MINCED FISH TECHNOLOGY AND ITS POTENTIAL FOR DEVELOPING COUNTRIES

by

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Abstract

Since the development of 'frozen mince' (reito surimi) from Alaska pollack in 1959, there has been a remarkable increase in the catch of this North Pacific fish, resulting in a supply of three million tonnes of fish per year to the Japanese market. The frozen mince technique is based on the prevention of denaturation, during freezing, of the fish actomyosin by the removal of albumins and inorganic salts and by the addition of sucrose and polyphosphates.

Based on a fundamental study of frozen fish mince, the author and his colleagues have proposed some twenty new cryoprotective additive compounds, among which glutamate and aspartate have the greatest effect. These compounds can also modify the eating quality of cooked products.

These results, together with the technical success of fish mince and a proposal for another new technique, illustrate the potential for products developed from fish mince in many areas of the world.

INTRODUCTION

The success of the frozen surimi (frozen mince or reito surimi) industry in Japan presents an example of the successful development of an unutilized food resource by introducing an original technique.

This paper deals with a profile of the frozen surimi industry, its scientific background and an analysis of the conditions which were instrumental to success.

FROZEN SURIMI INDUSTRY

History

In spite of the continuous demand for fish and of the intense fishing activity in Japan, the Alaska pollack, *Theragra chalcogramma,* caught in the northern waters of this country, was not attractive to the fishermen until 1960 because the fish had little commercial value. Alaska pollack meat was not only unpalatable but was also a poor material for processing into any kind of conventional food. It was used for dried fish or fishmeal. The meat could not be processed into kamaboko (a popular Japanese fish jelly), when it was ice-stored for more than 2 days after capture. Conventional frozen storage also damages the processing quality.

In 1959, a new technique was proposed by a group of scientists headed by K. Nishiya (Nishiya *et al.* 1959, 1961; Nishiya, 1963). With this technique, the problems of frozen storage of the susceptible Alaska pollack meat were overcome and the product, frozen surimi, could be processed successfully into a kamaboko jelly which has excellent jelly strength and eating equalities. This success stimulated the market and the catch of Alaska pollack increased annually.

Until that time, the kamaboko industry had suffered a shortage of raw material in spite of the increasing demand by the consumers; the supply of the new material was, therefore, welcomed by kamaboko manufacturers.

The major concerns in the fishing industry took up the challenge in developing the North Pacific resources, dispatched their factory ships with on-board frozen surimi plants and, until 1976, brought back every year 1 million tonnes of fish. They are now subject to a limit imposed by the coastal countries.

From Table 1 it is seen that the increase in the catch and in kamaboko production is apparently triggered by the growth in the production of frozen surimi. In 1973, the total catch was 3 million tonnes and production of frozen surimi was 380 000 tonnes. This indicates that an extra 100 000 tonnes of animal protein was added to the Japanese food basket; it represented 900 g protein *per caput* per year or 2.4 g protein *per caput* per day. The introduction of this new technique has provided a means of utilizing a huge marine resource, which nobody had cared about previously, as a food for the people and has also resulted in a great deal of profit and income to the people engaged in Alaska pollack fishing and kamaboko processing. Sales of frozen surimi in 1973 are estimated to be as high as Yen 100 billion (U.S.$ 400 million).

Table 1

Catch of Alaska pollack and production of frozen surimi and kamabokos (thousands of tonnes)

Year	Alaska pollack	Frozen surimi	Kamabokos	Note
1955	231		306.7	
1956	235		369.6	
1957	281		434.4	
1958	279		436.6	
1959	343		476.3	Proposal of frozen surimi
1960	354	0.25	509.4	
1961	390	2.5	573.4	
1962	452	4.5	649.6	
1963	531	9.3	688.1	Patent registered
1964	683	18.1	734.6	
1965	690	31.8	797.2	Beginning of on-board production
1966	774	43.0	895.1	
1967	1 247	84.1	912.0	
1968	1 606	144.6	999.4	
1969	1 944	196.4	1 077.2	
1970	2 347	261.3	1 081.3	
1971	2 707	324.0)	1 127.1	
1972	3 035	359.0) a/	1 156.2	
1973	3 021	381.0)	1 185.1	
1974	2 856	384.0	1 148.7	
1975	2 677	360.8	1 155.0	

Statistics of Ministry of Agriculture and Forestry, Japan

a/ Estimated figure

Description of the technique

The process for preparing frozen surimi is illustrated in Table 2. The whole process is simple and the additives used are all popular and harmless.

For processing into kamabokos, the frozen surimi is thawed and 2 to 4 percent common salt added with some taste improvers. It is ground or minced, cast into pieces and then heated, resulting in an elastic jelly. If the proteins in the raw material are denatured in freezing, an elastic, smooth jelly is not produced. With the above method the proteins are, however, well preserved from denaturation. For as long as one year in cold storage below −20°C, they give kamaboko jellies with excellent quality

Table 2

Major processes of frozen Surimi technique

	Operation	Equipment
1.	Dressing	None (manual)
2.	Removal of skin and bones	)
3.	Mincing of meat	) Deboning machine
4.	Washing of meat with water (2-3 times)	Washing tank and revolving sieve 1/. 4/
5.	Removal of connective tissues	Revolving press sieve
6.	Reduction and adjustment of moisture content	Revolving press squeezer 4/
7.	Addition of stabilizer 2/ 10 percent sucrose +02–0.5 percent polyphosphate	Mixing tank
8.	Packing	Packer 3/
9.	Freezing and frozen storage	Freezer (either shelf or contact plate)

1/ Three sets of a washing tank and a revolving sieve are lined up in successive series

2/ Ten percent sucrose may be substituted by either five percent sucrose plus five percent sorbitol or ten percent sorbitol

3/ The mince (surimi) is rolled out into a 10 kg flat block and wrapped with film

4/ The revolving sieve and the revolving press squeezer are machines originally designed for improvement of the frozen surimi technique

Scientific background of frozen surimi

The studies of many research workers, including Nishiya's group, have resulted in the successful prevention of the freeze denaturation of fish proteins in frozen surimi. This success has been attributed to the following three effects:

(a) Removal of inorganic salts from the fish muscle
(b) Removal of albumins or water-soluble proteins
(c) Preventive effect of the additive compounds on the freeze denaturation of the fish muscle proteins (actomyosin).

Experimental analyses of the processes have proved that the washing process (Table 2) is responsible for the first and the second affects (Takada, 1971; Okada, 1964); the third effect is due to the added sucrose, sorbitol and polyphosphates (Tamoto (et al., 1961; Arai, 1971).

Extensive studies (Noguchi and Matsumoto, 1970, 1971, 1975 a, b, c, 1976; Matsumoto, 1971) have shown that the preventive effect on the freeze denaturation of the fish muscle proteins is not only caused by sucrose, sorbitol and polyphosphates, but is related to a number of Biochemical compounds. Compounds including amino acids, hydroxylic acids, dicarboxylic acids, pentoses, hexoses, disaccharides, oligosaccharides and polyalcohols were effective in preventing freeze denaturation. The most effective among those tested was Na-glutamate which was effective at a concentration as low as 0.025 mol/1 (0.38 percent of meat).

Physico-chemical studies on parameters, such as solubility, salting-out behavior, viscosity, ultra-centrifugal behaviour and electrophoretic properties have proved that the fish actomyosin was preserved in its native state, when stored frozen with the protective additives. The same effect was shown on the biochemical properties such as ATPase activity, and superprecipitation capacity. Food technological tests on processed kamaboko jellies made from fish mince, stored frozen with Na-glutamate and other additives, were successful. The prevention of freeze denaturation was also proved by electron microscopic studies (Tsuchiya *et al.*, 1975; Oguni *et al.*, 1975).

These results have shown that the frozen surimi technique, which had been based upon the incidental findings of the inventors, is in accordance with current scientific thinking. The results also provide scope for extending the technique to the use of other varieties of fish and to the use of a wider variety of additive compounds, many of which are found in natural living bodies. In addition to preventing freeze denaturation, some of the additives are of use in improving the eating quality of the product, for example, Na-glutamate accelerates the jelly formation of proteins (Noguchi and Matsumoto, 1970).

ANALYSIS OF COMMERCIAL SUCCESS

The conditions which favoured the commercial success of this novel technique can be listed as follows:

(a) Potential market demand. When frozen surimi appeared in the market, the kamaboko industry lacked plentiful supplies of raw material due to the decline of fishing in the East China Sea.

(b) Abundant undeveloped natural resources. In spite of the large size of the stock, Alaska pollack had not been fished efficiently because of its poor quality.

(c) Excellent quality of the new product. Thanks to scientific research, the poor quality of Alaska pollack flesh was given an excellent commercial value by the frozen surimi treatment.

(d) Simplicity of the technique. The technique was simple and safe and did not need any vigorous treatment or dangerous chemicals. Consequently, the equipment was comparatively inexpensive and the technique was extended with little difficulty.

(e) Technical potentiality of food engineering. The frozen surimi industry was aided by equipment improvements, which relied on a favourable technological base in Japan.

(f) Drive and determination of people in Government and industry. This has encouraged investment and the organization of the industry.

These conditions, except possibly item (e), can be found in any part of the world. Equipment can be imported and if capital investment is lacking it may be made available through international cooperation. The essential ingredient is the will of the local technologists. The success of the Japanese frozen surimi industry suggests that there is considerable scope in developing countries for introducing novel fish products.

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