this paper and in the preceding paper on "Kamaboko". Factors for initial consideration are summarized here.

### Fish Raw Material

The inherent "Kamaboko"-forming capability (elastic characteristic or gel-forming capacity) of fish muscle proteins varies from species to species as does the rate of loss of this "Kamaboko"-forming capability during iced storage of the fish. For a given species, factors such as freshness of the fish, age and sexual maturity, season, area of catch, etc., may affect its "Kamaboko"-forming capability. Thus, each species must be tested for its suitability. For economical processing, the fish must be available in abundant quantities throughout a long season.

### Processing Equipment

Commercial equipment available for surimi production includes flesh separators, washers, dewaterers, and strainers. Heading-and-gutting machines have been designed and are available for such species as Alaska pollock, now used for surimi production. All unwanted soft material (i.e., kidney, bits of viscera, dark membrane lining the visceral cavity) that could be separated from skin and bone together with the fish muscle must be removed before the fish is passed through the flesh separator. For example, the Japanese have developed machines that remove the Alaska pollock's belly flaps, which are lined with a black peritoneum, and the backbone. Similarly, any species suitable for surimi production must lend itself to rapid and economical heading, gutting, and removal of soft extraneous material.

### Quality Standards

To produce surimi that meets the quality standards now used by the Japanese surimi manufacturers' association will require close quality control. High standards of sanitation are required throughout the processing plant owing to the opportunity for bacterial contamination of the minced fish muscle during the various processing steps and because final "Kamaboko"-type products have only a limited shelf life. The Japanese have demonstrated that a high quality surimi can be produced by using good manufacturing practices.

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