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Surimi Processing Technology

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Abstract: Surimi technology and development of products relying on surimi technology have been carried out by the countries of Far East and Europe as well as the USA since the beginning of 1940's. However, production of food relying on surimi technology has never been operational in Turkey, yet. Surimi technology has developed in aforementioned countries because (1) economically less important species can successfully be converted to a valuable product, (2) shelf life of frozen surimi is long, (3) surimi has a substantial amount of functional protein content, and (4) production of surimi and related products are rather easy when accompanied by various technologies together with the use of additives. Surimi is Japanese term describing wet concentrate of fish muscle protein.

Keywords: Surimi Technology, Additives, Quality, Alaska pollock.

Introduction

Surimi is Japanese term commonly used for minced fish flesh obtained after necessary processing steps. The product known as “Frozen Surimi” is minced fish flesh gone through washing with water, draining the water, mixing thoroughly with sugar and polyphosphate and freezing. Frozen surimi is mainly made from Alaska pollock (*Gadus chalcogrammus*). Kamaboko, nerisehin, chikuwa, hanpen, kanibo, kanikame, naruto, satsuma-age, shio-surimi are fish gel product widely used in Japan (Çaklı and Duyar, 2001).

Since the ancient time products from marine organisms were consumed in different ways. Development in food industry has also provided the standardization in seafood. Surimi produced with local differences since the old times has benefited from the standardization and became a product produced with standard characters all year around. Surimi is produced is a unique product obtained in different ways and is a Japanese term meaning kneaded fish flesh. The history of Kamaboko, produced by a regional method involving steam cooking of dough from salted fish meat, goes back 400 years. The way of production then was just to bake the fish mince produced from fish filet which, first, washed with fresh water and, then, with salted water, and shaped on a piece of wood. Therefore, kamaboko is a general term used for all surimi products. However, surimi, today, covers a range of different products.

In general surimi produced after mechanical removal of bones from fish flesh and further removal of fat, free amino acids and peptides from the remain of the meat by washing which is followed the addition of various additives, is described as the concentration of myofibrillar proteins (Lee, 1984; Lanier, 1986; Ercoşkun, 2000). Washing is necessary to remove sarcoplasmic proteins. The removal of sarcoplasmic proteins concentrates myofibrillar proteins, which is the primary component in the formation of three-dimensional gel structure, responsible for the gel forming ability of surimi. The number of washing cycles and the volume of water vary with fish species, freshness of fish, type of washing unit and the desired quality of the surimi (Hall and Ahmad, 1997).

Species Used for Surimi Production and Production Technology

Fish species with high commercial mince value, such as cod, whiting, croaker, hake, are used for surimi production (Fig. 1). Besides Alaska pollock, fish caught in tropic and subtropics waters, small pelagic fish such as mackerel, saurel, sardine, sprat and anchovy, and freshwater fishes which are more reliable than marine fishes can be used for the same purpose.

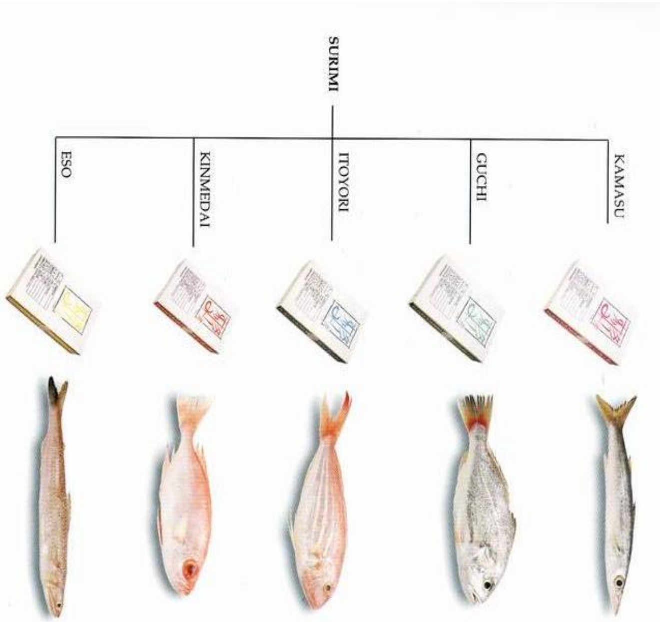

Figure 1. Fish names is Japanese, which is commonly used for surimi production.

Desired Features of Fish Processed for Surimi:

Ability to form strong gelous structure,
Good organoleptic quality from the point of taste, odor (smell) and appearance,
Having white meat,
Year around availability,
Having a suitable price.

None of the fish species can have all these features together. Especially, gel forming ability shows differences according to the species. Generally, gel strength is more in marine fish than in freshwater fish as well as in fish with white flesh (non fatty) than in with black flesh (fatty) (Kolsarıcı and Ensoy, 1996).

The characteristics of the meat to produce Surimi vary depending on the fish species fishing season. The features of raw material have to be well-determined in order to be able to produce high quality surimi at all times (Fig. 2).

Surimi can be produced from 60 different fish species. Although each species requires slight changes in production the general technology is the same for all. However, only some fish species can provide necessary requirements as raw material, strong gel forming capacity, whitish color, good taste, and odor. Hence, sometimes, surimi produced from different fish can be blended in order to obtain desired quality. The steps of surimi production are given in flow chart (Fig. 3).

Figure 2. Surimi Production

SURIMI PRODUCTION PROCESS

Raw Fish
Washing
Fish Tank

Removal of Head and Internal Organs
Washing

Mechanical Separation of Meat (Minced Fish)
1. Washing and Draining
2. Washing and Draining

Purification
Water Removal Under Press

Adding Additives and Mixing

Metal Detector

Plate Freezer

Packaging and Storage

Figure 3. Flow diagram of surimi production (Motohiro et al., 1992)

Surimi Production from Fish with Fatty and Black Meat

Economical value of the surimi produce from fish with red meat is low since the application suitable food processing is limited for such meat. Iron pigments in light-colored meat can be removed easily during surimi production. However, the removal of theses pigments in dark-colored meat is more difficult because the muscles are more hard and firm in such meat. Therefore, they contain more pigment which has to be removed. An important factor causing weak gel forming capacity in dark-colored meat might be low final pH of the meat. pH has to be in the range of 6-8 in order to produce elastic gels. Meat pH of sardine or mackerel declines rapidly to 5.8 after the death. The reason of this occurrence is high lactic acid concentration caused by high glycogen reserves at the time of death. Dark-colored fish are generally pelagic fish and they have to have high glycogen reserves in order to bear the long distance migration (Shimizu, 1965; Çaklı and Duyar, 2001).

Surimi Products

Fish gel products are most commonly used in Japan. Widely used gel products are: kamaboko, nerisehin, chikuwa, hanpen, kanibo, kanikame, naruto, satsuma-age, shio-surimi (Fig. 4).

Figure 4. Surimi Based Products

Surimi are also classified according to their shapes as follows.
Products without supporting media: Satsuma-age, Tsumire
Products on sticks: Chiquwa, Sasa-kamaboko
Products fixed on a wooden plate: Mushi-ita, Yaki-ita
Rolled Products: Kobu-maki, Age-maki
Products shaped in a mould: Namba-yaki, Ume-yaki
Products with casing: **Sausages,** Hamburger, Salami
Fabrication Products: **Crab** analogs
Decorated Products: Suridashi, Kiridashi

Additives Used in Surimi Technology

Surimi is primarily myofibrillar muscle protein concentrate dissolved by salt, water and temperature. This gel is shaped by continuous matrix of surimi hydrogel. Formation gel matrix from myofibrillar proteins of surimi is depend on many factors such as the interaction between additives and myofibrillar proteins, pH, time/temperature relation and myofibrillar protein content (Lee, 1984; Lanier, 1990).

1. Cryoprotectants

Surimi may lose its functional properties during frozen storage due to unfolding of the myofibrillar protein. This process leads to protein aggregation (Shenouda, 1980), loss of gelling and water holding capacity (Caravajal et al., 1999) and decrease myosin ATPase activity (Suzuki, 1981). Cryoprotectants such as sucrose or sorbitol are required to prevent these undesirable changes in the myofibrillar protein and to preserve maximum functionality of surimi. Sorbitol is combined with sucrose to reduce sweetness of the products. In addition to its function to protect myosin from denaturation (Konno et al., 1997), sorbitol enhances the cohesiveness of thermo-induced gels by controlling the cross-linking reactions of myosin during setting (Kimura et al., 1991).

2. Starch

Starch is a material that has widely used in surimi and surimi products. Factor affecting the selection of the type of starch are the effect of the starch in the strength of the gel, freezing and thawing stability, and the price. Wheat, corn (50-75%) and potato starches have obvious starch forming effect.

3. Proteins excluding muscle proteins

Egg white: Egg white, 3-10% of the weight of surimi, is most frequently used additives in dry form and in frozen material as well as analogue products. In dry for less than 3% is used. When used in frozen material egg white increases the gel strength at a level of 6% (Chen, 1987) and provides that the gel appearance is more white and brighter.

Soybean Protein Isolate (SPI): Soybean protein isolate has a wide usage in industry due to its water and fat binding, and gel forming capability SPI causes the disappearance of white color in products and they become creamy when it is used in high amount in the products.

Corn gluten: Corn gluten generally reduces the gel strength of products. The optimum level was determined as 2% when 6% starch is used. Over 5% product becomes darker and tastes like graminae (wheat related crops).

Milk protein concentrate: Milk protein concentrate is used as a filling material in surimi technology (Bugarella et al., 1985). It can be used as a water binder or a material helping gel formation. Casein, protein isolate in curdled milk water and lacto albumin is milk protein concentrates.

Starch protein systems: Different combinations of both starch and egg albumin can be added at around 10% level in surimi formulations.

4. Hydrocolloids

Gums are a group of water soluble polymeric materials with thickening and gel forming properties. Their natural structures are colloidal and they are known as hydrocolloids. Thickening and gel forming properties of hydrocolloids depend on the type of the gum, pH, temperature, hydration technique, ionic strength and the presence of synergistic elements.

Carrageen: Carrageen is obtained from red algae and has three types known as kappa (K), lota (L) and lamda (X). Although K and L carrageen's have the forming capability reversed with temperature, X carrageen hasn't got such a property. Carrageen can be used in formulations up to % 0.1-0.5 (Bullens et al., 1990).

Alginate: Alginate is obtained from Brown alg. Functional feature of Alginate is to react with polyvalent cations, especially calcium, and to form a gel irreversible with the temperature. Alginate can especially be used for the preparation of different variants of fabrication products (Clark, 1980).

Methyl Cellulose: Methyl cellulose is produced by the chemical modification of cellulose extract from wood and it is used for forming a strong gel in surimi products

Gelatine: Gelatine is water soluble protein of denatured collagen which is main element of proteins of animal bones, skin and connective tissues. Gelatine is soluble near the body temperature and forms a gel thermodynamically reversible. Hence, surimi containing gelatine obtains a soft texture.

Cellulose (Powder): Cellulose is a biopolymer bound with -1.4 glucosidal bounds and is present in powder form to be used in food. Due to be large surface area and polymeric structure it has the ability absorb a large amount of water. Different from starch and protein cellulose does not change form as a result of temperature alterations (Yoon and Lee, 1990).

Quality Control Analysis of Surimi and Surimi Products

Amino acid content: Full amino acids profile analysis was conducted according to AOAC method (AOAC 1995).

Folding test: Samples are cut into a round-shape slice 3 mm thick, and evaluate by a five stage method, as follow: (Lanier, 1992).

Grade Condition

1. breaks by finger pressure
2. cracks immediately when folded in half,
3. crack gradually when folded in half,
4 .no crack showing after folding in half,
5 .no crack showing after folding twice

Organoleptic analyses: Sensory evaluation is conducted based on a 5-point Hedonic scale method (Meilgaard, 1987).

Color measurement: Color measurement of minced meat is done using Tristimunus colorimeter

Texture profile analysis: Texture profile analysis of Surimi is done Gel using rheometer.

Chemical composition analysis (Moisture, Fat, Ash, Protein): The moisture, total protein, fat and ash contents were determined in accordance with standard AOAC methods (AOAC 1995).

Solubility of proteins: The solubility of protein obtained from different processes should be measured according to the method of Rawdkuen et al. (2009). Samples (2 g) were homogenized with 18 ml of 0.5 M borate buffer solution, pH 11.0, for 60 s and stirred for 30 min at 4°C. The homogenates were centrifuged and the protein concentration of supernatant was measured by Biuret method. Protein solubility (%) was defined as the fraction of the protein remaining soluble after centrifugation and calculated as follows:

Protein solubility (%) = (protein concentration in super natant/protein concentration in homogenate) × 100

Water Holding Capacity: Water holding capacity can be defined as the ability of a protein gel to retain water against a gravitational force. The level of water retained in a gel is affected by the same factors that affect the formation of a good protein gel: pH and ionic strength (i.e.
salt). Water holding capacity and expressible moisture usually reflects the extent of denaturation of the protein and water content. WHC should be measured according to the method of Lin and Huang (2003) with slight modification.

Determination of inorganic ions: Inorganic ions in soluble collagen is determine using ion specific electrodes.

Results

Surimi technology and development of products relying on surimi technology have been operational in Japan, Singapore, USA and European countries since the beginning of 1940's. However, production of food relying on surimi technology has never been operational in Turkey, yet. Development of new surimi and surimi products, determination of production method and development of technology should become as one of main targets in Turkey. These are the factors providing the development of the technology in the USA and Europe;

1- Non and less economical species can successfully be used as raw material.

2- Frozen surimi has a long shelf life and has high level of functional protein content,

3- The price such fish material is usually more suitable than commercial species.

Surimi products are obtained by increasing quality standards, developing necessary technological processes and application of additives. Surimi technology has been developed in Japan for a few hundred years. The development of the industry has been supported by

a- the increase in obtaining raw material,

b- the development of new products,

c- the development of new marketing technologies and strategies,

d- the development of the new techniques for the preservation and marketing of products.

Although providing benefit from surimi technology is most likely, product yield and quality of candidate fish species has to be studied thoroughly. In addition to technological researches economical analyses has to be carried out to take further steps for the development of seafood processing sector in Turkey and for the better resources without wasting what is available for the time being.

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