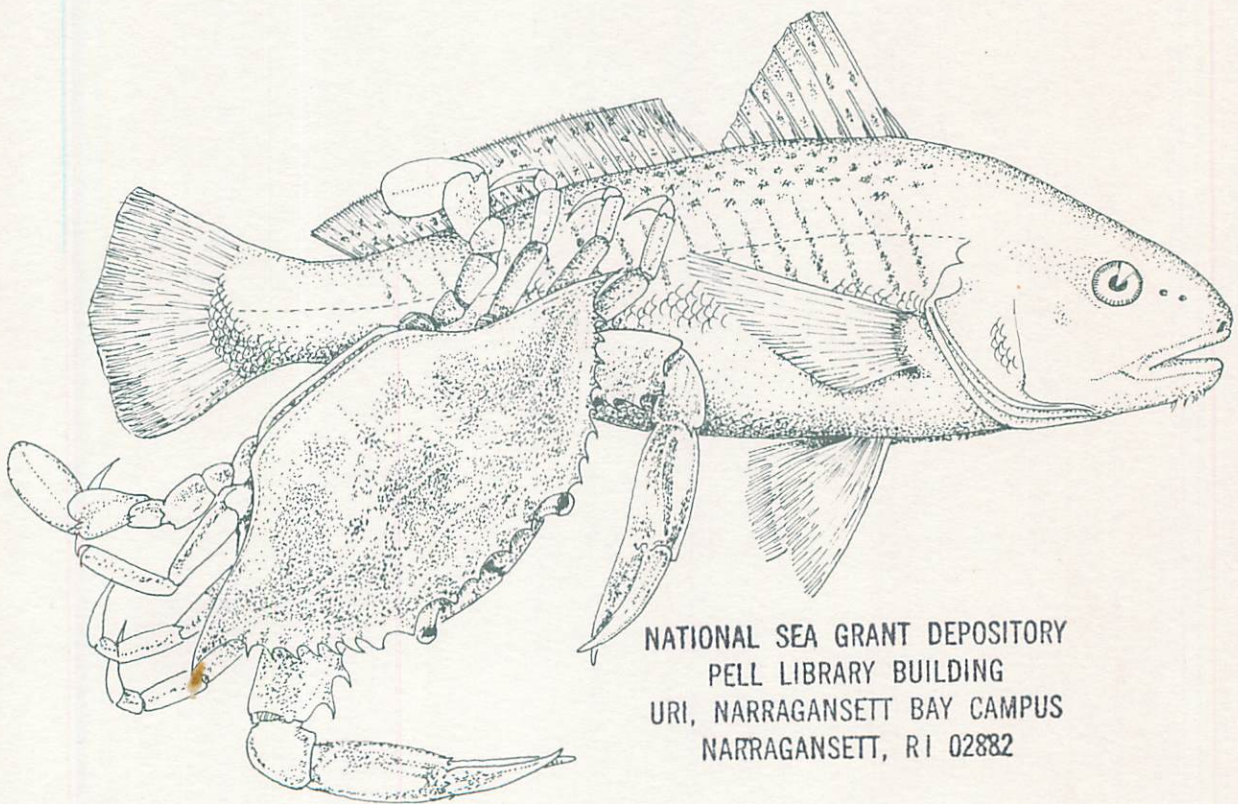


An annotated bibliography On mechanically separated Finfish and crustacea meats

By Frank B. Thomas, Joyce A. Taylor and Freda A. Ramey

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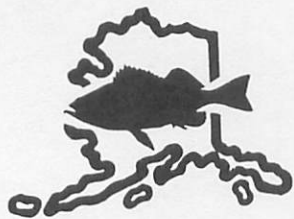


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AN ANNOTATED BIBLIOGRAPHY
ON MECHANICALLY SEPARATED FINFISH AND CRUSTACEA MEATS
Second Edition

Authors: Frank B. Thomas, Joyce A. Taylor, Freda A. Ramey

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INTRODUCTION

The study of deboned fish flesh at North Carolina State University began in 1970. In 1977 a limited compilation of relevant available literature on the subject of mechanically deboned finfish and crustacea meat was published.

Since the 1977 edition of this work was published, the developments in minced fish have advanced from early laboratory work to commercial application. Surimi products are now being commercialized on several continents. The market for these new food products from seafoods offers the seafood industry a great potential for the next decade and beyond.

The literature was reviewed and annotated to form a ready source of information gathered in a single collection. Efforts centered on reputable publications, trade journals, and selected technological conferences. References to patents were added to the second edition. Editorial discrimination was used when virtually the same work and results were published in several different sources.

Among the sources contacted were national, university, and local libraries, universities with ongoing work in this field, domestic and foreign labs and agencies, and industry sources.

In the reference section, authors are listed alphabetically. The subject index consists of general headings placed in a sequential order according to treatment of the subject. Each reference, identified by author(s) and date, is placed under the headings which predominate in the work.

Also provided are general references, listings of meetings and symposiums, and abstract and index sources.

This publication provides a guide to the present literature, summarizes the state of the art, and points out the needs for future areas of emphasis.

REFERENCES

Akahane, Takayuki; Chihara, Satoshi; Yoshida, Yutaka; Tsuchiya, Takahide; Noguchi, Satoshi; Ookami, Hiroshi; Matsumoto, Juichiro J. Application of differential scanning calorimetry to food technological study of fish meat gels. Bulletin of the Japanese Society of Scientific Fisheries. 47(1):105-111; 1981.

To study gel properties and formation, differential scanning calorimetry was applied to fish meat gels (Kamaboko) in parallel with jelly strength measurements.

Alexander, A. The strange case of the Norwegian fish burger. Food Flavourings, Ingredients, Packaging and Processing. 1(11):42; 1980.

The Seakist Fish Burger, manufactured from cod and rice, with onion and spice seasonings, can be sliced and fried or used as a base for fish cakes, fish balls, soups and sauces. It is available in 295 and 590 g cans. The Burger was found to be particularly acceptable to children in the UK and Norway.

Amano, K. Inspection and quality assessment of Japanese comminuted fish products. Kreuzer, Rudolf (ed.). Fish inspection and quality control. London, England. Fishing News (Books) Ltd. 1969:119-124.

A description of the Japanese inspection system for fish sausage and some criteria for evaluation of the quality of kamaboko and frozen minced fish meat were given. The author discussed the production methods for minced fish products and examined the influence of several factors on the quality of the final product.

Amano, Keishi. Fish sausage manufacturing. Borgstrom, Georg (ed.). Fish as food. New York: Academic Press; 1965. Vol. 3, part 1.

Chemical aspects - raw materials - preparation and processing - recipes - shelf-life, bacteriological problems - quality control - chemical composition.

Anderson, M.L.; Mendelsohn, J.M. A study to develop new products from whiting or other underutilized species. U.S. Dept. of Commerce, Economic Development Administration. 1971; 67 p. Technical Assistance Project No. 01-6-09131.

Rapid salt-curing resulting in a product with desired properties was obtained when fillets were ground in saturated brine with enough added salt to keep the brine saturated during salting. The salted product

was highly acceptable as an ingredient of fish cakes. Smoked fish, fish cakes, and smoked fish balls made from whiting in various forms, including mechanically deboned flesh, were some of the highly acceptable products which retained their quality well during storage.

Angel, S.; Weinberg, Z.G. Development of an emulsion-based product from minced silver carp in Israel. *Journal of Food Technology*. 14:405-419; 1979.

A fairly firm-textured emulsion product (sausage) was obtained with 30% minced whole silver carp and 70% minced or ground fillets while the trimmings from filleting rendered the least acceptable products in any combination with the other kinds of flesh.

Anonymous. Eight firms offer deboning machines; how they work. *The National Provisioner*. 172(14):12-50; 1975.

A description of mechanical deboning equipment offered for sale in the United States by eight manufacturers was given.

Anonymous. New sea foods. *Polish Maritime News*. 21(236):20; 1978.

Research at Szczecin Agricultural Academy's Institute of Sea Food Technology, Poland, involving a method for producing frozen minced fish was described. The method involved adding a mixture of natural pepper, herb pepper, garlic salt, or juniper to comminuted fresh minced fish prior to freezing. The method extended shelf life by 2 to 6 months. Production of a fish paste involved mixing natural vegetable antioxidants under steam pressure in order to combine with fish fat and slow down rancidity.

Anonymous. Blue whiting fails the test. British trials to make 'surimi' proved disappointing. *Fishing News International*. 18(2):30-31; 1979.

Trials carried out by the British White Fish Authority in cooperation with the Japanese company Nippon Suisan (Nissui) on the production of surimi from blue whiting in spring 1978 were described. Results of tests on raw surimi and tamin samples were disappointing, and frozen-at-sea blue whiting failed to produce special grade surimi.

Antonacopoulos, N. Further studies on evaluation of frozen breaded fish portions. *Deutsche Lebensmittel-Rundschau* 73(10):315-320; 1977. (In German; English summary.)

Problems of evaluating fish fingers and fish rissoles were discussed regarding the differences between prefried and non-prefried products,

methods for separation of the bread or batter coating from the fish, and evaluation of fish content on the basis of trimethylamine oxide content. The samples studied complied with legal requirements and guidelines for breaded fish products.

Antonacopoulos, N. Grading standards for mixed fillet/finch blocks and products thereof. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981: 524-546.

The Federal Research Center for Fisheries, Hamburg, Germany, has been responsible for compiling the necessary background experimental data necessary to prepare product definitions, regulations, and methods currently being elaborated for the German Food Book, E C Marketing Standards and FAO/WHO Standards. Studies have been conducted on the effects of mince additions to cod fillet blocks in order to estimate the "labeling-free" level of acceptance. Some preliminary results from studies on boneless mixed fillet-mince blocks, prepared with diphosphate and alginate addition, cut into portions, and batter/breaded with conventional equipment, were discussed. Analysis of the samples included: (a) mince recovery by analytical techniques, (b) organoleptic assessment, (c) texture measurement by Kramer/Instron apparatus, (d) estimation of the water absorption and binding capacity as indicators of protein denaturation, (e) estimation of drip losses during thawing, cooking, and pressing within the Kramer cell, (f) determination of dimethylamine and formaldehyde during frozen storage. Other relevant activities under investigation are the "bone problem" and the estimation of the real fish content of fish blocks and battered/breaded portions.

Aoki, H.; Mochizuki, A.; Tsuyuki, H. Studies on shear strength of fishery products. I. Shearing strength of kamaboko. Journal of Japanese Society of Food Science and Technology. 29(3):180-184; 1982.

Shearing analysis, stretching tests and jelly strength determinations were made on 20 samples of commercial kamaboko using an Instron-type universal food testing machine. The best correlation was between shear strength and jelly strength x breaking strain values followed by shearing strength and jelly strength. It was concluded that shear analysis is a useful technique for evaluation of kamaboko texture.

Arai, K.; Kinumaki, T. Feeding trials to evaluate the nutritional value of Kamaboko made from a fish species with a high wax content. Bulletin of the Tokai Regional Fisheries Research Laboratory. 91:93-99; 1977. (In Japanese; English summary.)

Studies were conducted to evaluate the potential for use of Hoplostethus spp. for manufacture of kamaboko, a fish with a high wax content in the flesh, which leads to a purgative action when consumed. During kamaboko manufacture, the lipid content of the fish meat was reduced from 10% to 1.8% by repeated washing with water, and subsequent rat feeding trials showed no toxicity or other adverse effects. It was therefore suggested that flesh of wax-rich fish may be usable for human consumption if it is processed by methods which reduce the lipid content to low values.

Areche, T.N.; Fujii, Y. Effects of vegetable protein added to frozen surimi on the properties of its kamaboko. Bulletin of the Tokai Regional Fisheries Research Laboratory. 100:1-7; 1979.

Studies were conducted on effects of addition of 0, 3, 5, 7 or 10% vegetable protein on the quality of kamaboko made from frozen Alaska pollock or sardine surimi. Quality was evaluated on the basis of jelly strength, expressible water content, resistance to folding, Hunter whiteness value, moisture content and organoleptic evaluation. Results showed that jelly strength, water binding capacity, whiteness and organoleptic quality of Alaska pollock kamaboko deteriorated with increasing vegetable protein content. Jelly strength and whiteness of sardine kamaboko improved with addition of up to 3% vegetable protein, but deteriorated with addition of higher levels. Water binding capacity and organoleptic quality decreased with increasing vegetable protein content.

Arocha, P.M.; Toledo, R.T. Descriptors for texture profile analysis of frankfurter-type products from minced fish. Journal of Food Science. 47(3):695-698; 1982.

The texture profile of frankfurter-type products prepared from minced Spanish mackerel was evaluated. Twelve character notes were identified springiness, hardness, cohesiveness, moisture release, crumbliness, coarseness, graininess, juiciness, adhesiveness, lumpiness, chewiness, and mouthfeel-oiliness. Overall texture acceptability was also evaluated. Soy protein fiber, egg white, and ground drum-dried fish were added to test for texture improvement.

Atkinson, A.; Evans, D. Canned meal-in-one fish and maize pack. Annual Report, Fishing Industry Research Institute. 34:15; 1980.

A combination of canned fish mince and maize meal porridge was prepared as a food for low income population and as a method of extending pilchards by the use of other species. The canned product was attractive and inexpensive.

Atkinson, A.; Evans, D. Fish balls made from shark and hake mince. Annual Report, Fishing Industry Research Institute. 34:21-22; 1980.

Experimental packs of hake formulated as mince balls in tomato sauce were attractive in appearance with light colored flesh in good red sauce, but the fish balls were too firm in texture. Shark flesh was prepared similarly as fish balls after leaching with brine (1.5%) and canning with either tomato sauce or aspic gel. Both products were attractive but the fish ball texture was too firm. Shark prepared from unleached materials was unsatisfactory.

Atkinson, A.; Wessels, J.P.H.; Simmonds, C.K.; Evans, D. Food technology. Annual Report, Fishing Industry Research Institute. 34:8-12; 1980.

Minced hake was divided into 2 color classes, light or dark (due to blood, which turns grey). Color, flavor, texture, oil content, free fatty acids, dimethylamine, and color ratio were examined initially and after one month of frozen storage. Several lightening techniques were discussed. Results of washing and bleaching were discussed. The most acceptable product was mince washed with water only.

Atkinson, Alison; Wessels, J.P.H. Flavour and texture changes during the storage of frozen blocks of shredded hake. South African Food Review. 2(5):147-149; 1975.

Storage methods to control degradation in flavor and texture of blocks were investigated in a series of three tests.

Babbitt, J.K.; Crawford, D.L.; Law, D.K. Decomposition of trimethylamine oxide and changes in protein extractability during frozen storage of minced and intact hake (Merluccius productus) muscle. Journal of Agricultural and Food Chemistry. 20(5):1052-1054; 1972.

Formation of dimethylamine (DMA) and formaldehyde (FA) was greatly accelerated in minced muscle during frozen storage at -20°C as compared with fillets. Trimethylamine, DMA, and FA determined immediately after mincing of the muscle were 2-4 times greater than determined in the intact fillet; this corresponded to a much lower trimethylamine oxide content in minced muscle. The decrease in the amount of total extractable protein in minced muscle corresponded to the increase in FA and DMA content.

Babbitt, J.K.; Law, D.K.; Crawford, D.L.; McGill, L.A. Acceptance of a fish-shrimp portion utilizing machine-separated minced fish flesh. Journal of Food Science. 39(6):1130-1131; 1974.

Incorporating 20% shrimp with minced fish muscle significantly improved flavor and desirability. Fish-shrimp portions containing either 50% machine-separated minced muscle or 50% ground fillets showed no differences in flavor, texture, or desirability.

Babbitt, J.K.; Law, D.K.; Crawford, D.L. Improved acceptance and shelf life of frozen minced fish with shrimp. *Journal of Food Science*. 41(1): 35-37; 1976.

Increasing the amount of shrimp in the frozen portions of minced fish muscle markedly improved the acceptability and shelf-life stability of the minced fish. This was directly related to the decreased formation of malonaldehyde and peroxides. The beneficial effects of incorporating shrimp with minced fish were attributed to substances extractable in ethanol that exhibited antioxidant properties.

Bailey, R.S. A review of the resources available to British fisheries, with particular reference to minced fish technology. Keay, James N. (ed.). Conference: the production and utilisation of mechanically recovered fish flesh (minced fish), 1976, proceedings. Ministry of Agriculture, Fisheries and Food, Torry Research Station, Aberdeen. 1976:9-17.

The traditional resources for human consumption (demersal and pelagic fisheries), the industrial fish resources, and underexploited resources of the United Kingdom were discussed for possible exploitation. The underexploited blue whiting resource was deemed large enough to sustain a considerable fishery, although little commercial interest has been shown so far.

Baker, Robert C. Canned and prepared minced products. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute. 1981:357-361.

At Cornell University about 20 new products from underutilized species of fish and fish racks have been developed from both ocean and freshwater species. Producing convenience foods involves several stages including idea, development, taste paneling, sampling, shelf life, packaging, production and market testing. Six of the new products have been market tested and two are now on the market. Five of these products are canned and three frozen.

Baker, R.C.; Darfler, J.M. Development of products from minced fish: 5. tasty dishes from minced fish. 1979; 21 p. Available from: Cornell University, New York Sea Grant Institute.

Recipes are provided for the use of minced fish as a ground beef substitute and for gourmet dishes such as Newburg, crepes, stroganoff, and moussaka.

Baker, R.C.; Darfler, J.M. Development of products from minced fish: 7. canned fish bites in tomato sauce. 1980; 17 pp. Available from: Cornell University, New York Sea Grant Institute.

Since small bite-sized portions of a fish mixture in a creamy sauce had been found to be an acceptable product (Creamy Fish Bites), a canned fish bite in tomato sauce was developed. Several species of fish and several combinations of fish with meats were compared with fish bites made from minced white sucker.

Baker, R.C.; Darfler, J.M.; Mulnix, E.J. Development of products from minced fish: 8. canned minced fish. 22pp. Available from: Cornell University, New York Sea Grant Institute.

Canned minced mullet was developed as a lower priced alternative to canned grated tunafish. Precooking procedures were evaluated for precook yield, amount of drip (cookout) in cans, and the most desirable product for color, texture, tenderness, flavor, juiciness, and overall acceptability. The procedure that produced the best product included cooking fish in a steam-jacketed kettle, constantly stirring, draining off cookout liquid and packing in cans with 1% salt and 5% vegetable broth.

Baker, R.C.; Kline, D.S. Development of products from underutilized species of fish: 11. burbot convenience foods. 1982; 34 pp. Available from: Cornell University, New York Sea Grant Institute.

Mechanically deboned burbot was used in convenience products which were compared with the same products made from white sucker. Burbot fillet chunks were also canned. Minced burbot products were inferior to those made from minced white sucker. There were also handling problems with the burbot. The burbot chunks were comparable to canned pollock and tuna. It was recommended that commercial canning of burbot might be successful and that further research be conducted with minced burbot.

Baker, R.C.; Regenstein, J.M.; Darfler, J.M. Development of products from minced fish: 1. seafood chowders. 1976; 32 pp. Available from: Cornell University, New York Sea Grant Institute.

Both New England and Manhattan style seafood chowders using minced fish were developed and tested by taste panels. Formulas and procedures for these nutritious, low cost soups, containing up to 37 percent seafood by weight per can, were included.

Baker, R.C.; Regenstein, J.M.; Darfler, J.M. Development of products from minced fish: 2. seafood crispies. 1976; 24 p. Available from: Cornell University, New York Sea Grant Institute.

Seafood crispies, bite-sized, battered, breaded, and fried for serving as hors d'oeuvres or as an entree, were developed. They contained at least 66 percent minced fish from underutilized species or from filleting wastes. Formulations for the well-accepted product were included.

Baker, R.C.; Regenstein, J.M.; Darfler, J.M. Development of products from minced fish: 4. creamy fish bites. 1977; 27 p. Available from: Cornell University, New York Sea Grant Institute.

A "Swedish meat ball" type of product, traditionally made from beef and pork and being light in color, was developed to take advantage of the light color of most fish muscle. A taste panel and a sensory profile panel were used to obtain a satisfactory product suitable for either freezing or canning.

Baker, R.C.; Regenstein, J.M.; Raccach, M.; Darfler, J.M. Development of products from minced fish: 3. frozen minced fish. 1977; 42 p. Available from: Cornell University, New York Sea Grant Institute.

Phosphated mullet (white sucker) showed superior storage stability compared to cod, whiting, pollock, and flounder. It was decided to evaluate the potential of frozen minced mullet in one-pound packages as a retail item. An attractive package was developed to include instructions for use and recipes.

Bello, R.A.; Pigott, G.M. A nutritious dried fish product suitable for use in Venezuela. Paper presented to the international congress of food science and technology. Kyoto, Japan; 1978 September 17-22. Available from: College of Fisheries, University of Washington, Washington.

A dried smoked product with sensory characteristics resembling the dried salted fish eaten in parts of Venezuela and the Caribbean was developed from a mixture of minced flesh of several underutilized fish species with 5% soy fibre, 5% modified tapioca starch and 0.5% NaCl. Proximate analysis of the dried fish patties showed 55.5% protein, 19% fat, 15.4% carbohydrates and 4.6% ash. Protein efficiency ratio was 3.18 (reference casein 2.75). A storage study employing 0.05% potassium sorbate and/or an antioxidant mixture showed no essential change in pH while moisture content varied from 3.7% to 8.3%. Total bacterial count was 10^2 - 10^3 cells/g. The stability of the dried product was attributed mainly to the low water activity (0.3) and the heat treatment.

Bello, Rafael A.; Pigott, George M. A new approach to utilizing minced fish flesh in dried products. *Journal of Food Science*. 44(2):355-362; 1979.

Mixed, minced flesh from several fish species (lingcod, rockfish, herring, and Pacific cod) was used to develop dried fish patties to be kept without refrigeration; to enhance the product's binding, rehydration and sensory properties, modified tapioca starch, texturized soy fiber, and salt were required. The product was dried to 5% moisture level in the temperatures of 71-82°C for 10 hours and rehydrated in water for 20 minutes submersion. The product was assessed by microbiological, physicochemical, organoleptical, and histological tests.

Bello, Rafael A.; Pigott, George. Dried fish patties: storage stability and economic considerations. *Journal of Food Processing and Preservation*. 4:247-260; 1980.

Dried fish patties prepared from mixture of several comminuted fish species (rockfish, Pacific cod, lingcod, and Pacific herring) and structured vegetable protein, modified tapioca starch, sodium sorbate and/or sodium chloride, and antioxidants were examined monthly during four months storage period at 25°C. Slight variations in tests for moisture content, pH, total volatile nitrogen, TBA, total pour plate counts, and yeast and mold counts indicated the stability of the patties, while nutritional quality was indicated by proximate analysis, amino acid profile, and protein efficiency ratio.

Beloborodov, V.V.; Simov'yan, S.V. Dielectric properties of sea fish (Lemonema) sausage. *Izvestiya Vysshikh Uchebnykh Zavedenii, Pishchevaya Tekhnologiya*. 3:156-158; 1978.

Dielectric properties of sea fish sausage were studied using a double waveguide bridge, in relation to the content of water, salt (0-1%) and temperature. Results are tabulated in the form of regression equations. The equations are suitable for calculation of the dielectric properties of sausage products from sea fish containing little fat.

Beuchat, L.R.; Jones, W. Kelly. Growth of Vibrio parahaemolyticus in seafoods extended with soy protein concentrate, structured protein fiber, and textured vegetable protein. *Journal of Food Science*. 44(4):1114-1117; 1979.

Structured protein fiber (SPF), soy protein concentrate (SPC), and textured vegetable protein (TSP) enhanced the growth of V. parahaemolyticus in liquid culture media. Growth of the bacterium was retarded in shrimp, ground flounder, and crab extended with SPF (10 and 25%) and SPC (5 and 10%) and stored at 15 and 25°C for periods of time ranging to 72 hr. Compared to controls, TSP promoted the rate of

growth of V. parahaemolyticus when added to seafoods at levels of 5 and 10%. Caution is advised when formulating seafood-soy blends for distributing and marketing at 15°C or higher.

Birnbaum, A. Production of comminuted fish meat from bone-rich trimmings from fillet preparation. Determination of the yield from cod. Informationen für die Fischwirtschaft. 28(4):149-153; 1981.

The yield of comminuted fish meat from mechanically separated v-cuts from cod fillets was 84.6%; from manually separated v-cuts the yield was 86.4%. The mean yield from other mechanically-separated, bone-rich trimmings was 69.1%; this product was darker than that from the v-cuts.

Blackwood, C.M. Utilization of mechanically separated fish flesh-- Canadian experience. Kreuzer, Rudolf (ed.). Fishery products. Surrey, England: Fishing News (Books) Ltd.; 1974:325-329.

Mechanical separation of marine, crustacean, and freshwater fish flesh, minced flesh products, product description, and quality were discussed.

Bligh, E.G. A note on salt minced fish. Paper presented at the conference on the handling, processing and marketing of tropical fish; London, U.K.; 1977. Available from: Halifax Laboratory, Halifax, Nova Scotia.

A light colored, salted press cake developed at Canada's Halifax Laboratory from mechanically deboned minced fish has neutral odor and flavor and contains approximately 42% moisture, 26% salt, and 32% protein. Drying to 20% moisture (35% salt, 45% protein) prevents growth of halophilic bacteria and allows storage at 35°C for approximately 1 yr. The product and processing technology offer a simple and inexpensive procedure particularly suitable for developing countries.

Bligh, E.G. Better use of fish as food. Paper presented at A.A.A.S. symposium on "research on fish - a renewable resource." Toronto, Ont.; 1981. January 3-8.

Current fish harvesting capability can decimate fish stocks and the prospects for substantial increases in landings are presently not encouraging. Nevertheless, more edible protein can be produced from existing fish catches through the application of science and technology. Although seafood consumption is increasing as a reflection of its status as a health food, much innovative research and development are necessary to improve the utilization of available resources and to realize the food potential of perishable species like squid, of minced fish flesh, and of underutilized and readily cultured species.

Bligh, E. Graham. Utilization of fish proteins. Stanley, D.W. (et al.). Utilization of protein resources. Westport, CT. Food and Nutrition Press, Inc. 1981:260-268.

General review of status of world fisheries, fish as a protein source, and improved utilization of fish protein.

Bligh, E.G.; Duclos, R. Salting of minced fish. Fish by-catch...bonus from the sea. Report of a technical consultation on shrimp by-catch utilization held in Georgetown, Guyana; 1981 October 27-30; International Development Research Centre, Ottawa, CA; 1982:81-83.

Since cod myosin can be denatured by salt concentration of about 10%, it was thought possible to salt minced fish with < the 25% salt previously recommended. Preliminary results showed less brine released from lightly salted mince. The physical and functional properties of the product were related to salt concentration.

Blomo, Vito J. Market potential for fish as an extender in meat products. Cobb, Bryant F., III and Stockton, Alexandra B. (eds.). Proceedings of the first annual tropical and subtropical fisheries technological conference; 1976 March 8-10; Corpus Christi, TX; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-77-105. 1976:645-659.

Results of the study indicated a favorable situation for use of fish as extender in meat products. A considerable margin for profit on the part of fishermen, fish processors, and meat packers was estimated.

Bon, J. Freezing and associated deterioration of fish and mechanically separated fish muscle. Voedingsmiddelentechnologie. 15(20):31-37; 1982.

Aspects considered included mechanically-deboned fish meat, composition of fish muscle, changes in muscle during freezing and frozen storage, effects of frozen storage temperature, freezing and thawing, chemical changes, protein changes, enzymic activity, fats and fatty acids, and deterioration.

Bond, R.M. Background paper on minced flesh. FAO Fisheries. 1975; 24 p. Circular No. C332, F II P/C332.

Upon recommendation by an ad hoc committee to the FAO Technical Conference in Tokyo, 1973, the Food and Agriculture Organization canvassed member countries for information regarding minced fish flesh under the subject headings "Raw material," "Method of manufacture," "Product composition," "Quality criteria," "Microbiology,"

"Additives" and "Product labelling." The paper was organized under these headings and a review was made of currently available literature (38 references listed).

Borderias, A.J.; Moral, A.; Garcia Matamoros, E. Studies on the stability of frozen minced fish obtained from blue whiting (Micromesistius poutassou, Risso) by the 'cutter', extrusion and mincing methods. Paper presented to the international congress of food science & technology. Kyoto, Japan; 1978 September 17-22. Available from: Cent. Exp. del Frio, Ciudad University, Madrid 3, Spain.

Blue whiting minced fish flesh was obtained from headed, gutted and filleted fish by (1) mincing or (2) the 'cutter' method (mincing and homogenization) or from headed and gutted fish by (3) extrusion. Minced flesh was stored at -20°C for 12 months, with periodic sampling. Decrease of soluble proteins in stored flesh was less in the first sample than in the other two samples until after 10 months. Dimethylamine values increased progressively while sensory tests indicated that all samples were acceptable until after 7 months.

Borderias, A.J.; Moral, A.; Tejada, M. Stability of whole, filleted, and minced trout (Salmoirideus Gibb) during frozen storage. Refrigeration Science and Technology. 1981-4:409-418; 1981.

The stability of frozen products from large trout during 1 year storage at -20°C was investigated. Products included headless gutted whole fish, skinned fillets, and minces. Analyses showed the greatest protein insolubilization in minced fish, little change in cooking drip, nucleotide degradation following a sinusoid time pattern, and a steep rise in rancidity after 120 days. Sensory rancidity detection limited acceptability to 4-5 months.

Borderias, A.J.; Moral, A.; Tejada, M.; Garcia Matamoros, E. Effects of additives on the stability of frozen minced fish. II. Minced of blue whiting (Micromesistius poutassou, Risso) obtained by the 'mincing' method with the addition of protein protectors and antioxidants. Paper presented to the international congress of food science and technology. Kyoto, Japan; 1978 September 17-22. Available from: Cent. Exp. del Frio, Ciudad University, Madrid 3, Spain.

Minced blue whiting was subjected to treatments (1) control; (2) antioxidant, sucrose and sodium alginate; and (3) antioxidant, sucrose and sodium tripolyphosphate and was stored at -20°C for 12 months. Sampling results indicated that sodium tripolyphosphate protects actomyosin against denaturation. Drip values increased. Thiobarbituric acid and dimethylamine content increased in early samples, then decreased.

Bremner, H.A. Mechanically separated fish flesh from Australian species-- a summary of results of storage trials. Food Technology in Australia. 30(10):393-401; 1978.

The degradative changes that occurred in several separate storage experiments conducted on frozen minced blocks from a variety of Australian fish species varied in nature and degree according to the species. Saline-extractable protein, pH formaldehyde, TBA, bone content, and texture were analyzed, while a taste panel's detection of off-aromas and off-flavors indicated decreased acceptability.

Bremner, H.A. Processing and freezing of the flesh of the blue grenadier (Macrurus novaezelandiae) Food Technology in Australia. 32(8):385-393; 1980.

The results of an experiment freezing and storing minced flesh of blue grenadier, a potentially important commercial trawl fish related to the merluccid hakes, can be regarded as accelerated storage trials on fillets.

Bremner, H.A. Taster response to salt in minced fish. Journal of Food Science. 47(6):2066-2067; 1982.

Cooked fish minces, alone and with 4 added levels of salt, were compared with 5 solutions of similar salt concentration. Saltiness was measured by tasters using the magnitude estimation method. The magnitude estimation exponent for salt in cooked fish mince was 1.05; that for the solution was higher at 1.51.

Bremner, H. Allan. Storage trials on the mechanically separated flesh of three Australian mid-water fish species. 1. Analytical tests. Food Technology in Australia. 29(3):89-93; 1977.

Blocks of minced flesh from three Australian fish species were frozen and stored at -18°C and evaluated at regular intervals for pH, moisture, crude protein, fat, salt extractable protein, perchloric acid extract, formaldehyde, DMA, TMA, TMAO, free fatty acid, extractable malonaldehyde, and water holding capacity. The flesh of ocean perch (Helicolenus papillosus) and spiny flathead (Hoplichthys haswelli) did not significantly deteriorate in 6 months and was deemed suitable raw material. Formaldehyde formation causing a loss of salt extractable protein and water holding capacity, in cucumber fish (Chlorophthalmus nigripinnis) precluded its recommendation for frozen fish products.

Bremner, H. Allan. Storage trials on the mechanically separated flesh of three Australian mid-water fish species. 2. Taste panel evaluation. Food Technology in Australia. 29(5):183-188; 1977.

Blocks of minced flesh from three Australian fish species were frozen and stored at 18°C and evaluated at regular intervals by a taste panel. Results showed that neither ocean perch (Helicolenus papillosus) nor spiny flathead (Hoplichthys haswelli) showed significant deterioration during six months storage, but cucumber fish (Chlorophthalmus nigripinnis) received decreasing ratings in aroma and flavor, developed off-odors and off-flavors, toughened in texture, and generally decreased in acceptability. These findings agreed with previous chemical analyses showing ocean perch and spiny flathead suitable for new frozen fish products and the difficulty of preparing stable products from cucumber fish.

Bremner, H. Allan. Minced fish in Australia--usage and research. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute. 1981:422-437.

The Australian experience with minced fish is characterized by importing, the greater proportion of the product being used in a variety of products ranging from fishburgers and fishbites to soup bases and pet foods. Australian research on minces has centered on such aspects as formaldehyde production, the relation between textural properties and chemical variates, the importance of flavor and off-flavors as determinants of acceptability, and the mixed benefits of washing minces in water.

Bremner, H. Allan; Laslett, G.M.; Olley, June. Taste panel assessment of textural properties of fish minces from Australian species. Journal of Food Technology. 13:307-318; 1978.

The validity of the underlying concept outlined by Cowie and Little (1966, 1967) regarding the relationship between toughness, pH, salt extractable protein, and moisture on frozen stored cod was re-examined and extended to results on samples of mince from sixteen Australian fish species.

Bremner, H. Allan; Snell, P.J.I. Chemical and taste panel tests on the mechanically separated flesh of six tropical fish species. Paper presented at Indo-Pacific fishery commission/FAO conference on fish utilization, technology and marketing in the IPFC region. Manila, Philippines; 1978. March.

Minced fish blocks from species common in Malaysian waters--grunter (Pomadasy argyreus), lizard fish (Saurida tumbil), catfish (Arius spp.), pony fish (Leiognathus splendens), threadfin bream (Nemipterus japonicus), and ribbon fish (Trichiurus lepturus) were examined for crude protein, moisture, total lipid saline, extractable protein, trimethylamine oxide, dimethylamine, formaldehyde, trimethylamine, free fatty acid,

thiobarbituric acid value, and bone content. Taste panel evaluations on the minces and fish fingers prepared from the minces showed that these "trash fish" were not very acceptable even in the popular fish finger form. Preparation of the fish was difficult due to the small size and unacceptable levels of bone and scale in the resulting minces.

Brooker, Jim. Codex international standards and labeling for minced fish blocks. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh; 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute. 1981:520-523.

The Codex Alimentarius, a collection of international food standards which developed under the auspices of the Joint FAO/WHO Food Standards Program, included provisions of an advisory nature in the form of Codes of Practice. The proposed draft code of practice for minced fish is intended to be an advisory document even after final adoption by the Codex Alimentarius Commission. In the U. S., it would supplement present FDA regulations concerning Good Manufacturing Practices.

Brotsky, Eugene; Swartz, William E. Use of polyphosphates in minced fish. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh; 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute. 1981:299-303.

The theory of the effects of polyphosphates on fish proteins, oxidation, and catalytic reactions was discussed. The use and application of several commercial phosphate products specifically designed for minced fish were described.

Brown, J.W.; Waters, M.E. Optimization of processing of three under-utilized fish species. Fish by-catch...bonus from the sea. Report of a technical consultation on shrimp by-catch utilization held in Georgetown, Guyana; 1981 October 27-30; International Development Research Centre, Ottawa, CA; 1982:113-117.

The economics of preparing spot, croaker, and weakfish, whole, minced, and filleted (with and without skin) were evaluated. Results were expressed in diagrammatic form.

Budina, V.G.; Morzlov, E.N. Determination of the consistency of frozen fish sausage meat on the basis of its elasticity. Rybnoe Khozyaistvo. 4:68-71; 1980.

The effect of six stabilizer mixtures with levels of sugar, salt, sodium tripolyphosphate and sorbitol time on the elasticity of

frozen minced cod was studied, along with the effect of refrigerated storage time. The elasticity dropped markedly with salt as a stabilizer, but only slightly with sugar products.

Budina, V.G.; Rekhina, N.I. Manufacture of skinless fish sausages. Rybnoe Khozyaistvo. 11:79-81; 1977.

The following formula for skinless fish sausages was considered best organoleptically and technologically: 71% comminuted fish meat, 15% bacon, 6% eggs, 5% starch, and 3% dried milk; salts, phosphates, spices and water (28%) were added. Sausage forming and cooking times, the dependence of fish sausage pH on temperature, the effect of air temperature, and thermal processing were also discussed.

Bykova, V.M. Effect of some admixtures to fish hash on its water binding properties. Rybnoe Khozyaistvo. 46(3):47-49; 1970.

The influence of sodium chloride, sodium pyrophosphate, sodium tri-polyphosphate, acid sodium pyrophosphate, and of a proteolytic enzyme preparation orizine PK on the water binding qualities of minced fish was studied. Adding sodium chloride to frozen fish increased the amount of bound water. While phosphates did not influence the ability to bind water, orizine (0.05 and 0.1%) has the same effect as 1.0 and 1.5% salt. Compared with salt, orizine resulted in an increase of the bound water after longer storage periods. In fresh minced fish the effect of these admixtures was the same except that phosphates affect the quantity of bound water more markedly than sodium chloride.

Byt'eva, V.V.; Suprunova, E.A.; Shelest, N.N.; Doronin, A.N. Products obtained from dried Alaska pollock sausage meat by pressing. Issledovaniya po Tekhnologii Rybnukh Produktov. 7:58-62, 108-109; 1977.

Five types of sausage meat were produced from frozen Alaska pollock; control (no additives), with 1-3% flour, with and without 1% salt, and with 20 or 50% Okean (krill) paste and 1% salt, and dried in a semi-fluidized bed to a moisture content of 4-30%; particle size was 2.5-4mm. Pressing was influenced by moisture content. Best results were obtained with 9-12% moisture and at a pressure of 9.8-14.7 MPa giving a firm porous structure and optimum cooking (swelling) characteristics.

Callahan, C.A.; Biede, S.L.; Rutledge, J.E. Flavor losses in mechanically picked crab meats. Nickelson, Ranzell, II (ed.). Proceedings of the third annual tropical and subtropical fisheries technological conference of the Americas. 1978 April 23-26; New Orleans, LA; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-79-101. 1978:251-253.

Preliminary work reaffirmed a flavor loss in machine-picking of blue crab meat, directly relating to amount of water used in processing. Final cook solutions containing salt, ribotide, and MSG were found to improve the flavor of the mechanically-picked crab meat.

Calvo, M.L.; Borderias, A.J. Changes taking place in the protein polymers of the muscular tissues of poutassou (Micromesistius poutassou) and Chinchard (Trachurus trachurus) minced fish flesh during the various stages of freeze-drying. Bulletin de l'Institut International du Froid. 59(4):1120-1121; 1979.

Muscular tissues of minced fish undergoing only 1 freezing process showed practically no protein solubility loss, while in the product thawed and refrozen in the form of granules the loss was significant. There was a significant increase in the protein solubility loss in dried granulated product vs. the product dried as cubes. The texture of the freeze-dried product reflected the loss of protein solubility, and taste panel scores indicated a decrease in juiciness.

Cann, D.C.; Taylor, Lesley Y. The bacteriology of minced fish prepared and stored under experimental conditions. Keay, James N. (ed.). Conference: the production and utilisation of mechanically recovered fish flesh (minced fish), 1976, proceedings. Ministry of Agriculture, Fisheries and Food, Torry Research Station, Aberdeen; 1976:39-45.

It was stated that provided adequate hygiene is practiced, the initial bacteriological quality of minces made from iced fish is dependent entirely on the intrinsic quality of the starting material. The fillets of cod (representative of fresh white fish) provided the best quality minces with trimmings, frames, and backbones following. Under the conditions of storage, time affected bacterial counts more than temperature did.

Carver, J.H.; King, F.J. Fish scrap offers high quality protein. Food Engineering. 43(1):75-76; 1971.

Potential uses of comminuted fish flesh were briefly outlined. A short explanation of how meat/bone separation works was given.

Chambers, M. Roland. Marketing outlook for surimi based products in western Europe. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute. 1981:366-371.

The history and background of the production of Neri products

(products made from fish meat paste) in Japan, their present penetration into Western markets, and the future outlook in Neri product development for Western markets were discussed.

Chandrasekhar, T.C.; Mohite, R.R. Effect of fat coated sorbic acid (FCSA) on the shelf life of fish sausage stored at refrigerated (+10°C) and ambient temperature--a short communication. *Seafood Export Journal*. 10 (11):19-23; 1978.

Fish sausage samples treated with FCSA, a white powder made of sorbic acid and oil, and stored at ambient temperature for 6 days had low total volatile base values, low standard plate counts and retained acceptable flavor and texture. Samples stored at 10°C for 45 days were acceptable and retained color and flavor satisfactorily for 45 days of storage or even longer.

Cheng, C.S.; Hamann, D.D.; Webb, N.B. Effect of thermal processing on minced fish gel texture. *Journal of Food Science*. 44(4):1080-1086; 1979.

Rapid heating to 85°C internal temperature generally produced firmer, more springy texture in fish gels than those heated slowly to 70°C internal temperature. Tropomyosin and myosin degradations in cooked fish gels were highly related to gel textural properties, while changes in muscle proteins during heating were caused by proteolytic factors in the sarcoplasmic fraction. Optimal temperature for proteolytic activity, which was activated by calcium ion, was 60°C.

Cheng, C.S.; Hamann, D.D.; Webb, N.B.; Sidwell, V. Effects of species and storage time on minced fish gel texture. *Journal of Food Science*. 44(4):1087-1092; 1979.

Comminuted fish gels from Atlantic croaker, mullet, ribbon and sand trout were stored at -29°C for up to 12 months and examined for differences in gel textures evaluated instrumentally and by a texture profile sensory panel. Although fish gel texture was not significantly related to protein solubility or raw tissues, it was closely related to water-holding capacity and protein solubility of cooked gels.

Choy, A.A.; Meinke, W.W.; Mattil, K.F. Comparative nutritive value of fillets and minced flesh from some species of fish. Paper presented at the 35th annual meeting of the Institute of Food Technologists. Chicago, Ill.; 1975 June 8-12.

It was found that there was no statistical difference between Protein Efficiency Ratio and Net Protein Ratio values for fillet and

minced flesh prepared from the same fish. Chemical scores indicated that the amino acids cystine and phenylalanine were the limiting amino acids from a nutritional viewpoint.

Choy, A.A.; Meinke, W.W.; Mattil, K.F. Preparation and characterization of some fish flesh products from Gulf Coast trawl fish. Paper presented at the 35th annual meeting of the Institute of Food Technologists. Chicago, Ill.; 1975 June 8-12.

Experimental yields of minced flesh obtained from spot, white trout, and golden croaker ranged from 42% to 45% on a whole fish basis. The trawl fish minced flesh was higher in protein and lower in moisture than the commercial Alaska pollock; also, the amino acid contents of the trawl fish were higher than for the pollock product.

Clark, Ross. Hydrocolloid applications in fabricated minced fish products. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute. 1981:284-298.

Significant features of several commercially important hydrocolloids, including xanthan gum, algin, guar, pectin, locust bean gum, carboxymethylcellulose, and tragacanth were discussed. Application of these gums for binding, water holding, texture modification, and extension/simulation was discussed.

Cole, Bruce J. Full utilization: is the industry throwing profit overboard? Pacific Packers Report. Spring issue:60; 1981.

A general review of the utilization of fishery resources through mechanical recovery was given.

Cole, Bruce J. Deboning technology awaits fishing industry. Pacific Packers Report. Spring issue:68; 1981.

A general review of major available deboning equipment was given.

Cole, B.J.; Keay, J.N. The development of rancidity in minced herring products during cold storage. Keay, James N. (ed.). Conference: the production and utilisation of mechanically recovered fish flesh (minced fish), 1976, proceedings. Ministry of Agriculture, Fisheries and Food, Torry Research Station, Aberdeen; 1976:66-69.

Herring fingers proved to have somewhat superior keeping qualities to kipper fingers. This could be due to the salt present in the

kippers. In some instances significantly higher peroxide values were recorded for fingers which were flash fried than for their counterparts which had not received this treatment. The effect of the availability of oxygen as controlled by the type of packaging material used and the effect of temperature were illustrated.

Connell, J.J.; Hardy, R. (eds.). Trends in fish utilization. Farnham, Surrey, England. Fishing News Books Ltd. 1982. 103 p.

Methods of using unused or little used marine animal resources for human consumption were discussed. Resources included those fish not fully exploited in biological terms, stocks rarely used for human consumption, and edible flesh which can be recovered by mechanical deboning. Subjects included descriptions of deboning equipment, washing and treatment of deboned fish meat, texture, flavor, and product formulations.

Crawford, D.L.; Law, D.K.; Babbitt, J.K.; McGill, L.S. Yield and acceptability of machine separated minced flesh from some marine food fish. *Journal of Food Science*. 37(4):551-553; 1972.

Information on yield of minced flesh obtainable by machine deboning and skinning of important commercial species was developed (yields ranging from 40.4%-54.5%), and the comparative acceptance of portions prepared from frozen blocks of intact and minced flesh was evaluated. Sodium tripolyphosphate added to minced flesh to reduce drip loss was also evaluated as means of improving acceptance.

Crawford, D.L.; Law, D.K.; Babbitt, J.K.; McGill, L.S. Comparative stability and desirability of frozen Pacific hake fillet and minced flesh blocks. *Journal of Food Science*. 44(2):363-367; 1979.

Sensory evaluation scores for hake were very acceptable; the hake quality did not deteriorate more rapidly during storage (-26°C) than true cod (used as a highly acceptable commercial specie for comparative purposes), but true cod was preferred over-all. Minced blocks were not as desirable as fillet blocks. Oxidative rancidity in hake exceeded that in true cod while the TBA analysis for minced flesh was greater than fillet blocks. Textural deterioration in minced over fillet blocks after six months storage was detected by sensory evaluation. Extensive list of references.

Crawford, David L.; Law, Duncan K.; Babbitt, Jerry K. Nutritional characteristics of marine food fish carcass waste and machine-separated flesh. *Journal of Agricultural and Food Chemistry*. 20(5):1048-1051; 1972.

Yield and nutritional characteristics of whole carcass wastes, machine-

separated flesh, and bone-skin fractions of six marine food fish were determined. Machine separation of bone and skin markedly improved the quality of protein in carcass waste. Protein efficiency ration values for separated flesh fractions were significantly higher than values for whole carcass waste.

Dagbjartsson, B. Utilization of blue whiting, Micromesistius poutassou, for human consumption. Journal of the Fisheries Research Board of Canada. 32(6):747-751; 1975.

Blue whiting is similar to other gadoid species in chemical composition and close to cod in eating quality. Minced blue whiting is darker in appearance than most other whitefish products and is stable for only 3 months in frozen storage. Bleaching adversely affects the eating quality.

Daley, L.H.; Deng, J.C. Determining the optimal ranges of factors affecting the sensory acceptability of a minced mullet sausage. Journal of Food Science. 43(5):1497-1500; 1978.

Liquid smoke flavoring, textured soy flour, sodium tripolyphosphate, and water were examined for maximum acceptability ranges of minced mullet sausage. Liquid smoke flavoring's optimum level was 0.5%; sodium tripolyphosphate's, 0.3%; soy flour's, 15%; and water's, between 10 and 15%.

Daley, L.H.; Deng, J.C.; Cornell, J.A. Development of a sausage-typed product from minced mullet using response surface methodology. Journal of Food Science. 43(5):1501-1506; 1978.

Seventeen formulations varying proportions of mullet, soy, water, and sodium tripolyphosphate (TPP) were analyzed for cooking loss, shear force, expressible water, and sensory acceptability. Optimum combinations of ingredients for the most acceptable product were determined by a response surface analysis. All the responses were significantly influenced by water level; sensory ratings were affected by soy level; objective results were affected by TPP level.

Daley, L.H.; Deng, J.C.; Oblinger, J.L. Stability of refrigerated mullet sausage. Journal of Food Science. 44(3):883-891; 1979.

Microbiological assay, rancidity determination, and sensory evaluation were performed on a sausage-type product made from minced mullet. The effects of liquid smoke flavoring, textured soy flour, and hand filleting vs. mechanical deboning were determined. A shelf life of approximately 2 weeks at 2°C was obtained with a limiting factor being off-flavor correlating with total bacterial counts of approximately 4.8×10^5 APC/g.

Dassow, J. Improving the keeping quality of frozen pollock surimi. *Marine Fisheries Review*, 44(2):22; 1982.

The effects of washing, additives, and storage temperatures on the keeping quality of surimi were studied. Preliminary results included: washing improved the keeping quality; some additives improved the quality of the washed product; unwashed samples were much poorer than washed.

Dawood, A.A. Factors affecting the functional properties of fish muscle proteins. *Dissertation Abstracts International*, B. 41(3):875; 1980.

Mechanically deboned freshwater sucker was blast frozen and stored for 90 days, and the effects of storage on solubility of myofibrillar and sarcoplasmic proteins, and non-protein N of sucker flesh were analysed. Effects of addition of NaCl, sodium tripolyphosphate, and soy protein isolate on protein solubility, pH, swelling and gel formation of the flesh were studied. It was also analysed for fat, protein and moisture content.

Dawson, L.E.; Uebersax, K.L.; Uebersax, M.A. Stability of freshwater sucker (*Catostomus* spp.) flesh during frozen storage. *Journal of the Fisheries Research Board of Canada*. 35(2):253-257; 1978.

Coarsely ground (eviscerated) fish, minced flesh, and loin and belly flap muscles prepared from freshwater suckers harvested from Lakes Huron, Michigan, and Superior during different seasons of the year were stored at -18°C for 1-, 3-, 6-, and 12-month periods. Calcium levels of minced flesh, averaging 0.08%, were only one tenth of the levels in eviscerated fish, while lipid analyses (2-thioibarbituric acid test, TBA) indicated an increase in lipid oxidation with storage time (at but 6 months, TBA numbers for untreated minced flesh averaged 2.0). Lipids in minced flesh were less oxidized than those in belly flaps and eviscerated fish but more than those in the loin muscle.

Decker, C.D.; Holt, S.K.; Westerling, D.B. Gelling proteins. Martin, Roy E. (ed.). *Third national technical seminar on mechanical recovery & utilization of fish flesh*. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981:324-339.

The studies were reviewed on the utilization of isolated soy protein with minced fish in some traditional Japanese fish paste products (kamaboko, chikuwa, and satsumage), and the relevance of the Japanese experience to minced fish utilization in the U. S. was examined. The role of isolate in Japan was to extend the supply of minced fish in a variety of traditional products such that the traditional eating quality of the products was maintained. A likely role of isolated soy protein in U. S. minced fish products will be to contribute to the quality of new foods. Isolates are easy to use, but should be properly associated with water to maximize their functional contribution to a food.

Del Valle, F.R.; Bourges, H.; Haas, R.; Gaona, H. A research note: proximate analysis, protein quality and microbial counts of quick-salted, freshly made and stored fish cakes. *Journal of Food Science*. 41(4):975-976; 1976.

The cakes contained an average of 30% protein, 60% salt and 10% moisture. Eighteen-month-old cakes were slightly inferior to casein in protein quality (Protein efficiency ratio and net protein utilization values). After 18 months storage, total plate and halophilic counts of the freshly made cakes decreased from 9,000 and 12,000/g. respectively, to almost zero.

Del Valle, F.R.; Hinojosa, J.; Barrera, D.; De La Mora, R.A. Bacterial counts and rancidity estimates of stored quick-salted fish cakes. *Journal of Food Science*. 38(4):580-582; 1973.

Bacterial contamination of the cakes depended upon their salt and moisture contents and tended to decrease with time after about 2 months. Staphylococci were apparently not present. The cakes became rancid with time to different degrees; some of the rancid components were removed by desalting in boiling water.

Del Valle, F.R.; Padilla, M.; Ruz, A.; Rodriguez, R. Pilot plant production of and large scale acceptance trials with quick-salted fish cakes. *Journal of Food Science*. 38(2):246-250; 1973.

The possibility of producing quick-salted fish cakes in an industrial or semi-industrial scale employing low-cost raw materials was judged valid. Considering calculated production costs, retail prices of the cakes would probably be low and, extrapolating results of the taste trials, acceptance of the cakes would probably be assured.

Deng, J.; Toledo, R.T.; Lillard, D.A. Effect of temperature and pH on protein-protein interaction in actomyosin solutions. *Journal of Food Science*. 41(2):273-277; 1976.

The extent of protein-protein interactions registered as an increase in light scattering absorbance of a solution undergoing change, indicating an increase in the size of the macromolecules. In treatments where protein-protein interaction was extensive, film formation and/or precipitation of the macromolecules occurred. At constant protein concentration the kinetics of the reaction was dependent upon temperature, pH and the type of actomyosin used. In general, the rate and maximum extent of change increased with decreasing pH and increasing temperature. Below 40°C more change was generally observed in beef actomyosin solution compared to mackerel at the same temperature and pH. While at higher temperatures, mackerel actomyosin often shows more change than beef under the same conditions. Arrhenius-type plots of the characteristic slopes derived from the reaction curves showed three possible mechanisms of change predominating within certain temperature ranges, as indicated by well-defined inflections in the curves, reflecting varying activation

energies for the reactions. The three temperature zones are: below 40°C; between 40 and 60°C; and above 60°C. Below 40°C, the rate and maximum extent of protein-protein interaction is very strongly temperature dependent.

Deng, J.C.; Toledo, R.T.; Lillard, D.A. Protein-protein interaction and fat and water binding in comminuted flesh products. *Journal of Food Science*. 46(4):1117-1121; 1981.

The possible role of protein-protein interaction in influencing the water and fat binding capacity of comminuted flesh products was studied. Water and fat binding by meat batters diminish when temperatures exceed 16°C during comminution. The loss of binding capacity was partially reversible, and cooling the batters to 0°C by addition of dry ice and rechopping allowed a partial recovery of the fat and water binding capacity. A cause and effect relationship between the change in fat and water binding by meat batters on chopping and protein-protein interaction in actomyosin solutions was demonstrated. Protein-protein interaction results in molecular aggregation and when measured as an increase in light scattering absorbance at 320 nm by a protein solution, the reaction was shown to be reversible between 4 and 30°C. When actomyosin solutions extracted from meat samples showed reduced protein-protein interaction in the temperature range used in chopping, the batters made from these meats also showed the least loss in fat and water binding capacity with prolonged chopping. Controlling temperatures during chopping within a range where protein-protein interaction in actomyosin solutions was found to be minimal, allowed prolonged chopping without loss in fat and water binding.

Deng, J.C.; Tomaszewski, F.B. The use of response surface methodology to determine the effects of salt, tripolyphosphate and sodium alginate on the quality of fish patties prepared from minced fish, croaker. Connell, J.J. (ed.). *Advances in fish science and technology*. Surrey, England; Fishing News (Books) Ltd.; 1980:218-223.

It was found that NaAlg was the primary factor affecting texture of fish patties made from minced croaker, affecting both breaking force and a panel evaluation of firmness. As NaAlg level increased, the breaking force of the patties decreased. A high positive correlation between breaking force and panel evaluation of firmness was found, with higher preference scores being at low NaAlg levels. The breaking force parameter may thus be used to determine texture preference.

Deng, J.C.; Tomaszewski, F.B. Preparation of fish patties from minced light color fish flesh. Paper presented at the 41st annual meeting of the Institute of Food Technologists, Atlanta, Georgia; 1981 June 7-10. Abstract only.

Deboned and washed sheepshead flesh was mixed with varying proportions of sodium chloride (NaCl), sodium tripolyphosphate (TPP) and sodium alginate (NaAlg) in an attempt to develop a product with highly acceptable texture. The texture quality of the cooked patties was determined

by measuring the breaking force and sensory acceptability. Results from a response surface analysis in general showed that all texture responses were significantly influenced by the NaAlg and TPP level.

Deng, J.C.; Watson, M.; Bates, R.P.; Schroeder, E. Ascorbic acid as an antioxidant in fish flesh and its degradation. *Journal of Food Science*. 43(2):457-460; 1978.

Ascorbic acid degradation in dark or mixed (ground fillet) mullet flesh followed first order kinetics and zero order kinetics in light color flesh. In light color flesh, ascorbic acid acted as an antioxidant with initial concentrations of 50 ppm and 500 ppm or higher over an 11-day storage period at 2°C but acted as a prooxidant at 100 ppm between 4 and 11 days storage. Ascorbic acid showed an antioxidant effect in dark color flesh with initial concentration at 1000 ppm or higher over 9 days storage, but acted as a prooxidant with initial concentration of 50, 100 and 500 ppm after 3, 3.5 and 9 days storage, respectively. The antioxidant to prooxidant shift was observed in the mixed flesh at an added ascorbic acid concentration of 2000 ppm stored for 5 days.

Didenko, A.P.; Goroshko, T.N. Effect of addition of flavour compounds and binders on the structural, mechanical and sensory properties of cooked/frozen fish sausage. *Issledovaniya po Tekhnologii Rybnukh Produktov*. No. 6:78-84, 151; 1976.

Fish sausage made in 10 variations, incorporating 98.5-75.4% minced Alaska pollock, 0-3% wheat flour, 0-2% sugar, 0-5.2% dried milk, 0-2.6% water and (1 variant each), cream, vegetable oil, dried egg, starch, tomato paste, spices or smoked perch was evaluated for changes in rheological properties (adhesiveness, plasticity, compression strength, elasticity), pH and moisture content. The following additions were recommended: 2.7% wheat flour, 1.3 or 2% sugar, 5.2% dried milk, 2.7% potato starch, and 1.2% cooking salt.

Didenko, A.P.; Goroshko, T.N. Effect of added flavour compounds and binding agents on structural and mechanical properties of sausage meat made from deep-water fish. *Issledovaniya po Tekhnologii Rybnukh Produktov*. No. 7:37-41, 108; 1977.

Sausage meat was produced from comminuted deep-water fish (*Lemonema*, *Lycogramma*, and 3 species of grenadier). Sausages were made with each of the following additives: 1.3% salt, 1.3% sugar, 5.2% wheat flour, 5.2% dried milk and 1 sample of sausage meat was made incorporating all these additives. Effects of the additives on the adhesiveness, plasticity, compression strength, elasticity, and bound and free water in raw and boiled sausage meat were determined and tabulated.

Dingle, J.R.; Aubut, W.D.; Lemon, D.W.; Robson, Wanda. The measurement of the bone content in minced fish flesh. *Environment Canada, Fisheries and Marine Service, Halifax Laboratory New Series Circular No. 44*. 1974; 7 p.

A simple alkaline hydrolysis procedure for the estimation of bone particles in mechanically separated fish flesh was described.

Dingle, J.R.; Hines, J.A. Protein instability in minced flesh from fillets and frames of several commercial Atlantic fishes during storage at -5°C . *Journal of the Fisheries Research Board of Canada*. 32(6):775-783; 1975.

Minced flesh of Atlantic cod and pollock suffered a rapid loss of protein solubility during storage at -5°C , due to the presence of kidney tissue which caused the formation of dimethylamine and formaldehyde from the trimethylamine oxide of the muscle. Minced flesh of which flounder, American plaice, and Atlantic mackerel was more stable. The exclusion of gadoid kidney and blood from minced fish preparations was recommended.

Dingle, J.R.; Hines, J.A.; Robson, Wanda. Frozen storage stability of minced fish. Environment Canada, Fisheries and Marine Service, Halifax Laboratory New Series Circular No. 48. 1974; 4 p.

Deboned material from fillets and fillet frames of gadoid species--cod, haddock, pollock, cusk, silver hake, and red hake--was frozen in 1-lb. blocks wrapped in polyethylene bags and stored at -5°C . The blocks were analyzed for extractable protein (EPN) and DMA (to measure formaldehyde formation). With breaded cod frames, EPN fell to a minimum within 3 days while DMA was rapidly produced; skinned fillets, however, were relatively stable with little DMA production. The results from pollock studies were similar to those for cod.

Dingle, J.R.; Keith, R.A.; Lall, B. Protein instability in frozen storage induced in minced muscle of flatfishes by mixture with muscle of red hake. *Canadian Institute of Food Science and Technology*. 10(3):143-146; 1977.

During storage at -10°C , protein of minced red hake (*Urophycis chuss*) muscle became insoluble and the texture became sponge-like. While minced flatfish muscle remained stable for 50 days at -10°C , in a 4:1 mixture with hake muscle it was also made insoluble due to formaldehyde and dimethylamine formation from trimethylamine oxide by constituents of the hake muscle. The mixture was stable for at least 52 days at -30°C , although some deterioration occurred in the hake.

Dingle, J.R.; Lall, B. Stability in frozen storage of minced cod flesh from v-cuts, napes, and frames. Fisheries and Oceans Canada, Technology Branch, Halifax Laboratory New Series Circular No. 69. 1979; 5 p.

The rates of quality-loss changes in minced flesh from v-cuts, napes, and frames of cod due to the presence of blood and kidney tissue were compared. Samples were held at -10°C . In accordance with maintaining

the level of extractable protein nitrogen at 0.6 percent, it was suggested that minced v-cut flesh would have a shelf life of about 75 days, 25 days for nape flesh, and 15 days for flesh from frames.

Dingle, J.R.; Lall, B. Stability of the minced flesh of argentine (Argentina silus) and roundnose grenadier (Coryphoenoides rupestris) during storage at -10°C . Canadian Institute of Food Science and Technology Journal. 12(1):40-41; 1979.

Minced flesh of argentine was found stable at -10°C with extractable protein nitrogen (EPN) decreasing at an average 0.16% of original value per day. EPN of roundnose grenadier decreased more rapidly at about 6.4% of original value per day while dimethylamine was formed at a moderate rate.

Dingle, J.R.; Lall, Barbara S. The effect of temperature of frozen storage on deteriorative changes in the minced flesh of cusk (Brosme Brosme). Fisheries and Environment Canada, Fisheries and Marine Service Technical Report No. 913. 1979; 11 p.

Frozen storage temperature of -5° , -7.5° , -10° , -13° , -18° , and -30°C were used to assess extractable protein nitrogen, dimethylamine (DMA) and formaldehyde (FA) in the minced flesh of cusk. Results showed that at 10°C deterioration of minced flesh was about twice as rapid as that of intact fillets. The investigators recommended a storage temperature of -25°C or lower for minced cusk and the use of DMA or FA concentrations as quality indices.

Dingle, J.R.; Lall, Barbara; Keith, R.A. The mixing of minced flesh of different fish may be risky. Environment Canada, Fisheries and Marine Service, Halifax Laboratory New Series Circular No. 59. 1976; 8 p.

To test the possibility of fish having poor stability in frozen storage affecting the quality of more stable flesh in a mixture, values for extractable protein, dimethylamine, and formaldehyde were taken from minced samples of red hake, the more stable flatfish, and the mixture of the two species. It was found that changes occurring during storage at -10°C in the hake flesh affected the flatfish portion as well.

Duersch, James W. Development and utilization of textured soy proteins and foods. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute. 1981: 312-323.

The development and utilization of structured vegetable protein in food systems and the potential use of such material in fishery products were reviewed.

Eide, O.; Borresen, T.; Strom, T. Minced fish production from capelin (Mallotus villosus). *Journal of Food Science*. 47(2):347-349, 354; 1982.

A new method for producing fish mince, involving cutting the fish into short pieces, washing out the depot fat, dark pigments and viscera under acid or neutral conditions, and bone separation was discussed. The mince had a white appearance, low fat content, and low water-holding capacity.

Fardiaz, D.; Markakis, P. A research note: amines in fermented fish paste. *Journal of Food Science*. 44(5):1562-1563; 1979.

The following amines were tentatively identified in fermented fish paste: histamine, ethanolamine, 2-phenylethylamine, 2-methylbutylamine, 2-mercaptoethylamine, cadaverine, tyramine, dopamine, octopamine, and tryptamine. Concentration of these amines ranged from 0.5-64 mg/100g. Histamine and 2-phenylethylamine were the major amines found with maximal amounts of 64.0 and 60.0 mg/100g, respectively.

Finch, Roland. Whatever happened to fish protein concentrate? *Food Technology*. 31(5):44-53; 1977.

A major purpose of FPC was to improve man's overall use of the protein in fish, but the success of the FPC concept has appeared to recede. Therefore, the possibility of increasing the protein yield from the ocean by applying flesh separation technology to fish assumes greater importance than ever before.

Finne, Gunnar; Nickelson, Ranzell, II; Quimby, Annette; Connally, Nina. Minced fish flesh from nontraditional Gulf of Mexico finfish species: yield and composition. *Journal of Food Science*. 45(5):1327-1340; 1980.

Fish processed both as fresh and pre-frozen included sheepshead, sandtrout, black drum, croaker, mullet, and fresh-water tilapia. Yield of minced flesh ranged from 31.3% for fresh croaker to 20.0% for pre-frozen round mullet. Moisture content varied from 75.22% (black drum) to 81.96% (mullet); protein, 14.19% (mullet) to 18.69% (sandtrout); fat, 1.33% (mullet) to 5.83% (croaker).

Finne, Gunnar; Nickelson, Ranzell, II; Vanderzant, Carl. Deboned fish flesh from non-traditional Gulf of Mexico finfish species. 2. microbiology. Nickelson, Ranzell, II. (ed.). *Proceedings of the fourth annual tropical and subtropical fisheries technological conference of the Americas*. 1979 April 22-25; St. Petersburg, FL; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-80-101. 1979:173-177.

Total aerobic plate counts fluctuated during processing, with a general trend towards lower counts after scaling and deheading and increases at evisceration and mincing. Counts of finished product were reduced by at least one-log after freezing but remained relatively constant during 6 months storage. Moraxella Acinetobacter spp. were a substantial part of the microbial flora of whole fish as well as the finished minced product.

Flink, J.M.; Goodhart, M. Transport of oxygen through ice and frozen minced fish. *Journal of Food Processing and Preservation*. 2(3):229-248; 1978.

O₂ transport through ice and minced fish at -5°C was determined using a Clark-type O₂ electrode in a sample of known geometry. Slow frozen minced fish exhibited higher permeability to O₂ than slow frozen ice; coating of the minced fish with a slow frozen ice glaze resulted in reduced O₂ transport.

Food and Agriculture Organization of the United Nations. Report of the FAO/NORAD round table discussion on expanding the utilization of marine fishery resources for human consumption. 1975 August; Svanoy, Norway. Available from: Food and Agriculture Organization of the United Nations, Rome, Italy; FAO Fisheries Report, No. 175.

FAO fisheries reports. Fish utilization. Fish in human nutrition. Marine resources potential - small pelagic fish - cephalopods - mussels - mesopelagic species - krill. Fish handling, preservation, processing. Fish protein concentrates. Functional protein from fish. Minced fish. Hydrolysates. Canned fish. By-catch utilization. Protein yields.

Food & Agriculture Organization, FAO/WHO Codex Alimentarius Commission; World Health Organization, FAO/WHO Codex Alimentarius Commission. Report of the 14th session of the Codex Committee on Fish and Fishery Products. Bergen(Norway). FAO/WHO Food Standards Programme. ALINORM 81-18; 1981. 73 pp.

Progress in the formulation of standards for fish and fishery products was reported. Proposed standards included those for canned Pacific salmon; quick frozen blocks of fillets, minced fish, and mixtures; fish fingers and portions; and dried salted fish.

Food and Agriculture Organization of the United Nations. Code of practice for minced fish. FAO Fish Production and Marketing Service, Fishery Industries Division, FAO Fisheries Circular C700. 1977; 32 p.

Technological and hygienic requirements based on good commercial practice and on the FAO/WHO Recommended International Code of Practice--General Principles of Food Hygiene are offered for those in the minced fish industry.

Froning, G.W. Mechanical deboning of poultry and fish. *Advances in Food Research*. 27:109-147; 1981.

This review article included discussions of mechanical deboners, composition and nutritive properties, flavor stability, color stability, functional characteristics, utilization of bone residue, microbial quality, regulations, and needed research.

Fujita, Y.; Miyazaki, W.; Kanayama, T. Microbial control at 'kamaboko' (and fish sausage) processing plants. I. Airborne microorganisms at the processing plants. *Bulletin of the Japanese Society of Scientific Fisheries*. 45(7):891-899; 1979.

Numbers of airborne microorganisms at 3 plants were estimated during April and July 1978 by exposure of 9 cm plates containing nutrient or potato dextrose agar for 15 min., followed by incubation. Average counts of Staphylococcus aureus were 0.26-2.06/plate in April, and 1.32-2.09/plate in July, for an exposure time of 30 min. Average counts of coliform bacteria were 0.34-2.41/plate in April and 2.5-5.7/plate in July. It was suggested that the results indicated the need for careful control of airborne microbial contamination in processing plants.

Fujita, Yatsuka; Kanayama, Tatsuo. On the brown discoloration in fish jelly products--III. Various conditions affecting the discoloration by two species of bacteria. *Bulletin of the Japanese Society of Scientific Fisheries*. 39(3):327-331; 1973. (In Japanese; English summary.)

Various conditions under which the brown discoloration of fish jelly products was produced by Achromobacter brunificans and Serratia marcescens were described.

Fujita, Yatsuka; Matsumoto, Toshiko; Matsuda, Toshio. On the brown discoloration in fish jelly products--VII. The mechanism of browning precursor production by Enterobacter cloacae UFF-107. *Bulletin of the Japanese Society of Scientific Fisheries*. 44(6):643-651; 1978. (In Japanese; English summary.)

The mechanism of brown discoloration caused by the microorganism Enterobacter cloacae UFF-107 was studied. The browning precursor which was participating in the reaction with various amino acids or proteins to form the brown substance was confirmed to be formed from glucose or 2-ketogluconic acid by intact cells of E. cloacae UFF-107.

Fukuda, Yutaka; Kakehata, Koichi; Arai, Ken-ichi. Comparative study on thermostability of actomyosin in minced muscle of chub mackerel and Alaska pollock. *Bulletin of the Japanese Society of Scientific Fisheries*. 43(6):717-725; 1977. (In Japanese; English summary.)

During storage of the minced muscle of chub mackerel and Alaska pollock at 2°C, it was found that a decrease in the amount of actomyosin and concomitant deterioration of the kamaboko quality rapidly occurred in the muscle samples from chub mackerel. It was concluded that the rapid deterioration of chub mackerel muscle quality should be attributed to the denaturation of actomyosin due to a marked decline in the pH value of raw muscle.

Fukuda, Yutaka; Kakehata, Ko-ichi; Arai, Ken-ichi. Denaturation of myofibrillar protein in deep-sea fish by freezing and storage. Bulletin of the Japanese Society of Scientific Fisheries. 47(5):663-672; 1981. (In Japanese; English summary.)

During freezing and subsequent frozen storage of deep-sea fish muscle, the denaturation of muscle was studied in terms of myofibrillar ATPase activity and solubility of muscular proteins.

Furukawa, T.; Koyama, S.; Ohta, S. Interactions between fish protein and soy protein as related to their gel forming properties. Journal of Japanese Society of Food Science and Technology. 29(4):208-213; 1982.

Interactions between fish protein and isolated soy protein based on heat-induced gel forming property of mixed systems composed of both proteins were studied. The interactions depended on the protein concentration and mixing ratio of fish paste to isolated soy protein. Reasons for gel strength increases were discussed.

Gates, Keith, W.; Wu, C.M, Arnold. Process development for a foreign marketable fish product from underutilized fish. Nickelson, Ranzell, II (ed.). Proceedings of the third annual tropical and subtropical fisheries technological conference of the Americas. 1978 April 23-26; New Orleans, LA; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-79-101. 1978:29-44.

The feasibility of mechanized Yu-sone production, a seasoned, semi-dried, ground fish flakes, from underutilized croaker was demonstrated by successful 3-month room temperature storage of Yu-sone produced from mechanically deboned croaker flesh. Since fish of low fat content and fine muscle fiber are preferred raw materials, other suitable American finfish species for Yu-sone production are spot, whiting, trigger fish, red porgy, sea trout, grouper, and black sea bass. Oily fish such as mullet pose problems of product rancidity.

Ghadi, S.V.; Lewis, N.F. Preparation of minced muscle blocks from trash fish. *Fleischwirtschaft* 57(12):2155-2157, 2243-2244; 1977.

The preparation and storage characteristics of frozen minced muscle blocks from croaker (*Johnius dissumieri*), anchovies (*Thrissoles spp.*) and mixed fish var. were studied. Tabulated results on frozen minced muscle blocks of croaker, anchovies, and mixed fish showed that mechanically deboned fish had slightly higher moisture and ash contents, thiobarbituric acid (TBA) and protein extractability values than manually deboned muscle. Polyphosphate + NaCl treatment enhanced protein extractability, especially during storage, e.g. from 80 to 85% at the start and from 20 to 50% after 6 months' storage in croaker, from 45 to 65% in anchovies.

Ghosh, S.K.; Ghadi, S.V.; Lewis, N.F. Effect of method of deboning on the emulsifying capacity of trash fish muscle. *Fleischwirtschaft* 57(12):2157-2158, 2245-2246; 1977.

Results showed considerable differences in emulsifying capacity between fish varieties, e.g. 43.5 (golden anchovies)-29.5 (anchovies) for manually separated muscle, 54.0 (shark)-39.0 (croaker) for mechanically separated muscle.

Gill, T.A.; Dingle, J.R.; Smith-Lall, B.; Stanley, D.W. Improved utilization of fish protein--quality enhancement of mechanically deboned fish. *Canadian Institute of Food Science and Technology Journal*. 12(4):200-201; 1979.

A procedure optimizing the ionic strength and pH of washing solutions for the production of good quality minced cod was described. NaCl concentrations were varied between 0 and 0.25 M for wash waters ranging from pH 5 to 7. Lowering wash water pH reduced blood color and water uptake of the minces and enhanced removal of trimethylamine oxide; lowering pH of the washing solution also reduced protein loss due to leaching.

Gillies, M.T. *Fish and shellfish processing*. Noyes Data Corporation, Park Ridge, New Jersey. 1975; 338 p.

Detailed, descriptive information based on U.S. patents since 1960 relating to the large scale processing of fish and shellfish was given. Subject, company, inventor, and patent number indexes were listed.

Goodrich, Dana C., Jr.; Whitaker, Daniel B. Retail market tests of frozen minced fish. *Cornell University. A.E. Res.* 77-6. June, 1977; 23 p.

Frozen minced fish was test marketed in eight supermarkets and one retail seafood market for 89 cents per package (one-pound) for varying periods of 3 to 18 weeks. During introductory weeks of in-store

product demonstrations sales in each store were very high. After the introductory period, sustained sales levels were achieved in six of the seven stores carrying the product for at least 11 weeks. This performance and the high proportion of consumers surveyed intending to repurchase suggested potential success for further commercial marketing of minced fish products.

Goodrich, Dana C., Jr.; Whitaker, Daniel B. Retail market tests of minced seafood chowders. Cornell University. A.E. Res. 78-4. May, 1978; 13 p.

Market tests for two styles of Minced Seafood Chowder were conducted in two upstate New York retail food stores for 21 weeks. In-store and mail surveys administered to chowder consumers showed that more than 85% were willing to buy the chowder products again. The test products achieved a high proportion (75%) of total specialty chowder sales in the initial weeks of in-store demonstrations.

Goodrich, Dana C., Jr.; Whitaker, Daniel B. Retail market tests of minced seafood crispies. Cornell University. A.E. Res. 79-2. February, 1979; 10 p.

Although test sales and customer surveys were carried out in a limited number of retail food stores over only a 12-week period, Frozen Seafood Crispies, developed from under-valued fish and seafood, appeared to be successful in the commercial market.

Grabowska, J.; Sikorski, Z. Technological quality of minced fish preserved by freezing and additives. Acta Alimentaria, Academic Scientiarum Hungaricae. 2(3):319-326; 1973.

To investigate the suitability of minces as components of sausage emulsions, exhaustive water extraction and/or the additives of sucrose, sodium monoglutamate, molasses, sodium chloride, polyphosphates, and wood smoke condensate in minced fish before freezing and storage were studied. Protein solubility in the thawed material and texture deterioration in the sausages decreased as a result of frozen storage. Technological value of minced fillets was improved by water extraction and addition of glucose.

Granroth, B. Keeping quality of minced Baltic herring. Kemia-Kemi 6(12):760; 1979.

Sensory evaluation was more sensitive a criterion for minced Baltic herring quality after frozen storage than were objective criteria (such as drip value, free fatty acid content, peroxide number and soluble actomyosin). Retardants for oxidation reactions were discussed.

Grantham, G.J. Minced fish technology: a review. FAO Fisheries Technical Paper. No. 216; 1981. 72 pp.

Included in this review article were discussions of raw materials and sources, separation processes, mince stabilization, mince products, production, and marketing.

Greenfield, J.E. The economics of the commercial development of Gulf of Mexico bottomfish. Cobb, Bryant F., III and Stockton, Alexandra B. (eds.) Proceedings of the first annual tropical and subtropical fisheries technological conference. Texas A & M University-Sea Grant College. Publication No. TAMU-SG-77-105; 1976:631-644. (Vol. 2).

The small size of Gulf of Mexico bottomfish required mechanical flesh separation technology. The author approximated the economic feasibility of using these bottomfish resources for marketing in conventional minced fish block forms.

Groninger, H. Fish frankfurters. Fishing News International. 20(8): 24-25; 1981.

Fish frankfurters and other products from frozen minced pollock flesh were discussed in relation to food outlets in the United States. Functional properties, along with the effects of handling and processing conditions, were also discussed.

Hamada, M.; Inamasu, Y. Linear viscoelasticity of kamaboko by dynamic testing. Bulletin of the Japanese Society of Scientific Fisheries. 45(7): 905-912; 1979.

The linear viscoelasticity of 3 grades of kamaboko were studied in relation to *ashi*, or textural quality, using a non-resonant forced oscillation at 0.54-98.7 Hz and 12-60°C. Kamaboko was shown to be slightly cross-linked and a thermorheologically simple material.

Hamann, D.D.; Webb, N.B. Sensory and instrumental evaluation of material properties of fish gels. Journal of Texture Studies. 10:117-130; 1979.

Small strain material properties of over 100 heat coagulated fish pastes were evaluated instrumentally using uniaxial sinusoidally varying force at a frequency of 2 Hz and recording stress, strain and the phase angle between the two. A multibeade shear/compression cell mounted in an Instron Universal Testing machine measured the shear/compression failure force which was a good predictor of sensory springiness, firmness, cohesiveness, and gel strength evaluated by a trained texture profile panel. Gumminess and adhesiveness ratings were similar; varied inversely with the shear/compression cell force and with sensory springiness, firmness, cohesiveness, gel strength; and were directly proportional to the loss tangent of the product.

Hansen, P. Concentration and preservation of mechanically recovered fish flesh. Fish by-catch...bonus from the sea. Report of a technical consultation on shrimp by-catch utilization held in Georgetown, Guyana; 1981 October 27-30; International Development Research Centre, Ottawa, CA; 1982:84-88.

The addition of salt, acidifying to pH 4, draining, and pressing were reported to reduce water, volatile bases, and trimethylamine oxide in raw mince from cod frames. The results from this preliminary study may be applicable to other species in the by-catch from shrimp trawling.

Harrison, A.P., II; Suter, D.A.; Cobb, B.J., III; LePori, W.A.; Jones, E.R. Mechanical processing of Atlantic cutlassfish. Abstracts of the second annual tropical and subtropical fisheries conference of the Americas. 1977 April 17-20; Biloxi, MS; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-77-112.

A 41.5% yield was achieved for the mechanically deboned form of the underutilized Atlantic cutlassfish. Preference taste and texture showed no significant differences due to ice storage prior to processing or subsequent frozen storage for both frozen raw minced block or frozen pre-cooked fish sticks, compared to commercial codfish. Objective textural measurements showed no significant differences due to frozen storage or periods on ice, prior to processing, as compared to codfish.

Heen, Eirik; Kreuzer, Rudolf (ed.). Fish in nutrition. London, England. Fishing News (Books) Ltd.; 1962.

International Congress by FAO, Washington, D.C., September, 1961. Main topics: The role of fish in world nutrition - Chemical components of fish and their changes under treatment - Contribution of fish and fish products to national diets - Fish and fishery products in animal nutrition - Demand for fish as human food and possibilities for increased consumption.

Herborg, L. Quality control and inspection of European comminuted products. Kreuzer, Rudolf (ed.). Fish inspection and quality control. London, England. Fishing News (Books) Ltd.; 1971:124-128.

The normal process for manufacturing comminuted products and typical examples of various types of products were described. Methods for quality control and inspection were outlined.

Herborg, L. Development of novel fish products in the Caribbean area. Paper presented at the conference on the handling, processing and marketing of tropical fish; London, U.K.; 1977. Available from: Ministry of Fisheries, Technical University, Lyngby, Denmark.

Small-scale development in the South Caribbean area in 1971 of marinated products to create marketing possibilities for glut landings and cooked/minced products to commercialize under-utilized fish species (e.g. catfish and sharks) was discussed. Methods for preparing marinated fish, fish sausages and fish burgers were described.

Herborg, Lars. Production of separated fish mince for traditional and new products in Denmark. Keay, James N. (ed.). Conference: the production and utilisation of mechanically recovered fish flesh (minced fish), 1976, proceedings. Ministry of Agriculture, Fisheries and Food, Torry Research Station, Aberdeen. 1976:82-83.

New minced fish products for the Danish market were discussed.

Herborg, L.; Johansen, S. Fish cheese: the preservation of minced fish by fermentation. Paper presented at the conference on the handling, processing and marketing of tropical fish; London, U.K.; 1977. Available from: Ministry of Fisheries, Technical University, Lyngby, Denmark.

Minced fish flesh from a meat/bone separator was heated to 80°C for 20 min., cooked, and whey powder or sucrose added. After incubation, the curd was pressed into blocks, brined, and vacuum packed. Shelf life of several months at ambient temperature is possible.

Herborg, Lars; Pedersen, Karin. Classification of minced fish. Paper - Technological Laboratory. 1974; 7 p. Available from : Ministry of Fisheries, Technical University, Lyngby, Denmark.

Bone content, bone size, and grading according to color of separated fish blocks were investigated. A standard of freshness for pure cod blocks was suggested while a standard for bone content was not, but a method of analysis by digesting the minced fish by ethanolic KOH and weighing the remaining bones was recommended.

Herrera L., P.M. Utilization of shrimp and prawn by-products in the formulation of human edible foods. Paper presented at the 37th annual meeting of the Institute of Food Technologists, Philadelphia, Pa.; 1977 June 5-8. Abstract only.

The procedure used to recover and convert residual edible by-products into food products consisted essentially of mechanically deboning and heating (95°C-97°C) to coagulate the proteins until a paste was formed. The proximate chemical composition of this intermediate raw material, its yields, microbial levels, physical, chemical, and organoleptic properties were included.

Hiltz, D.F.; Lall, B.S.; Lemon, D.W.; Dyer, W.J. Deteriorative changes during frozen storage in fillets and minced flesh of silver hake (Merluccius bilinearis) processed from round fish held in ice and refrigerated sea water. Journal of the Fisheries Research Board of Canada. 33(10):2560-2567; 1976.

Holding round fish up to 6 days in refrigerated sea water (RSW) at 0-1°C before processing extended the frozen storage life of fillets at -10°C by 2-3 weeks and of minced flesh by 1 week over that for comparable materials prepared from round fish held in ice. Saturation of the sea water with CO₂ retarded the onset of bacterial spoilage in RSW-held fish. Spoilage otherwise developed more rapidly than in iced fish.

Hiltz, D.F.; North, D.H.; Lall, B.; Keith, R.A. Storage life of refrozen silver hake (Merluccius bilinearis) processed as fillets and minced flesh from thawed, stored, round-frozen fish. Journal of the Fisheries Research Board of Canada. 34(12):2369-2373; 1977.

During storage at -18°C processed fillets and minced flesh from refrozen silver hake underwent rapid deterioration compared with once-frozen control samples. Some initial deterioration occurred after 6 months, particularly in refrozen minced flesh; otherwise, the quality of the refrozen samples immediately after thawing and refreezing was similar to the quality of the round-frozen fish. Minced flesh was more unstable in frozen storage than fillets and dimethylamine formation occurred simultaneously with a decrease in protein extractability.

Hiltz, Doris F.; Dyer, W.J.; Lemon, D.W. Some properties of fillets and minced flesh of silver hake (Merluccius bilinearis) in frozen storage. Environment Canada, Fisheries and Marine Service, Halifax Laboratory New Series Circular No. 46; 1974. 9 p.

Minced flesh of silver hake was more unstable than intact fillets. While holding round fish in refrigerated sea water for up to 6 days before processing resulted in improved frozen storage properties for intact and minced fillets compared with holding in ice, differences in pre-processing holding conditions for minced flesh obtained from headed and gutted fish were less marked. Initial quality (up to 6 days) had little effect on rate of frozen storage deterioration in any intact or minced samples. Findings indicated that frozen fillets or minced blocks

prepared from silver hake can be acceptable to the consumer, but the potential instability of this gadoid species in frozen storage due to DMA-formaldehyde formation, as well as a tendency toward rancidity, points to the importance of constant low-temperature storage (preferably below -20°F).

Hing, Francisco S.; Tang, Nora Yu-Ang; Cavaletto, Catherine G. Stability of fish Sausage at low temperature storage. *Journal of Food Science*. 37(2):191-194; 1972.

Fish sausage made with striped marlin and skipjack tuna and processed in boiling water for 50 minutes was shown to possess good sensory and microbial quality. The product was stable for 15-26 weeks at 35°F as well as at 45°F .

Hirata, Sadao. Rheology of kamaboko--IV. Comparisons of dynamic visco-elastic properties of two kinds of commercial kamaboko prepared in Odawara and in Maizuru. *Bulletin of the Japanese Society of Scientific Fisheries*. 30(8):635-638; 1964. (In Japanese; English summary.)

Dynamic rigidities, dynamic viscosities, relaxation spectra, and loss tangent, of three different foodstuffs, i.e. processed cheese, commercial kamaboko prepared in Odawara and in Maizuru were calculated from the data of the periods and the damping coefficients measured by means of damped free vibration in torsion.

Horiuchi, H.; Azuma, K. Mechanical properties of waxy rice cake, mochi. IV. Effect of mixed air bubbles on mechanical properties of kamaboko and hanpen (fish jelly products). *Journal of the Agricultural Chemical Society of Japan*. 55(12):1225-1231; 1981.

The complex modulus, apparent specific volume and distribution of pores in kamaboko and hanpen with different air contents were measured in order to clarify the effect of fine air bubbles in mochi cake on the large temperature dependence of the elastic modulus.

Howgate, Peter. The sensory properties of minced cod and herring. Keay, James N. (ed.). Conference: the production and utilisation of mechanically recovered fish flesh (minced fish), 1976, proceedings. Ministry of Agriculture, Fisheries and Food, Torry Research Station, Aberdeen. 1976:49-53.

Color of minces and unprocessed fish meat were similar, except that the mince from cod backbones was slightly darker. The odor, flavor, and texture of the backbone mince appeared unacceptable, while the minces from other cod fractions were acceptable but of inferior quality.

Mincing affected the flavor of herring, but appeared not to have affected its texture. It was hypothesized that in both species the extrusion and concomitant mincing processes rapidly accelerated enzyme reactions that occur, but slowly, in the intact fillet.

Hujita, Masao; Simidu, Wataru; Inoue, Ken-iti. Studies on utilization of gluten in fish sausage--I. Influence of gluten on elastic property of fish sausage. Bulletin of the Japanese Society of Scientific Fisheries. 27(2):199-202; 1961. (In Japanese; English summary.)

The behavior of gluten mixed with fish sausage was observed regarding the elastic properties of the product. The elastic properties of fish sausage were not influenced by mixing with gluten, except for exceeding over 60-65% water in gluten which was the maximum amount holding in it. The water content of gluten less than 60-65% improved the quality, while an increase of water was affected in inverse.

Hume, A.; Mackie, I.M. The use of electrophoresis of the water-soluble muscle proteins in the quantitative analysis of the species components of a fish mince mixture. Connell, J.J. (ed.). Advances in fish science and technology. Surrey, England. Fishing News (Books) Ltd. 1980:451-456.

Mixtures of cod and saithe were analyzed and the percentage of each species determined reasonably accurately using optimal methods for quantitative electrophoresis. Due to the difficulty in identifying unequivocally all species present and the reliance on single characteristic bands from the species to be analyzed well separated from other zones, the methods have limited application for unknown mixtures.

Ikeuchi, Tsuneo. Enhancing effects of various jelly-forming substances on kamaboko-jelly. Bulletin of the Japanese Society of Scientific Fisheries. 30(1):75-81; 1964. (In Japanese; English summary.)

The effects of addition of polyvinyl alcohol, methyl cellulose, carbomethyl cellulose, gelatin, gluten and starch on kamaboko-jelly were discussed summarily in comparison with one another.

Ikeuchi, Tsuneo. Study on protein-oil-water system in kamaboko--VI. Effect of brayed fish meat on emulsion formation. Bulletin of the Japanese Society of Scientific Fisheries. 30(3):272-278; 1964. (In Japanese; English summary.)

The emulsification efficiency of brayed meat was discussed in relation to the conditions of fish meat such as the water content, the salt concentration and the pH.

Ikeuchi, Tsuneo; Simidu, Wataru. Studies on protein-oil-water system in kamaboko--I. Effect of added oil on jelly strength of kamaboko. Bulletin of the Japanese Society of Scientific Fisheries. 20(9):814-815; 1955. (In Japanese; English summary.)

To improve the nutritive value of kamaboko and the flavor of fish sausage, oil or fat was blended into these products in the process of manufacturing. Even a small quantity such as 2% of oil proved to reduce jelly strength to some extent, but with the addition of up to 15% of oil, jelly strength remained constant or rather showed a tendency to increase. When oil was added over 15%, the physical properties of the paste were spoiled and the jelly structure of the products was demolished in a marked degree.

Ikeuchi, Tsuneo; Simidu, Wataru. Studies on protein-oil-water system in kamaboko--II. A change of jelly strength by adding oil in kamabokos made from different species of fish. Bulletin of the Japanese Society of Scientific Fisheries. 25(2):141-143; 1959. (In Japanese; English summary.)

When oil was added to kamaboko for the purpose of improving its quality, the jelly strength was not affected if the amount of oil did not exceed 20%. When the amount of added oil exceeded this limit, the strength dropped down suddenly.

Ikeuchi, Tsuneo; Simidu, Wataru. Studies on protein-oil-water system in kamaboko--III. Effect of freshness of raw fish to jelly strength of kamaboko containing oil. Bulletin of the Japanese Society of Scientific Fisheries. 25(2):144-146; 1959. (In Japanese; English summary.)

In kamaboko made from less than fresh fish, jelly strength was found to decrease with an increase of oil content.

Ikeuchi, Tsuneo; Simidu, Wataru. Studies on protein-oil-water system in kamaboko--IV. Effect of water in kamaboko containing oil on jelly strength. Bulletin of the Japanese Society of Scientific Fisheries. 25(4):316-318; 1959. (In Japanese; English summary.)

The jelly strength of kamaboko was not affected so much by adding water to minced raw meat, as long as the amount of water did not exceed a certain limit; but when the amount of water exceeded this limit, the strength dropped remarkably.

Ikeuchi, Tsuneo; Simidu, Wataru. Studies on protein-oil-water system in kamaboko--V. Effect of starch on elastic properties of kamaboko containing oil. Bulletin of the Japanese Society of Scientific Fisheries. 26(12):1167-1170; 1960. (In Japanese; English summary.)

Even when the elastic properties of kamaboko were diminished as a result of adding oil to modify the quality, it was found that starch added together with the oil not only kept the elasticity of kamaboko in good condition but also strengthened it markedly.

Ikeuchi, Tsuneo; Simidu, Wataru. Study on cold storage of brayed fish meat for the material of kamaboko--I. Effects of setting phenomenon on the jelly-forming ability of frozen brayed fish meat. Bulletin of the Japanese Society of Scientific Fisheries. 29(2):151-156; 1963.

In this study, the decreases of jelly-forming ability and solubility of protein in 0.6N NaCl aqueous solution were regarded as indexes of setting. It was found that the impossibility of cold storage of brayed meat was caused mainly by setting, and that this phenomenon appeared at the initial stage of storage in most cases.

Ikeuchi, Tsuneo; Simidu, Wataru. Study on cold storage of brayed fish meat for the material of kamaboko--II. Effects of saccharides and others on setting of brayed fish meat. Bulletin of the Japanese Society of Scientific Fisheries. 29(2):157-160; 1963.

Ikeuchi, Tsuneo; Simidu, Wataru. Study on cold storage of brayed fish meat for the material of kamaboko--III. Effects of saccharose concentrations on setting of brayed fish meat. Bulletin of the Japanese Society of Scientific Fisheries. 29(3):258-262; 1963.

Ikkala, Preben. The organoleptic assessment of the texture of minced fish (method to determine texture profiles). Paper, Technological Laboratory, Ministry of Fisheries, Technical University. Lyngby, Denmark; 1975.

An introductory attempt to demonstrate a working method of obtaining subjective texture profiles of minced fish was described.

Institute of Food Technologists. Mechanically deboned red meat, poultry, and fish. Food Technology. 33(3):77-79; 1979.

The scientific status of mechanically-deboned red meat, poultry and fish was reviewed. The deboning process and deboned meat products were briefly described. The regulation of the use of mechanically deboned meat, the safety of using mechanically deboned meat regarding bone fragments, antibiotic and pesticide residues, trace elements and microbial hazards and the nutritive value of mechanically deboned meat were discussed.

Iredale, D.G.; Shaykewich, K.J.; Rastogi, R.K. An approach to the development of a formulated breaded product from mechanically deboned freshwater fish. Environment Canada, Fisheries and Marine Service Research and Development Technical Report No. 463; 1974. 14 p.

Preliminary work on developing a breaded or battered fish shaped portion from mechanically deboned sucker was undertaken to achieve various characteristics in the product, assess by sensory evaluation, and outline possible commercial scale production.

Iredale, D.G.; York, R.K. Modified processing system and pilot plant application of an improved formulated product from mechanically deboned freshwater fish. Environment Canada, Fisheries and Marine Service Research and Development Technical Report No. 574; 1975. 17 p.

A two-stage processing system was developed to produce a battered and breaded formulated portion from mechanically deboned sucker (Catostomidae), a "difficult to market species". The processing procedure improves the dispersion of shortening in the product base, improves quality retention by minimizing temperature rises during product molding, and allows more regulation of secondary processing.

Iredale, D.G.; York, R.K. Effects of chemical additives on extending the shelf life of frozen minced sucker (Catostomidae) flesh. Journal of the Fisheries Research Board of Canada. 34(3):420-425; 1977.

Sensory testing and 2-thiobarbituric acid values were used to evaluate the effects of sodium erythorbate, disodium EDTA, and sodium tripolyphosphate on development of oxidative rancidity in samples of minced sucker stored for 44 days at -4°C. Results showed that sodium erythorbate inhibited development of oxidative rancidity and helped maintain higher flavor score in sensory evaluation.

Ishii, S.; Amano, K. Reprocessing fish into composite products. Kreuzer, Rudolf (ed.). Fishery products. Surrey, England. Fishing News (Books) Ltd.; 1974:281-283.

The materials, presentation, and wide acceptance of composite fishery products--those made chiefly from comminuted fish meat with other ingredients such as cereals, vegetables, flavoring, and coloring substances--were discussed.

Ishikawa, S. Manufacture of kamaboko and surimi from sardines. II. Effect of temperature during manufacture on the jelly strength of kamaboko. Bulletin of the Tokai Regional Fisheries Research Laboratory. 94:37-44; 1978.

Studies on effects of environmental temperature after catching sardines and during the manufacture of kamaboko were described. Sardines caught during the summer showed poorer kamaboko-forming ability than those caught in the winter. Jelly strength of the kamaboko decreased with increasing temperature during mixing.

Ishikawa, S.; Nakamura, K.; Fujii, Y. Manufacture of kamaboko and surimi from sardines. I. Effects of freshness and handling of raw material on its kamaboko-forming ability. Bulletin of the Tokai Regional Fisheries Research Laboratory. 90:59-66; 1977.

Studies on kamaboko made from sardines stored in ice showed that kamaboko-forming ability decreased with increasing storage time, kamaboko-forming ability decreased and color and odor increased as increasing proportions of dark meat were used, and surimi prepared from sardines immediately after catching maintained strong kamaboko-forming ability during storage for 3 months. The jelly strengths of kamaboko made from sardine light meat or light and dark meats were equal to those of samples made from some Alaska pollock.

Ishikawa, S.; Nakamura, K.; Fujii, Y.; Yamano, G.; Sugiyama, T.; Shinozaki, K.; Tobita, K.; Yamaguchi, Y. Fish jelly product (kamaboko) and frozen minced meat (frozen surimi) made of sardine. III. Influence of treatment methods for materials just after catching on the kamaboko forming ability of sardine meat. Bulletin of the Tokai Regional Fisheries Research Laboratory. 99:31-42; 1979.

Three treatments of sardines immediately after catching were tested: (1) storage in ice immediately after catching; (2) leaving for several hours at ambient temperature, then storage at 0°C in iced water; and (3) icing immediately after catching, followed by pH adjustment by soaking in NaHCO₃ 90 min. after catching. Treatment 3 gave better jelly strength and better kamaboko-formation characteristics during storage.

Ito, H.; Iizuka, H. Use of gamma-irradiation to prevent spoilage of "retainer-type" Kamaboko. Journal of Japanese Society of Food Science and Technology. 25(1):14-21; 1978.

Irradiation of kamaboko at 300 krad and 450 krad reduced the Bacillus subtilis, B. pumilus, B. megaterium, B. cereus, Pseudomonas, Brevibacterium, Aeromonas, and yeasts present in the fish meat jelly product at 20°, 10°, and 5°C to Bacillus and yeasts. The storage life of kamaboko was almost doubled at 10°C.

Itoh, Y.; Yoshinaka, R.; Ikeda, S. Effects of cysteine and cystine on the gel formation of fish meat by heating. Bulletin of the Japanese Society of Scientific Fisheries. 45(3):341-345; 1979.

To explain the role of -SH groups and -S-S-bonds in fish proteins in gel formation as a result of heating, the effects of addition of L-cysteine and L-cystine were examined. Adding cysteine and cystine to fish meat pastes from Alaska pollock, tuna, cod, and carp increased the gel strengths.

Itoh, Yoshiaki, Yoshinaka, Reiji; Ikeda, Shizunori. Gel forming ability of carp actomyosin. Bulletin of the Japanese Society of Scientific Fisheries. 45(1):73-77; 1979. (In Japanese; English summary.)

In order to establish a model system for the elucidation of the heat-gelling mechanism of fish meat in connection with the development of elastic properties of kamaboko, the gel forming ability of carp actomyosin (AM) was investigated under various conditions.

Itoh, Yoshiaki; Yoshinaka, Reiji; Ikeda, Shizunori. Effects of inorganic reducing agents on the gel formation of fish meat by heating. Bulletin of the Japanese Society of Scientific Fisheries. 45(4):455-458; 1979. (In Japanese; English summary.)

The effects of some inorganic reducing agents, sodium nitrite, sodium thiosulfate, and sodium hydrogen sulfite on the gel formation of Alaska pollock brayed-meat were examined in order to estimate the participation of intermolecular SS bonds of protein in the gel formation. It was found that the gel strength was increased by adding the inorganic reducing agents to the brayed-meat.

Itoh, Yoshiaki; Yoshinaka, Reiji; Ikeda, Shizunori. Behavior of the sulfhydryl groups of carp actomyosin by heating. Bulletin of the Japanese Society of Scientific Fisheries. 45(8):1019-1022; 1979. (In Japanese; English summary.)

In order to clarify the participation of sulfhydryl groups (SH) in the heat-induced gel formation of actomyosin, the effect of heating temperatures up to 80°C on the contents of total SH and reactive SH of carp actomyosin was examined. It was presumed that the reactive SH, which appeared on the molecular surface by heating, contributed to the gel formation of actomyosin through some bonding between the protein molecules.

Itoh, Yoshiaki; Yoshinaka, Reiji; Ikeda, Shizunori. Changes to higher molecular weight of protein molecules during the gel formation of carp actomyosin by heating participation of SH groups in these changes. Bulletin of the Japanese Society of Scientific Fisheries. 46(5):617-620; 1980. (In Japanese; English summary.)

The solubility in 8M urea solution (pH 8.5) of carp actomyosin gels formed with or without sulfhydryl (SH) reagents, N-ethylmaleimide and p-chloromercuribenzoate, and the chromatographic patterns of 8M urea soluble fractions of these gels on CPG-10 column were examined in order to prove the participation of SH groups in intermolecular bonding during the gel formation of actomyosin.

Ivanova, E.E.; Petrichenko, L.K.; Shul'zhenko, L.V.; Skachkov, V.P. Fish sausage from small freshwater fish. *Rybnoe Khozyaistvo*. 12:55-56; 1980.

The process of deboning small freshwater fish was described, along with composition changes during processing. The resulting product was reported to be pleasant in odor and taste. Further improvement was made by stabilizing the product with sugar, salt, and sodium citrate.

Iwata, K.; Kanna, K.K.; Okada, M. Kamaboko formation of mackerel and Red Sea bream myosins. *Bulletin of the Japanese Society of Scientific Fisheries*. 43(2):237; 1977.

Myosins prepared from white muscle of small mackerel (Pneumatophorus japonicus) and Red Sea bream (Chrysophrys major) and judged to be highly pure were subjected to the dilution-precipitation method ($l=0.05$). The elasticity of kamaboko from mackerel, Red Sea bream, and chicken myosins were evaluated as AA, AA, and A, respectively, while organoleptic scores were 9, 9, and 7, respectively, on a 0-10 scale.

Iwata, K.; Kobashi, K.; Hase, J. Studies on muscle alkaline protease. VI. Purification of proteins which induce the 'modori' phenomenon during kamaboko production and of cathepsin A from carp muscle. *Bulletin of the Japanese Society of Scientific Fisheries*. 43(2):181-193; 1977.

Two kinds of protein which induce the 'modori' (retrogression) phenomenon in kamaboko production were isolated from the white muscle extract of carp, Cyprinus carpio. Present in the ratio of 1 to 5, the proteins had estimated molecular weight of 44,000 and 50,000 daltons.

Iwata, K.; Kobashi, K.; Hase, J. Studies on muscle alkaline protease. VII. Effect of the muscular alkaline protease and protein fractions purified from white croaker and horse mackerel on the 'himadori' phenomenon during kamaboko production. *Bulletin of the Japanese Society of Scientific Fisheries*. 45(2):157-161; 1979.

Purified alkaline protease (AP) from the white muscle of horse mackerel, Trachurus japonicus, caused the himodori phenomenon (loss of elasticity) during preparation of kamaboko from white muscle of horse mackerel and of carp, Cyprinus carpio, but purified AP from white croaker, Argyrosomus argentatus, did not have this effect on kamaboko from the croaker or carp.

Iwata, Kazushi; Chandrasekhar, T.C.; Iida, Haruka; Suzuki, Taneko; Noguchi, Eizaburo. Evaluation of some of Peru and Chile coast fishes processed into kamaboko. Bulletin of the Tokai Regional Fishery Research Lab., No. 61:43-51; 1970.

Some fish stored at -20°C for about 3.0-4.5 months in the form of whole fish and frozen Surimi stored at -20°C for about 3.0-3.5 months were examined for their kamaboko-forming abilities.

Iwata, Kazushi; Kanna, Koichi; Umemoto, Shigeru; Okada, Minoru. Study of the quality of frozen stored Alaska pollock Surimi--1. The influence of freshness of the material and changes in storage temperature. Bulletin of the Japanese Society of Scientific Fisheries. 37(7):626-633; 1971. (In Japanese; English summary.)

The influence of changes in temperature during frozen storage of Muen-surimi and Kaen-surimi from Alaska pollock was investigated using materials in three different stages of freshness. The results of protein extractability and kamaboko forming ability of Muen-surimi showed that the quality change of the Muen-surimi during frozen storage was not influenced by the freshness of materials. The quality change of the Kaen-surimi during frozen storage depended upon the freshness of materials.

Iwata, Kazushi; Okada, Minoru. Protein denaturation in stored frozen Alaska pollock muscle--1. Protein extractability and kamaboko forming ability of frozen Surimi. Bulletin of the Japanese Society of Scientific Fisheries. 37(12):1191-1198; 1971.

Changes in protein extractability and kamaboko forming ability of muscle of Alaska pollock during processing into frozen Surimi and cold storage at -10°C up to three months, were examined.

Iwata, Kazushi; Yamada, Juami. Evaluation of some of New Zealand coast fishes for processing into kamaboko. Bulletin of the Tokai Regional Fishery Research Lab. No. 58:147-153; 1969. (In Japanese; English Summary.)

Notes were given on jelly forming abilities of flesh of some fishes, for processing into "kamaboko". Fourteen kinds of fishes were prepared for kamaboko by the usual method. Sea perch, Red gurnard, Groper, Trumpeter, Warehou, and Hoki were found to have good jelly forming abilities, while the jelly forming abilities of flesh of Barracouta, Elephant fish, and "Kuromatodai" appeared to be poor.

Jarenback, L. Frozen storage of fish mince - I. Quality changes in minced flesh from different parts of cod during frozen storage. SIK-The Swedish Food Institute. Report No. 409; 1976. 41 p. (In Swedish; English summary.)

Analyses of the raw minces obtained from fillets, fillets with skin, belly flaps, necks and frames of cod (Gadus morhua L.) showed that during storage at -10°C there were rapid losses in the amount of salt-extractable proteins and in water holding capacity. Only mince from fillets and belly flaps could form an acceptable product within 2 weeks of frozen storage.

Jarenback, L. Frozen storage of fish mince - II. Influence of kidney tissue and chilled storage on the subsequent frozen storage stability of minced cod fillets. SIK-The Swedish Food Institute. Report No. 411; 1976. 23 p. (In Swedish; English summary.)

Analyses of the raw mince from cod fillets stored at -20°C showed decreased protein extractability and a lower emulsifying capacity with increasing time in frozen storage. The presence of 0.6% kidney tissue accelerated the loss in quality. The longer the mince was stored at $+5^{\circ}\text{C}$ before freezing, the sooner the texture of the corresponding product deteriorated during frozen storage.

Jauregui, C.A.; Regenstein, J.M.; Baker, R.C. A research note: a simple centrifugal method for measuring expressible moisture, a water-binding property of muscle foods. *Journal of Food Science*. 46(4):1271-1273; 1981.

With the development of more refined methods of measuring water-binding properties of meats, the term "water-holding capacity" needs to be replaced with more specific and carefully defined terms such as expressible moisture, water-binding potential, and free drip. An improved method of measuring expressible moisture was described: it basically measures the amount of liquid squeezed out of a protein system with centrifugal force, by measuring the weight gain of a filter paper surrounding the sample. This method seems to be highly sensitive to factors that affect the water-binding properties of muscle foods. Fish, beef, and chicken muscle were used in this study.

Jauregui, Carlos A.; Baker, Robert C. A research note: discoloration problems in mechanically deboned fish. *Journal of Food Science*. 45(4): 1068-1069; 1980.

Two different reactions were found to influence the darkening of minced product from an auger-type deboning machine. One discoloration occurred immediately after deboning; its characteristic grayness was attributed to the release of melanin from the fish skin. The second discoloration, the development of yellow to brownish colors, occurred during frozen storage.

Jeng, S.S. Minced fish products. *Fishery products of Taiwan*. 1977: 39-42.

Marketing techniques; raw materials; processing methods (home or plant processing); quality; future uses of minced fish products in Taiwan.

Jensen, M.H. Chemical and textural changes resulting from freeze drying of minced cod flesh. *Lebensmittel-Wissenschaft und-Technologie*. 12(6): 342-345; 1979.

Freeze-drying of minced cod flesh resulted in a substantial fall in the level of salt-soluble protein regardless of the holding period on ice or heating plate temperature in the range 6-60°C, as well as reduced water binding capacity and toughness in chewing, all correlating with formaldehyde and dimethylamine formation.

Jiang, S.T.; Lee, T.C. Functionality changes of mackerel and amberfish muscle during ice storage and frozen storage at -5°C. Paper presented at the 41st annual meeting of the Institute of Food Technologists, Atlanta, Georgia; 1981 June 7-10. Abstract only.

The functionality changes of mackerel and amberfish during ice storage and frozen storage were studied. VB-N and K-value of the muscles of both fishes increased during ice storage and frozen storage. However, the velocity of denaturation of muscle proteins in frozen storage samples was faster than that in ice storage samples. The Ca⁺⁺-ATPase specific activity of mackerel and amberfish actomyosin was slightly reduced, in a marked contrast to those of frozen samples. A decrease in Kamaboko-forming ability of both fish muscle was in parallel with the increase of denaturation of muscle proteins during ice storage and frozen storage at -5°C.

Johansen, Steen, and Herborg, Lars. Preservation of minced fish flesh by lactic acid fermentation. Paper - Technological Laboratory. 1976; 7 p. Available from: Ministry of Fisheries, Technical University, Lyngby, Denmark.

A method of preserving minced fish meat from lean and fatty species by lactic acid fermentation, technology involved in the production of cheese, was described. It was concluded that the shelf life of the products will be several months at ambient temperature provided they are vacuum-packed in polyethylene bags.

John, Joshua. Some marketing considerations with respect to minced fish products. *Marine Fisheries Review*. 36(12):18-20; 1974.

Marketing problems such as adjustment to the introduction of a new product, a backlash effect on demand prompted by relatively low-priced items, and the need to avoid over-expansion in production were discussed as well as marketing opportunities of lower labor cost, unlimited size of the potential future market and high degree of versatility of minced fish. Minced fish products represent high value at a relatively low price.

Kai, M.; Vitali, A. de A.; Ferreira, V.L.P.; Eiroa, M.N.U.; Tavares, M.; Morais, C. de. Utilization of residues from canning of sardines in the manufacture of fish paste. *Boletim do Instituto de Tecnologia de Alimentos, Brazil*. 57:93-111; 1978.

Composition and microbiological quality of trimmings from canned sardine (*Sardinella brasiliensis*) for fish paste manufacture was evaluated. Sensory evaluation of two fish paste products showed a paste containing tomato concentrate to be more popular than one containing green olives. Both were rated highly acceptable.

Kakuda, K.; Uchiyama, H. Quality of Alaska pollack imported from the USSR. *Bulletin of the Tokai Regional Fisheries Research Laboratory*. 100:67-77; 1979.

Frozen Alaska pollock imported from the USSR was studied for quality characteristics. High actomyosin denaturation was reported, as was poor kamaboko-forming capacity. It was concluded that the protein denaturation was due to the frozen storage.

Kanayama, Tatsuo; Fujita, Yatsuka; Matsuda, Toshio. On the brown discoloration in fish jelly products--I. Sources of bacteria causing browning. *Bulletin of the Japanese Society of Scientific Fisheries*. 39(2):221-228; 1973. (In Japanese; English summary.)

Sources of bacterial contamination causing brown discoloration in fish jelly products during the manufacture and storage in factories were investigated. The properties of the browning bacteria and the reason for the occurrence of brown discoloration were also studied.

Kaneko, Yuzo; Ito, Takeshi; Takagi, Osamu; Fukushima, Kiyoshi. Effects of starch on the texture of kamaboko. *Bulletin of the Japanese Society of Scientific Fisheries*. 36(1):88-95; 1970. (In Japanese; English summary.)

An experimental study of the effect of starch on the physical properties of kamaboko was described. Breaking stress and breaking strain of kamaboko were measured with Okada's gelometer on specimens containing various amounts of starch and water. Texture scores were decided by sensory tests.

Kaplan, H.J.; Constantinides, S. Utilization of underexploited marine species through comminuting and mixing. Paper presented at the 37th annual meeting of the Institute of Food Technologists. Philadelphia, Pa.; 1977 June 5-8. 13 p.

Comminuted flesh from red hake, spiny dogfish, and ocean pout was mixed in various proportions and frozen, exhibiting good stability in frozen storage. End products displayed a high degree of acceptability.

Kapsalis, J.; Cardello, A.; Prell, P.; Segars, R.; Merritt, C., Jr.; Robertson, D.; Jarboe, J.; Maller, O.; Sawyer, F.; Johnson, E.; Pelog, M.; Fagerson, I.; King, F. Comparative edibility characteristics of fish species for mixed-species blocks. Martin, Roy E. (ed.). *Third national technical seminar on mechanical recovery & utilization of fish flesh*. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute. 1981:554-557.

Methodology has been developed for the instrumental measurement of the textural properties of finfish, using the Instron Universal Testing Machine and a Punch and Die Test device. Correlations with technical sensory panels were 0.87 ($p < .01$) between sensory chewiness and maximum shear stress and 0.81 ($p < .01$) between sensory hardness and maximum shear stress.

Karmas, Endel; Turk, Katherine. A research note: water binding of cooked fish in combination with various proteins. *Journal of Food Science*. 41(4):977-979; 1976.

Water binding of cooked fish was determined in combination with (a) sodium, calcium, potassium and isoelectric form of soy protein isolate; (b) sodium and calcium whey protein concentrate; and (c) sodium caseinate. The sodium proteins were added at 0%, 2%, and 5% level, the other proteins at 0% and 2% level. A gravimetric adaptation of the filter paper press method was used to determine water binding. All proteins increased the water binding of cooked fish. Fresh and 2-yr. old samples of sodium soy proteinate were significantly better water binders than that aged for 8 yrs. Sodium soy proteinate and sodium caseinate were both better water binders than the sodium whey proteinate.

Katoh, Noboru; Nozaki, Hisashi; Komatsu, Kazumiya; Arai, Ken-ichi. A new method for evaluation of the quality of frozen surimi from Alaska pollock relationship between Myofibrillar ATPase activity and kamaboko forming ability of frozen surimi. Bulletin of the Japanese Society of Scientific Fisheries. 45(8):1027-1032; 1979. (In Japanese; English summary.)

Evaluation of the quality of frozen surimi from Alaska pollock was achieved by measuring the ATPase total activity of myofibrils prepared quantitatively from frozen surimi. A definite correlation between the grade of surimi and the total activity was evident. The myofibrillar ATPase total activity of surimi was also closely related to the jelly strength of kamaboko from the same material.

Kawashima, Takayoshi; Arai, Ken-ichi; Saito, Tsuneyuki. Studies on muscular proteins of fish--IX. An attempt on quantitative determination of actomyosin in frozen "surimi" from Alaska pollock. Bulletin of the Japanese Society of Scientific Fisheries. 39(2):207-214; 1973. (In Japanese; English summary.)

A fundamental study on quantitative extraction of actomyosin by measuring Ca^{2+} -ATPase specific activity and protein content from frozen 'surimi' (fish paste) was made.

Kawashima, Takayoshi; Arai, Ken-ichi; Saito, Tsuneyuki. Studies on muscular proteins of fish--X. The amount of actomyosin in frozen "surimi" from Alaska pollock. Bulletin of the Japanese Society of Scientific Fisheries. 39(5):525-532; 1973. (In Japanese; English summary.)

Quantitative determinations of actomyosin in various kinds of frozen surimi prepared from Alaska pollock muscle were made by measuring total Ca^{2+} -ATPase activity after exhaustive extraction of the actomyosin.

Kawashima, Takayoshi; Ohba, Akiko; Arai, Ken-ichi. Studies on muscular proteins of fish--XIII. Relationship between the amount of actomyosin in frozen surimi and the quality of kamaboko from the same material in Alaska pollock. Bulletin of the Japanese Society of Scientific Fisheries. 39(11):1201-1209; 1973. (In Japanese; English summary.)

The amount of actomyosin in surimi was determined as Ca^{2+} -ATPase total activity and the quality of kamaboko from the same material was determined by its jelly strength and folding test. It was confirmed that there was a clear relationship between the amount of actomyosin in surimi and the quality of kamaboko as assessed by the folding test.

Ke, P.J.; Woyewoda, A.D. Frozen storage quality improvements of minced fatty fish. Paper presented at the 21st annual conference of the Canadian Institute of Food Science and Technology. Alberta; 1978 June 25-28.

Frozen storage stability in terms of primary and secondary lipid oxidation and hydrolysis reactions was measured at -15 and -30°C for minced Atlantic mackerel with various physical treatments as well as antioxidant additions. TBHQ was shown to be the best antioxidant improving frozen stability by at least 100%. Vacuum packaged minced mackerel maintained frozen quality 4 times longer than the control minced sample. By applying the rancidity index for mackerel, frozen storage life for various minced samples was compared and discussed.

Keay, J.N. Minced fish. Torry Research Station. Torry Advisory Note No. 79; 1979. 6 p.

General introduction to minced fish and mincing technology, including brief information on keeping quality and sensory properties of mince, utilization, and manufacturers of deboning machines.

Keay, J.N. Aspects of optimal utilization of the food fish resource through product innovation. Connell, J.J. (ed.). Advances in fish science and technology. Surrey, England; Fishing News (Books) Ltd.; 1980:275-278.

This review article discussed possible utilization for human food of 50% of the two-thirds million ton of fish which goes to waste in the United Kingdom each year. Possibilities discussed included development of cook/freeze fish products, spray application of smoke-flavor formulation, recovery of flesh from filleted carcasses by bone separators, methods of utilizing minced fish, and the use of mechanical formers to produce portions from small fillets.

Keay, James N. (ed.). Conference: the production and utilisation of mechanically recovered fish flesh (minced fish), 1976, proceedings. 1976 April 7-8; Ministry of Agriculture, Fisheries and Food, Torry Research Station, Aberdeen.

Conference by Torry Research Station, Aberdeen, Scotland, April, 1976. Sessions: Fish resources, minced fish production - Functional properties, quality control, microbiology and hygiene - Utilization, product development and marketing. International papers presented.

Keay, James N. Keynote address: a review of minced fish technology over the decade 1970-80. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981:1-23.

Minced fish technology over the decade 1970-80 was reviewed in the form of a keynote address to the seminar and an extensive list of references was given.

Khachmanuk'yan, S.G. Two-stage method of food comminution. Rybnoe Khozyaistvo. 12:69-70; 1977.

With no preliminary thawing or freezing, a two-stage comminution of fish produced a high-quality, loose and homogeneous comminuted flesh that keeps well under refrigeration.

Kiesvaara, M. The use of minced Baltic herring in foodstuffs. Kemia-Kemi. 6(12):761; 1979.

Color of Baltic herring mince was improved by removing dark-pigmented dorsal skin and mucous membrane; odor and flavor were diluted by adding milk or soy protein; and texture was improved by adding starch or other thickeners.

King, F.J. Past, present, and future uses of minced fish. Marine Fisheries Review. 39(4):1-4; 1977.

Work done in research and development of minced fish, blocks, and products was discussed. References for information in specific areas were provided.

King, Frederick J. Acceptability of main dishes (entrees) based on mixtures of ground beef with ground fish obtained from underused sources. Journal of Milk and Food Technology. 36(10):504-508; 1973.

The economic and nutritional feasibility of mixing ground beef and ground fish was tested by using well-known main dish recipes. Several combinations received favorable acceptance ratings.

King, Frederick J. Improving the supply of minced blocks for the fish stick trade: a progress report. Marine Fisheries Review. 35(8):26-32; 1973.

Test methods were performed on flesh recovered from fish frames or headed and gutted fish. Leaching blood pigments by washing the minced flesh reduced the intensity of the color of the product. Dewatering equipment (screens, presses, centrifuges) was discussed.

King, Frederick J. U. S. grading standards and labelling for minced fish blocks. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981: 492-519.

The present U. S. Standards for Grades of Frozen Minced Fish represent a culmination of several years in developing descriptions of quality by the National Marine Fisheries Service, the seafood industry and consumers. In addition to the National Marine Fisheries Service, the Food and Drug Administration and the U. S. Department of Agriculture have responsibilities related to the marketing of minced fish and the use of these Standards for Grades. These responsibilities are illustrated by comparing minced fish with mechanically deboned meat or poultry such as in proposed meat-fish products.

King, F.J.; Ryan, J.J. Development of a color measuring system for minced fish blocks. *Marine Fisheries Review*. 39(2):18-23; 1977.

A system for color classification relative to the categories of color styles in the present (1975) interim grade standard proposed for minced fish blocks was discussed. The measuring system was based on a reflectance spectrophotometer and Munsell neutral value standards. A set of color pictures was included to illustrate what is measured by these Munsell standards.

King, Frederick J.; Carver, Joseph H. How to use nearly all the ocean's food. *Commercial Fisheries Review*. 32(12):12-21; 1970.

Preliminary evidence and the concept of total oceanic production of seafood (TOPS) indicate the profitable utilization of meat/bone separators in the U. S. seafood industry.

King, Frederick J.; Carver, Joseph H.; Prewitt, Roy. Machines for recovery of fish flesh from bones. *The American Fish Farmer and World Aquaculture News*. 2(11):17-21; 1971.

Work on machine separated fish flesh in general and pond-reared fish in particular was topically described.

King, Frederick J.; Flick, George J. Beefish patties. *Marine Fisheries Review*. 35(7):31-33; 1973.

Beefish patties were made by mixing deboned fish meat with ground beef and seasonings, in varying proportions. The products were as acceptable as all-beef patties in appearance, odor, flavor, and texture in sensory evaluations.

King, Frederick J.; Heiligman, Fred; Wierbicki, Eugene. Solubilized fish muscle as a food binding material. *Marine Fisheries Review*. 36(1):18-20; 1974.

The assumption that a solution of 3 percent NaCl and 0.5 percent sodium tripolyphosphate (TPP) could be used with minced fish muscle as an effective binder was tested experimentally. It was found to have greater adhesion to surfaces of uncut muscle compared to a commercial starch-base binder and to produce a thinner, more flexible coating on fillet pieces than a fish paste binder.

Kirmse, D.; Kadler, D.; Tülsner, M. Determination of cooking times for comminuted fish meat. *Lebensmittelindustrie*. 27(10):455-458; 1980.

Heat transfer during cooking of comminuted fish meat was described, and methods for calculating cooking times in water, steam, and hot air were given.

Kishimoto, Akira; Maekawa, Etuji. Rheology of kamaboko--II. Shear creep and damped free torsional vibrations. *Bulletin of the Japanese Society of Scientific Fisheries*. 28(8):803-808; 1962.

The purpose of these studies was to investigate the rheological behavior of the visco-elasticity of kamaboko and to interpret the observed data in terms of the linear visco-elastic theory.

Kizeveter, I.V.; Alekseeva, T.I.; Susdal'tseva, S.P. Sausage meat from pre-blanched Alaska pollock. *Rybnoe Khozaistvo*. 10:66-70; 1977.

Comminuted blanched Alaska pollock processed with water had better sensory indices than boiled raw comminuted flesh. Heating the inner parts of the fish to 343°K for 600s was recommended.

Koburger, John A.; Dargan, Richard A.; Langston, Denise L.; Stevens, George R. Production of salted mince from mullet and frames of red drum and grouper. Nickelson, Ranzell, II (ed.). *Proceedings of the fifth annual tropical and subtropical fisheries technological conference of the Americas*. 1980 April 27-30; Charleston, S.C.; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-81-101. 1980:1-10.

Preliminary studies on pilot plant production of salted mince showed that maximum removal of brine following salting is the major influence on product stability during storage; both application of heat and acidification of the salted minced resulted in reduced moisture content; both grouper and red drum produced acceptable salted mince in manufacture and final product.

Koburger, John A.; Regier, Lloyd W. Salt-minced cod: microbial considerations. Cobb, Bryant F., III and Stockton, Alexandra B. (eds.). Proceedings of the first annual tropical and subtropical fisheries technological conference. 1976 March 8-10; Corpus Christi, TX. Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-77-105. 1977:556-564. (vol. 2).

Minced flesh from headed, gutted, and filleted cod was mixed with 35% salt, blended, and passed through a strainer to obtain a moist cake. Regardless of the initial microbial count, there was approximately a ten-fold reduction in viable organisms following the period of salting and equilibration, and a further decrease in the number of microorganisms occurred during storage of the salt cake at 35°C.

Kojima, Yoshio; Yamada, Kinjiro; Oba, Yasumasa; Kochi, Masayuki; Tagawa, Shoji. Experiments on protein recovery from the fluid discharged in the leaching process of "kamaboko" processing--I. Journal of the Shimonoseki University of Fisheries. 20(3):131-143; 1972. (In Japanese; English summary.)

Experiments included the analysis of proximate composition of different specimens obtained in the course of processing and examination of a method recovering proteins from the fluid discharged in the leaching process.

Kolakowski, E.; Lachowicz, K.; Szybowski, Z. Studies on fish sausage technology. I. Optimal conditions for comminuting process. Nahrung. 21(7):583-589; 1977.

Samples of fish sausage were made with 58% mechanically deboned hake, 20% water, 1.2% NaCl, 2% starch, 3% fat, 5% dried onion; frozen egg white or a squid-based product was added to some samples as emulsifying or stabilizing agents. Effects of comminution time on sausage emulsion temperature, soluble protein contents, consistency and elasticity of the cooked sausage, and effects of vacuum level during comminution on elasticity and viscosity of the cooked sausage were determined. A comminution time of 2.5-3 min. at a vacuum of 2.0-2.5 N/m² was recommended.

Kolakowski, E.; Lachowicz, K.; Szybowicz, Z. Studies on technology of fish hamburger manufacture from hake. *Przemysł Spożywczy*. 31(12): 466-469; 1977.

Effects of duration of blending and temperature on viscosity and adhesion properties of minced hake flesh on weight and form of raw and fried hamburgers rendered from a blend of the minced flesh and other additions were studied. Results showed that the optimal blending time on a (Netherlands) Hollymatic GMG installation was 2.5-3 min. and that mince blended at approximately 0°C with dynamic viscosity of 18×10^3 cP and adhesion value $<4\text{G}/\text{cm}^2$ was the most suitable for hamburger forming. Wheat flour at 3-6% and lard at 3-5% were recommended additions.

Kołodziejska, I.; Kostuch, S.; Sadowska, M.; Sikorski, Z.E. Effect of glucose and sodium pyrophosphate addition on stability of comminuted cod flesh in frozen storage. *Przemysł Spożywczy*. 31(11):433-435; 1977.

An increase in pH obtained in a blend of comminuted Baltic cod flesh and 2% sodium pyrophosphate solution (pH 7.5) and a blend of comminuted flesh and glucose and pyrophosphate solutions (pH 7.55) slowed down significantly the biochemical and physico-chemical processes during storage. Blending the minced flesh with 10% glucose solution (pH 6.6) also had a beneficial effect.

Krane, W. Fillet blocks and mixed fillet/mince blocks: production, quality and labelling aspects. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981:547-553.

To ensure optimal utilization of the fish, it is necessary to incorporate a certain amount (natural proportion) of minced fish flesh into fillet blocks to be used for fish finger (sticks), for example. Some quality aspects of products made from these "mixed blocks" were described. The most important aspect for the definition of "fillet" is that it must be "coherent fish flesh." The difference between the definition for "fillet" and "minced fish" was discussed. A proposal was made for the grading and labeling of raw material in the form of blocks (fillet, mixed blocks and minced fish flesh) and final products made thereof. Special attention was given to "boneless" and "not boneless" products.

Kreuzer, Rudolf (ed.). The technology of fish utilization. London, England. Fishing News (Books) Ltd. 1965.

International Symposium by FAO, Husum, Germany, May, 1964. Sessions: Rigor Mortis - Problems related to the preservation of fresh fish - Control of deteriorative changes in frozen fish - Measuring the degree

of freshness of fish - Production and storage of fish protein concentrate - Dehydration and canning of fish.

Kreuzer, Rudolf (ed.). Freezing and irradiation of fish. London, England. Fishing News (Books) Ltd.; 1969.

FAO Technical Conference, Madrid, Spain, September, 1967. Six parts: Freezing fish at sea - Freezing and processing frozen fish - Economics of producing and marketing frozen fish products - The quality of frozen fish products and its assessment - Storage, packaging and distribution of frozen products - Preservation of fishery products by irradiation.

Kreuzer, Rudolf (ed.). Fish inspection and quality control. London, England. Fishing News (Books) Ltd.; 1971.

FAO Technical Conference, Halifax, Canada, July, 1969. Topics: The need for fish inspection - Fish inspection programs - Inspection of fish and fishery products - Industrial and commercial aspects of quality control - Methods of quality assessment - Hygienic and safety aspects of quality control - Training in fish inspection and quality control - International cooperation in the promotion of quality control.

Kreuzer, Rudolf (ed.). Fishery products. Surrey, England. Fishing News (Books) Ltd.; 1974.

FAO Technical Conference, Tokyo, Japan, December, 1973. Parts: The influence of tradition and change - Present products and progress in techniques - Problems and trends in the utilization of specific resources - Product development - Quality requirements in product development and trade - Markets - Training in fish processing technology - International cooperation.

Kudo, George; Okada, Minoru; Miyauchi, David. Gel-forming capacity of washed and unwashed flesh of some Pacific coast species of fish. Marine Fisheries Review. 35(12):10-15; 1973.

Several species of Pacific Ocean fish were tested to determine the gel-forming capacity of their proteins when processed into heat-pasteurized "kamaboko". Lingcod, Pacific cod, rockfish, and some sharks had good gel-forming properties, while flounder, hake, and dogfish did not. Washing the minced flesh removed some of the water-soluble proteins and generally improved the gel-forming properties.

Kunisaki, N.; Matsuura, H.; Hayashi, M. A food hygiene study on the formation of N-nitrosodimethylamine from trimethylamine-N-oxide and nitrite. Bulletin of the Japanese Society of Scientific Fisheries. 43(11):1287-1292; 1977.

In the presence of 50-500 p.p.m. NO_2^- , in laboratory-prepared fish sausage containing 800mg trimethylamine-N-oxide/100g, no detectable N-nitrosodimethylamine (NDMA) was formed. However, approximately 0.9 p.p.m. NDMA was found in sausage with 2500 p.p.m. NO_2^- . In connection with NDMA formation during the manufacture of fish sausages in Japan, the use of nitrite at permissible concentration of <50p.p.m. as residual NO_2^- is acceptable from the food hygiene point of view.

Kuriyan, G.K. Fish product development in India. Paper presented at the conference on the handling, processing and marketing of tropical fish; London, U.K.; 1977. Available from: Cent. Institute of Fisheries Technology, Willingdon Island, Cochin-682003, India.

The development in India of new fish products, canned, frozen and specialty products utilizing minced fish meat and hydrolysed fish meat and new cured products of extended shelf life were reviewed.

Kurokawa, T. Kamaboko-forming ability of frozen and ice-stored lizardfish. Bulletin of the Japanese Society of Scientific Fisheries. 45(12): 1551-1555; 1979.

The jelly strength of kamaboko made from lizardfish stored in ice for 3 days was no more than 50% of that made from freshly caught fish. The shelf life of iced lizardfish as material for kamaboko was considered to be about 9 days. Little or no difference in kamaboko-forming ability was detected between quickly frozen fish (in liquid N_2) and slowly frozen fish (in air at -24°C).

Kurokawa, T. Quality of commercial frozen surimi of sardine. Journal of Japanese Society of Food Science and Technology. 29(1):48-54; 1982.

Commercially prepared and frozen samples of sardine surimi were examined for quality characteristics. Variations in chemical composition and quality factors of cooked kamaboko were found between surimis prepared in different seasons.

Kuz'micheva, G.M.; Rekhina, N.I. The effect of stabilizers on the content of soluble proteins in frozen fish sausage. Rybnoe Khozyaistvo. 10:71-73; 1977.

The most efficient stabilizers for fish emulsions from cod, putassa (blue whiting) and Carassius (crucian carp) were determined. The protein denaturation level in frozen emulsion was determined on the

basis of soluble protein content. The optimum combination of additives for the putassa was 1% sodium citrate, 1.5% kitchen salt, and 1% sugar; for cod, kitchen salt and sugar in the same concentration plus either 0.3% sodium polyphosphate, 1% sodium citrate, or 0.5% trisodium polyphosphate; and for Carassius, kitchen salt and sugar in the same concentration and 0.3% sodium polyphosphate.

Laird, W.M.; Mackie, I.M.; Hattula, T. Studies of the changes in the proteins of cod-frame minces during frozen storage at -15°C. Connell, J.J. (ed.). Advances in fish science and technology. Surrey, England. Fishing News (Books) Ltd.; 1980:428-434.

Four extractants with sodium dodecylsulphate (SDS) in 0.01M sodium phosphate buffer were used: (A) 1% SDS, (B) 1% SDS, and 1% 2-mercaptoethanol, (C) 1% SDS and 8M urea, (D) 1% SDS, 8M urea, and 1% 2-mercaptoethanol. The SDS electrophoretic analyses of the various SDS extracts showed mainly that the presence of 2-mercaptoethanol had no influence on the distribution of the various peptides. Heating at 100°C for 10 min. produced more of the higher molecular weight subunits. Other observations were presented to illustrate the problems of interpreting SDS electrophoretic analyses using different SDS-containing solvents. It was suggested that in frozen-stored material from frames there is covalent bond formation, but the type needs to be specified.

Laird, W.M.; Mackie, I.M.; Regenstein, J.M. Deterioration of frozen cod and haddock minces. Refrigeration Science and Technology. 1981-4: 395-400; 1981.

Cod, haddock, and lemon sole minces showed changes in texture, protein, and dimethylamine production during frozen storage. Results were shown in graphs and tables.

Lall, B.S.; Manzer, A.R.; Hiltz, D.F. Preheat treatment for improvement of frozen storage stability at -10°C in fillets and minced flesh of silver hake (Merluccius bilinearis). Journal of the Fisheries Research Board of Canada. 32(8):1450-1454; 1975.

Preheating to 80°C greatly retarded dimethylamine development in fillets and minced silver hake flesh during frozen storage for 1 month. Lipid hydrolysis (free fatty acid accumulation) was arrested by preheating to 60°C, but was little affected by preheating at temperatures up to 45°C.

Lanier, T.C.; Cheng, C.S.; Hamann, D.D.; Thomas, F.B. Factors affecting proteolytic breakdown of texture in minced fish gels: a project status report. Nickelson, Ranzell, II (ed.). Proceedings of the third annual tropical and subtropical fisheries technological conference of the Americas. 1978 April 23-26; New Orleans, LA; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-79-101. 1978:240-250.

It was shown that a proteolytic factor present in the water soluble fraction of certain fish species muscle degrades the texture of fish gels at normal processing temperatures. The effects of this factor may be controlled by rapid heating to elevated temperatures (85°C) for small-size products. Washing of fish flesh and/or better handling practices were suggested as the best means for control of texture in fish gels.

Lanier, T.C.; Hamann, D.D.; Thomas, F.B. Texture improvement in fabricated shrimp shapes by addition of surimi (washed minced fish.) Nickelson, Ranzell, II (ed.). Proceedings of the fifth annual tropical and subtropical fisheries technological conference of the Americas. 1980 April 27-30; Charleston, S.C.; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-81-101. 1980:40-53.

The desirable textural characteristics obtained by adding surimi to restructured seafoods result from the concentration of highly functional salt-soluble proteins of fish muscle in the washing process. Since small increases in moisture content result in a rapid decrease in textural firmness of gels prepared from both washed and unwashed fish, higher water contents can be used in the case of surimi.

Lanier, T.C.; Lin, T.S.; Hamann, D.D. Relationships between heat-stable protease activity and texture of gels prepared from minced fish. Paper presented at the fourth annual tropical and subtropical fisheries technological conference of the Americas. St. Petersburg, Florida; 1979. April 22-25.

Activity of heat-stable alkaline protease in raw minced fish tissue extract closely correlated with texture degeneration and protein degradation in corresponding fish gels under varying conditions of harvest time, location, temperature, cooking time, pH and ionic strength. Studies of the effects of several chemical and biological protease inhibitors also support the role of the heat-stable alkaline protease in the texture degradation of fish gels.

Lanier, T.C.; Lin, T.S.; Hamann, D.D.; Thomas, F.B. Effects of alkaline protease in minced fish on texture of heat-processed gels. *Journal of Food Science*. 46(6):1643-1645; 1981.

Properties relating to the physical integrity of heat-processed fish gels varied among samples subjected to various processing temperatures and correlated well with heat-stable protease activity in the raw samples. The researchers noted a significant inhibitor concentration—dependent relationship between gel strength

and the addition of a potato-derived protease inhibitor. It was suggested that the heat-stable protease could be responsible for the decrease in gel strength in fish gels processed in the temperature range of 50-70°C or beyond.

Lanier, Tyre C.; Lin, T.S.; Hamann, D.D.; Thomas, F.B. Gel formation in comminuted fish systems. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981:181-193.

The texture of fabricated shellfish-like products prepared from minced fish and surimi can be made to simulate the bite and fiber of actual shellfish meats by utilizing the inherent functional properties of the fish proteins. Factors affecting product texture include biological variables which affect protein functionality, such as species differences and compositional changes due to spawning cycles and seasonal response, and processing variables which affect the integrity, availability, and intermolecular reactivity of the salt-soluble proteins responsible for gel formation. Research into the causal relationship between these factors and product texture was discussed.

Lanier, Tyre C.; Thomas, Frank B. Minced fish: its production and use. UNC Sea Grant Publication UNC-SG-78-08; 1978.

Introduction to minced fish processing aimed at packers or processors of seafood or meat products. Selection and preparation of raw material, equipment, and operation, cost considerations, quality control, frozen storage, and product applications were discussed.

Laslett, G.M.; Bremner, H. Allan. Evaluating acceptability of fish minces and fish fingers from sensory variables. Journal of Food Technology. 14(4):389-404; 1979.

Statistical methods were used on taste panel results from several storage studies of minced flesh from Australian fish species. For fish minces, texture, off variables (off-flavor and off-aroma), and flavor were the predictors of acceptability. For fish fingers, the off variables were good predictors of quality, while aroma, flavor, and texture were not. It was generally concluded that taste panel work should be done on the finished product and not on the raw material (minces) to determine acceptability of the fish fingers.

Learson, R.J.; Reierstad, G.; Ampola, V.G. The application of continuous centrifugation to seafood processing. *Food Technology*. 27(7):32-34; 1972.

An experimental continuous centrifuge for meat and shell separation was used to determine the meat recovery from cooked crabs and lobsters, waste materials from crab processing plants, surf clam shucking plants, and fish filleting operations. The centrifuge rotated in the range of 200-800 rpm with a pool of brine 1-3cm deep held on the outside of the bowl.

Learson, R.J.; Tinker, B.L.; Ampola, V.G.; Wilhelm, K.A. Roller extraction of crab meat. Cobb, Bryant F., III and Stockton, Alexandra B. (eds.). *Proceedings of the first annual tropical and subtropical fisheries technological conference of the Americas*. 1976 March 8-10; Corpus Christi, TX; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-77-105. 1976:621-630. (vol. 2).

The concept of roller extraction of crab meat using the dual cook procedure (precooking crab sections at a relatively low temperature and finish cooking of extracted meats in steam) was investigated for Atlantic crab species. Red crab extraction was particularly successful. Blue crab meat extraction by rollers also showed promise.

Learson, R.J.; Tinker, B.L.; Ronsivalli, L.J. Technical note: fish proteins as binders in processed fishery products. *Commercial Fisheries Review*. 33(2):46-50; 1971.

Roll or loaf-type products and simulated crab meat were developed using comminuted fish flesh as a binder. It was suggested that a fish-protein binder could be used effectively in development of formed fishery products since it is economical to obtain and is reasonably stable at both refrigerated and frozen temperatures.

Lee, C.M.; Toledo, R.T. Degradation of fish muscle during mechanical deboning and storage with emphasis on lipid oxidation. *Journal of Food Science*. 42(6):1646-1649; 1977.

The degree of mechanical stress applied to the fish muscle during deboning did not cause significant variations in TBA values; an increase in temperature of the deboning drum resulted in adverse effects becoming significant with prolonged storage. An increase in TBA values resulted from contact of flesh with iron parts of the deboner. Washing significantly improved quality of frozen product.

Lee, C.M.; Toledo, R.T. Processing and ingredient influences on texture of cooked comminuted fish muscle. *Journal of Food Science*. 44(6):1615-1618; 1979.

In preparing a coarse textured smoked fish sausage from Spanish mackerel, two different comminution processes and different levels of shortening, soy protein fiber (SPF) and added ice were evaluated instrumentally and by taste panels. Incorporating at least 12g shortening, 100g fish muscle, and SPF at 15:85 SPF/fish muscle using a two-stage comminution process improved unacceptable sponge-like textural characteristics. Adding ice in excess of 15% markedly diminished shear and compressive strength. Using 25g shortening/100g fish muscle in one comminution process reduced strength and water-holding capacity and increased brittleness.

Lee, Chong M.; Abdollahi, Abbas. Effect of hardness of plastic fat on structure and material properties of fish protein gels. *Journal of Food Science*. 46(6):1755-1759; 1981.

Fat distribution pattern, which was itself affected by fat hardness, had a significant influence on material properties of fat-containing protein gels. When fat of 1.8cm⁻¹ hardness index (HI) was added at a level of 15% (fat/muscle), compressive and shear forces reached their maximum. Incorporation of medium hard fat (0.54-0.78cm⁻¹ HI) improved freeze-thaw stability thereby preventing a sponge-like texture development, made cooked gels less rubbery by increasing plastic deformation, and overcame weakening of texture due to cooking.

Lee, Chong M.; Toledo, Romeo T. Factors affecting textural characteristics of cooked comminuted fish muscle. *Journal of Food Science*. 41(2):391-397; 1976.

The factors affecting textural characteristics of cooked comminuted fish muscle that were investigated included time of comminution, presence of NaCl or NaCl and polyphosphates, effect of mechanical deboning, cooking temperature, and type of heating medium used.

Lee, E.H.; Cho, D.J.; Jeon, J.K.; Cha, Y.J.; Kim, S.K. Processing conditions and quality stability during storage of meaty textured fish protein concentrate. II. Quality stability during storage and utilization of meaty textured fish protein concentrate from filefish and sandfish. *Korean Journal of Food Science and Technology*. 14(1):43-48; 1982.

The quality of FPC was studied and meat balls and hamburgers made from the FPC were prepared and evaluated. Included in the results was the suggestion that FPC could be used to replace up to 50% of beef in the products without a significant loss in quality of taste, odor and texture.

Legendre, R.; Hotton, C. Separation of flesh and bones from fish. Environment Canada, Fisheries and Marine Service, Halifax Laboratory New Series Circular No. 50. 1975; 9 p.

Recovery of relatively large amounts of additional edible fish muscle is possible with the mechanical separation of flesh and bones. General appearance and storage properties of the minced flesh are improved by prior removal of backbone and washing of minced product.

Licciardello, Joseph J. Microbial aspects of minced fish. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute. 1981:458-470.

Surveys of commercial minced blocks for either certain pathogenic or indicator microorganisms have not revealed a potential public health hazard to exist and practically all minced blocks examined were in compliance with the proposed microbial standards of the International Commission of Microbiological Specifications for Foods.

Licciardello, J.J.; Ravesi, E.M.; Allsup, M.G. Effect of antioxidant concentration on stabilizing flavor of frozen minced whiting. Paper presented at the 22nd annual Atlantic fisheries technological conference. Halifax, Nova Scotia. 1977 August.

Results of organoleptic and chemical tests on samples of pre-cooked breaded minced whiting sticks stored at -6.7°C or -15°C indicated that a 0.3% sodium erythorbate treatment was the most effective as an antioxidant. Its efficiency was only slightly less at a 0.15% level but much diminished at 0.075%, although even at this low level it still exhibited antioxidant activity. No synergism resulted from combinations of disodium EDTA with sodium erythorbate.

Licciardello, J.J.; Ravesi, E.M.; Allsup, M.G. Quality aspects of commercial frozen minced fish blocks. Journal of Food Protection. 42(1):23-26; 1979.

Comparing frozen minced Alaska pollock blocks to minced blocks prepared from certain North Atlantic species (cod, haddock, ocean catfish, lingcod, hake) showed it to be inferior in flavor and texture. The cooking method--baked vs. fried--strongly influenced organoleptic scores. Objective tests of TBA, TMA, DMA, and aerobic plate count generally did not correlate with sensory scores.

Licciardello, J.J.; Ravesi, E.M.; Allsup, M.G.; Brooker, J.R.; King, F.J. Frozen storage characteristics of mixed fillet-mince cod blocks. Lebensmittel-Wissenschaft und Technologie. 12(5):290-292; 1979.

Mixed fillet-mince blocks containing 10, 20, or 30 percent cod mince had higher aerobic plate counts compared to all-fillet blocks; but during the 48-week frozen storage period at -17.8°C or the 32-week storage at -6.7°C , there were no differences in cross sectional appearance of the blocks or in appearance, flavor, or texture of stored breaded sticks or those prepared from the stored blocks. There was no difference in TBA number due to the mince content, but DMA content was generally higher in the 30 percent mince samples. Although in general, the EPN was slightly higher for the all-fillet block, following an initial rapid decline in EPN for all block samples, there was no difference in EPN during further analyses.

Licciardello, Joseph; Quinn, Margaret; Allsup, Michael. Efficiency of various antioxidants in stabilizing frozen minced whiting against oxidative rancidity. Paper presented at the 20th annual Atlantic fisheries technological conference, Arlington, Virginia; 1975. October 19-22.

Different antioxidant solutions were sprayed onto the minced fish while being slowly mixed in a Hobart mixer. The treated mince was formed into frozen blocks which were processed into cooked breaded sticks and stored at $+20^{\circ}\text{F}$. Based upon thiobarbituric acid (TBA) number, peroxide value and organoleptic score during storage, a 0.15% sodium erythorbate treatment was judged the most effective antioxidant. Rancidity was detectable in the controls after about four weeks whereas in the treated sample no rancidity was detectable even after 20 weeks. Tenox 20 (TBHQ + citric acid) and Tenox S-1 (propyl gallate + citric acid) were not effective when used at the legal limit but were effective at five times that amount. From an organoleptic standpoint, rancidity could be masked by added seasoning. Addition of a flavoring agent offers the advantage of tailoring the flavor of a bland minced fish to whatever flavor may be desirable.

Licciardello, Joseph J.; Hill, Wilma S. Microbiological quality of commercial frozen minced fish blocks. *Journal of Food Protection*. 41(12): 948-952; 1978.

Analyses for aerobic plate count, fecal coliforms, and coagulase-positive staphylococci on 208 commercial blocks of frozen minced fish showed compliance with proposed standards of the International Commission on the Microbiological Specifications for Foods.

Licciardello, Joseph J.; Ravesi, Elinor M.; Allsup, Michael G. Frozen storage characteristics of whiting blocks. *Marine Fisheries Review*. 42(1):55-60; 1980.

To determine the frozen storage characteristics of minced and fillet blocks at various temperatures, blocks were stored at 20°F , 5°F , -5°F , and -22°F and tested periodically for organoleptic qualities, TBA number, DMA and TMA nitrogen content, and

EPN content. The benefits of low storage temperature on stabilizing flavor and texture and the faster rate of quality deterioration in minced compared to fillet blocks were apparent. There was a strong association between DMA formation and deterioration of texture. Mincing or storage at higher temperatures accelerated a decrease in EPN.

Lin, T.S.; Lanier, T.C. Determination of species composition in minced fish blocks. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981:565-571.

Several developments in recent years with regard to species identification in meats and meat products were reviewed with primary emphasis on the use of soluble protein patterns for marine products identification. At the present time, no method exists for the identification of species in minced fish blocks, especially mixed specie blocks. Both electrophoretic and iso-electric focusing techniques are adequate for the identification of some major North Carolina fish species. An isoelectric focusing technique with 75% 4/9 and 25% 3/7 ampholine composition has great potential for the identification of fish species in mixed blocks. Approaches toward the speciation problem presented by washed mince (surimi) blocks were presented.

Lin, Tzong-Shin; Lanier, Tyre C. Properties of an alkaline protease from the skeletal muscle of Atlantic croaker. *Journal of Food Biochemistry*. 4:17-28; 1980.

An alkaline protease was partially purified from the skeletal muscle of Atlantic croaker. The protease is a cytoplasmic enzyme and heat stable. The enzyme preparation was shown to degrade fish actomyosin in vitro between 50-60°C, the temperature range often used in processing comminuted meat products in industry. The enzyme is a sulfhydryl protease and does not require Ca^{++} ions for its activity. Preparations of the enzyme do not hydrolyze TAME, BTEE or denatured hemoglobin. Column chromatographic analyses suggest an apparent molecular weight of $80,000 \pm 4,000$ and the isoelectric point is 6.0 ± 0.2 .

Lin, Y.M.; Lin, T.S.; Lanier, T.C. Heat denaturation of actomyosin solution prepared from Atlantic croaker. Paper presented at the 41st annual meeting of the Institute of Food Technologists, Atlanta, Georgia; 1981. June 7-10. (Abstract only)

Several physical (viscosity and turbidity) and chemical (sulfhydryl and ATPase) measurements were used to follow the heat denaturation of croaker actomyosin solution. All the properties were studied over a wide range of protein concentrations. The intrinsic viscosity

of croaker actomyosin was determined as 245, and 169 and 44 ml/g at 10, 30, and 40°C, respectively. No proteolytic degradation was evident during incubation. Apparent viscosity measurement was found to provide a convenient way of determining the setting and coagulation temperatures needed to develop a process design for manufacturing fish gel products.

Lovell, Richard T.; Apolinario, Kathrine. Yield and quality of mechanically separated flesh from several species of cultured freshwater fish. Cobb, Bryant F., III and Stockton, Alexandra B. (eds.). Proceedings of the first annual tropical and subtropical fisheries technological conference. 1976 March 8-10; Corpus Christi, TX; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-77-105. 1976:565-584. (vol. 2).

Buffalofish and tilapia, grown in combination with channel catfish, were mechanically deboned along with the catfish. Yields in percentage of whole fish were 50.5 for buffalofish, 39.7 for tilapia, and 43.7 for channel catfish. Proper quality control measures and removal of dark pigments before processing helped to insure yields of flesh slightly darker than that in most ocean fish, but with a mild flavor quality.

Lundstrom, R.C.; Correia, F.F.; Wilhelm, K.A. Enzymatic dimethylamine and formaldehyde production in minced American plaice and blackback flounder mixed with a red hake TMAO-ase active fraction. *Journal of Food Science*. 47(4):1305-1310; 1982.

A dialysed high molecular weight trimethylamine oxidase active fraction from red hake muscle produced DMA in-vitro. When mixed with the high weight fraction from red hake, minced blackback flounder and American plaice were induced to produce DMA and FA, giving support to the theory that DMA and FA production in the hake may be from an endogenous enzyme.

Mackie, J.M.; Thomson, B.W. Decomposition of trimethylamine oxide during iced and frozen-storage of whole and comminuted tissue of fish. Proceedings of the fourth international congress of food science and technology. 1974; Madrid, Spain. Instituto de Agroquímica y Tecnología de Alimentos, c/ Jaime Roig, 11, Valencia - 10, Spain. 1974:243-250.

Gas chromatography was used to determine the volatile amines produced in some marine fish (cod, saithe, haddock, and lemon sole) during iced and frozen storage at -15°C and to quantitatively measure amounts of TMA and DMA in the fish flesh. The Nash reaction with acetyl acetone was used to determine formaldehyde formation. DMA increased progressively from 0 except that no increase occurred during frozen storage of haddock. Only TMA increased in the other gadoid species during iced storage.

Mincing the flesh of cod accelerated TMA and DMA production during iced-storage and DMA and formaldehyde production during frozen storage. DMA concentration was greater than 20mg N/100g flesh in cod mince after only 2-3 weeks storage at -15°C.

Mai, J.; Kinsella, J.E. Composition of lipids and proteins of deboned minced and filleted white sucker (Catostomus commersoni). Journal of Food Biochemistry. 3:229-239; 1979.

Compared with filleted sucker, mechanically deboned minced sucker contained higher phospholipid concentration (534mg/100g vs. 370mg/100g) and higher carbonyl values (0.89 μ moles/g vs. 0.61 μ moles/g). No significant differences in fatty acid composition of total lipid and phospholipids were found, while protein content and amino acid composition were similar.

Mai, J.; Kinsella, J.E. Changes in lipid composition of cooked minced carp (Cyprinus carpio) during frozen storage. Journal of Food Science. 44(6):1619-1624; 1979.

Phospholipids levels of minced carp tissue cooked by baking and deep-fat frying and stored at -18°C for up to 8 weeks decreased while free fatty acids (FFA) increased. Higher values for FFA were obtained from samples treated with antioxidants while samples with none had higher thiobarbituric acid (TBA) values than those containing antioxidants. Cooked samples had higher TBA values than raw samples. During frozen storage, carbonyl content of the samples fluctuated but no significant change in fatty acid composition occurred.

Maia, E.L.; Rodriguez-Amaya, D.B.; Moraes, M.A.C. Formulation, acceptability and stability of fish patties made with the freshwater fish Prochilodus scrofa Steindachner. Ciencia e Tecnologia de Alimentos. 2(1):33-46; 1982.

Frozen patties from Prochilodus scrofa, prepared by different methods, were evaluated periodically for TBA values (raw) and sensory evaluations (fried). Results were given in tables.

Makinodan, Ysao; Amano, Hajime; Simidu, Wataru. Studies on muscle of aquatic animals--XXXXI. Protease in fish muscle (No. 2). Relation between protease in fish muscle and decrease of ashi of kamaboko. Bulletin of the Japanese Society of Scientific Fisheries. 29(12):1092-1096; 1963. (In Japanese; English summary.)

This study showed that the absorption at 275 m in trichloroacetic acid soluble fraction of the reaction mixture at 65°C was due to protease activity, not to the turbidity of other substances and that the protease in the minced muscle was carried away by washing with water.

Martin, Roy E. (ed.). Mechanical recovery and utilization of fish flesh. Oak Brook Seminar. 1972 September 21-22; Oak Brook, IL. 270 p. Available from: National Fisheries Institute, Washington, D.C.

Seminar by National Fisheries Institute and National Marine Fisheries Service, Oak Brook, Illinois, September, 1972. Sessions: Current technical status - Commercially available equipment - Why the cod shortage and what are the alternatives? - Quality, classification, designation, labeling and marketing - Products demonstration - Product information and typical formulas.

Martin, Roy E. (ed.). Second technical seminar on mechanical recovery and utilization of fish flesh. 1974 June 12-13; Boston, MA. 318 p. Available from: National Fisheries Institute, Washington, D.C.

Seminar by National Fisheries Institute and National Marine Fisheries Service, Boston, MA, June, 1974. Sessions: Summary of deliberations on minced fish at FAO technical conference in Tokyo - Current technical status - Commercially available equipment - Update of technology and industrial application - Products demonstration - Economic and marketing considerations - Standardization, quality assurance and nomenclature.

Martin, Roy E. Mechanically-deboned fish flesh. Food Technology. 30(9):64-70; 1976.

Yields, properties, quality standards, processing considerations, current and potential markets, and uses of minced fish were discussed.

Martin, Roy E. Krill: as a protein source - methods of recovery, potential uses, and problems. Food Technology. 33(1):49-51; 1979.

Biology and composition; harvesting techniques; processing and utilization, including precooking and freezing, krill paste production, whole peeled krill, and krill meal production, are reviewed. Extensive list of references.

Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. 581 p. Available from: National Fisheries Institute, Washington, D.C.

The purpose of the conference is to bring together those individuals with experience or keen interest in developing markets for underutilized fish resources by employing mechanical deboning equipment for flesh recovery in conjunction with innovative food technology and merchandising techniques to market high quality products at

reasonable prices to consumers. Conference sessions include resources, processing equipment, functional properties, product development and ingredients, and grades, standards, and quality control.

Maslova, G.V.; Maslova, A.M. A study of the rheological properties of mince made from various species of fish. *Rybnoe Khozyaistvo*. 49(6): 68-70; 1973. (In Russian; English summary.)

Tests were conducted on commercial fish of varying chemical composition and muscle tissue structure to study changes in the viscosity of fish mince under varying tangential stress and velocity gradient. The effect of specific features of fish species on rheological properties of mince was studied in both sea fish (held in frozen storage at -18 to -20°C for 2 1/2 to 3 months) and freshwater fish (held in cool storage after a 5 to 6 day storage in ice).

Maslova, G.V.; Skomorovskaya, I.R.; Prudovskaya, E. Ya.; Krylov, B.K. *Manufacture of cooked/frozen fish sausage*; 1978.

Chapters include: Properties of fish sausage; Technological principles of cooked/frozen fish sausage production; Production of cooked/frozen fish sausage using stabilizers and various flavoring agents; Utilization of cooked/frozen fish sausage; and Mechanization of the manufacturing process.

Matsuda, Y. Influence of storage temperature on the kamaboko-forming ability of lyophilized Alaska pollock 'surimi'. *Bulletin of the Japanese Society of Scientific Fisheries*. 45(4):511-515; 1979.

Frozen 'muen-surimi' (fish paste containing sugar) and 'kaen-surimi' (fish paste containing salt and sugar) made from Alaska pollock were freeze-dried, ground into powder, packaged in polyethylene bags, and stored for 6 months at 5°, 20° and 35°C. The kamaboko-forming ability of the powders was preserved fully for 6 months at 5°C, and for 6 months for muen-surimi and 2 months for kaen-surimi at 20°C. Both products lost their protein solubility after only 1 month at 35°C.

Matsuda, Y. Influence of packing on the kamaboko-forming ability of lyophilized Alaska pollock 'surimi' during storage. *Bulletin of the Japanese Society of Scientific Fisheries*. 45(4):517-521; 1979.

Lyophilized surimi powders were packaged in vacuum cans and 0.1 and 0.03mm thick polyethylene bags, and stored for 6 months at 20°C. The kamaboko-forming ability of the muen-surimi powder was lost only in the thinner polyethylene bag after 6 months. Kaen-surimi maintained its quality in the vacuum can for 6 months,

but lost its kamaboko-forming ability after 3-4 months in polyethylene bags. Hence, packaging is a major factor in the preservation of freeze-dried fish meat powder. Protein solubility of the samples also decreased gradually with all packagings.

Matsuda, Yumiko. Influence of platen temperature of freeze-drying on the kamaboko-forming ability of lyophilized "muen-surimi" (fish meat paste containing sugar). Bulletin of the Japanese Society of Scientific Fisheries. 37(2):130-134; 1971. (In Japanese; English summary.)

This study examined how the platen temperature of freeze-drying affects the quality of the lyophilized "Muen-Surimi" (made from Alaska pollock) where 0.2% polyphosphates, 4% sugar and 4% sorbitol are added. It was concluded that fish meat powder having kamaboko-forming ability could be produced by freeze-drying of frozen Alaska pollock "Muen-Surimi" and could be stored for 3 months at room temperature.

Matsuda, Yumiko. Influence of platen temperature of freeze-drying on the kamaboko-forming ability of lyophilized "Kaen-Surimi" (fish meat paste containing salt and sugar). Bulletin of the Japanese Society of Scientific Fisheries. 37(2):135-139; 1971. (In Japanese; English summary.)

This study examined how the platen temperature of freeze-drying affects the quality of the lyophilized "Kaen-Surimi" made from Alaska pollock, where 2.5% salt, 5% sugar and 5% sorbitol are added. It was concluded from that fish meat powder having kamaboko-forming ability could also be made from frozen Alaska pollock "Kaen-Surimi" and could be stored for at least 1 month at room temperature.

Matsuda, Yumiko. Influence of sodium chloride on denaturation of lyophilized carp myofibrillar protein during storage. Bulletin of the Japanese Society of Scientific Fisheries. 45(7):841-843; 1979. (In Japanese; English summary.)

The effect of NaCl on the quality change of lyophilized carp myofibrils during storage was examined and carp myofibrils were ground with 1.5% NaCl or with 1.5% NaCl+0.2% polyphosphates+5% sucrose. The former and the latter mixtures designated as samples A and B, respectively, were then freeze-dried at 60°C, ground into powder, and stored at a relative humidity of 42% for 3 months at 20°C. At suitable intervals, aliquots of the mixtures were taken out and examined as to the quality, using as indexes solubility in 0.6M KCl, relative viscosity and ATPase activity of 0.6M KCl extractable protein, and the total ATPase activity. No protein protective effect was observed with sample A. A marked effect was observed with sample B, which was almost comparable to that shown by the control to which polyphosphates+sucrose had been added. It was concluded that NaCl hardly affects the denaturation of lyophilized carp myofibrillar protein.

Matsumoto, J. Juichiro; Arai, Tomiko. Studies on fish meat jellies--III. Measurement of physico-chemical properties of fish paste. Bulletin of the Japanese Society of Scientific Fisheries. 18(7):319-326; 1952. (In Japanese; English summary.)

Two methods for studying physico-chemical properties, and measurement of resistance, or push-in, are described.

Matthews, A.D.; Park, G.R.; Anderson, E.M. Evidence for the formation of covalent cross-linked myosin in frozen-stored cod minces. Connell, J.J. (ed.). Advances in fish science and technology. Surrey, England. Fishing News (Books) Ltd.; 1980:438-444.

A rapid fall in salt solubility of all samples (except in a v-cut mince) indicated that covalent bonding is not the only explanation for myosin denaturation in cold-store minces. It was suggested that the formation of further non-reducible covalent links requires disulphide bridging.

McCullough, J.M. A non-metric analysis approach to the development of formulated minced flesh products from ratfish. Paper presented at the 37th annual meeting of the Institute of Food Technologists. Philadelphia, Pa. 1977 June 5-8. (Abstract only).

Conjoint measurement of consumer preference patterns was used to predict acceptance of formulations for minced flesh food products from ratfish. Monotone analysis of variance (MONANOVA) was employed to identify individual and aggregate preference structures which are used to predict subsequent product selection by subjects. Multidimensional scaling was employed to validate the attributes considered. Subsequent individual level analysis was shown to predict accurately individual preferences for product formulations. Aggregate analysis was found to be ineffective.

Meinke, W.W.; Finne, G.; Mickelson, R., II; Martin, R. Nutritive value of fillets and minced flesh from Alaska pollock and some underutilized finfish species from the Gulf of Mexico. Journal of Agricultural and Food Chemistry. 30(3):477-480; 1982.

Minced flesh from Alaska pollock and underutilized finfish species from the Gulf of Mexico was judged to contain protein of equal nutritional properties as fillets from the same species. The study showed that for nutritional purpose) mechanical deboning can be used to convert the shrimp by-catch into human foods.

Mendelsohn, J.M. A study: expanded processing techniques, production costs, and market survey of underutilized fish species. U.S. Department of Commerce, Economic Development Administration, Technical Assistance Project No. 01-6-09131-2; 1974. 51 p.

Laboratory processes used in a previous study (a study to develop new products from whiting or other underutilized species) for preparing salt-cured fish and convenience-type products (such as cakes, portions, puffs, logs and sticks) were scaled-up, production costs were estimated, and a large-scale marketing study was conducted on fish cakes.

Mendelsohn, J.M. Minced fish in a new form. *Marine Fisheries Review*. 36(8):34-36; 1974.

Results from a market survey showed that minced fish in one-pound blocks is a highly acceptable market form.

Mendelsohn, J.M. Stability of canned minced whiting. *Food Product Development*. 11(9):26, 30; 1977.

Minced whiting (Merluccius bilinearis) was packed in 1/2 pound tuna cans, 160g/can, sealed immediately, and heat processed at 113°C. Part of the batch was incubated at 37.5°C (100°F), the remaining cans were held at approximately 21°C (70°F). Samples stored at 37.5°C were taste tested each month for 5 months, while fish stored at room temperature were taste tested the first and second months, then every other month up to 12 months. The whiting was served as a salad and graded, scale ranging from 9 (excellent) to 1 (inedible), according to appearance, odor, flavor and texture. Results showed that whiting served as a salad is highly acceptable after storage at 37.5°C for 5 months or at room temperature (21°C) for 1 year. Only samples containing onion flakes and stored at 37.5°C for 3 and 5 months showed decreased ratings.

Mendelsohn, Joseph M. Rapid techniques for salt-curing fish: A review. *Journal of Food Science*. 39(1):125-127; 1974.

Advantages and disadvantages of various salting techniques are discussed: boiled salted fish (pindang), bagged salted fish (British method), dehydration, salt propulsion method, Del Valle/Nickerson method, Anderson-Mendelsohn method.

Mendelsohn, J.M.; Connors, T.J.; Callan, J.G. A machine for heading and eviscerating small fish. *Marine Fisheries Review*. 39(2):11-18; 1977.

A commercial fish eviscerating machine modified to automatically head, eviscerate, and clean whiting, Merluccius bilinearis, and similarly shaped species was discussed; photographs accompanied the text. Machine will process about 60 fish per minute, each weighing between 1/4 and 1-1/2 pounds. Cleaned fish (butterflied, backbone remaining) can be battered and breaded and deep-fried or directly processed into minced fish.

Migita, Masao; Okada, Minoru. The setting phenomenon of fish muscle--II. Influence exerted by alkaline salts. Bulletin of the Japanese Society of Scientific Fisheries. 18(4):159-170; 1952. (In Japanese; English summary.)

Influence of alkaline salts on setting (jellification of proteins due to salt) of fish muscle was investigated by grinding comminuted meat of horse mackerel with various concentrations of alkaline salts.

Migita, Masao; Okada, Minoru. Setting phenomenon of fish muscle--III. Action of organic denaturants especially on the formation of friable jellies. Bulletin of the Japanese Society of Scientific Fisheries. 19(4):589-595; 1953. (In Japanese; English summary.)

Influences of urea and guanidine hydrochloride, well-known protein denaturants which are deemed to cleave the hydrogen-bond, on setting phenomenon of horse mackerel meat were studied.

Migita, Masao; Okada, Minoru. Setting phenomenon of fish muscle--IV. Influence of hydrogen ion concentrations. Bulletin of the Japanese Society of Scientific Fisheries. 20(3):213-223; 1954. (In Japanese; English summary.)

Influence of pH on setting phenomenon of fish meat was studied, by using as the sample minced horse-mackerel meat mixed with half its own weight of water, pH being adjusted by adding KOH or HCl. Interpreted results were that both the hydration of meat proteins and the formation of gel structure are essential factors of setting phenomenon of meat.

Migita, Masao; Okada, Minoru. Setting phenomenon of fish muscle--VI. Influence of coexistent organic denaturants on setting phenomenon caused by inorganic salts. Bulletin of the Japanese Society of Scientific Fisheries. 20(6):530-538; 1954. (In Japanese; English summary.)

The influence of urea and guanidine hydrochloride (Gu-HCl) present with inorganic salts was studied, using horse mackerel meat as a sample. Conclusions were: (1) moderate denaturation of proteins

would be necessary for the formation of jelly of high elasticity and strength, while excessive denaturation would result in the formation of a friable jelly; (2) inorganic anions could take part in producing a gel structure by their action to denature proteins as well as in increasing the hydration of proteins.

Misuishi, I. Economic profiles for three products made from by-catch. Fish by-catch...bonus from the sea. Report of a technical consultation on shrimp by-catch utilization held in Georgetown, Guyana; 1981 October 27-30; International Development Research Centre, Ottawa, CA; 1982:118-119.

Economic profiles were given for three minced products--fish sticks, kamaboko, and fish paste or paté. All were judged suitable for white-fleshed fish found in the by-catch.

Miyake, Masato; Hayashi, Koichiro. Studies on fish jellies--II. Content of the myosin fraction in fish muscle. Bulletin of the Japanese Society of Scientific Fisheries. 22(1):48-50; 1956. (In Japanese; English summary.)

It was found that the amount of the myosin fraction was proportional to the strength of Ashi which is specific to each fish and that the viscosity of brine extracts from fish muscle was correlated with Ashi.

Miyake, Masato; Hayashi, Koichiro; Tanaka, Akiko; Niwa, Eiji. Studies on fish meat jellies (Kamaboko)--X. Electron microscopic observations on dispersion of myofibrils in kamaboko. Bulletin of the Japanese Society of Scientific Fisheries. 37(6):534-537; 1971. (In Japanese; English summary.)

A study on the fine structure of Kamaboko by electron microscopy, clarifying a network structure which is composed of myofilaments and other protein components in myofibrils, was reported.

Miyake, Masato; Kawakami, Ken. Studies on fish meat jellies (fish sausage)--VIII. Effect of amino acids on the elasticity of fish meat jellies--I. Bulletin of the Japanese Society of Scientific Fisheries. 32(5):446-449; 1966. (In Japanese; English summary.)

The favorable effect of some neutral and basic amino acids was confirmed, although the reason of the superior effect of basic amino acids than that of neutral amino acids remained obscure.

Miyake, Masato; Tanaka, Akiko. Studies on fish meat jellies (fish sausage)--IX. Relation between pH of fish meat paste and elasticity of fish meat jellies. Bulletin of the Japanese Society of Scientific Fisheries. 35(3):311-315; 1969. (In Japanese; English summary.)

A simple method for measuring Ashi (the elasticity proper to fish meat jellies) by clarifying the relation of pH of meat pastes and the elasticity of kamaboko was estimated. This method gave more satisfactory results than Miyake's gelometer and a close correlation with the values obtained by gelometer.

Miyauchi, D.; Kudo, G.; Patashnik, M. Effect of processing variables on storage characteristics of frozen minced Alaska pollock. Marine Fisheries Review. 39(5):11-14; 1977.

Comparison was made of preservation methods used to hold fish prior to processing (in ice, slush ice or refrigerated sea water). Washing of minced pollock flesh improved color but not flavor or texture. The bland flavor and stringy-tough texture of frozen minced pollock promote its use as an extender in processed meat products.

Miyauchi, David; Kudo, George; Patashnik, Max. Surimi--a semi-processed wet fish protein. Marine Fisheries Review. 35(12):7-9; 1973.

By being processed into surimi, fish muscle protein retain for a longer time the functional properties required for making good "kamaboko" and fish sausages. The preparation procedure and factors affecting quality of surimi were described.

Miyauchi, David; Patashnik, Max; Kudo, George. Frozen storage keeping quality of minced black rockfish (Sebastes spp.) improved by cold-water washing and use of fish binder. Journal of Food Science. 40(3):592-594; 1975.

Both fillet and minced muscle blocks of black rockfish had storage lives at -18°C of less than 4 months owing to rancid flavors and discoloration. Mixing a fish binder with minced muscle provided longer storage life for modified fish blocks (8 to 12 months), and washing the minced muscle improved color and flavor.

Miyauchi, David; Steinberg, Maynard. Machine separation of edible flesh from fish. Fishery Industrial Research. 6(4):165-171; 1970.

A flesh-separating machine which economically increases yields of edible flesh (37-60%), with such mechanization leading to utilization of undeveloped fisheries and industrial fisheries as sources of food, was described.

Moledina, K.H.; Regenstein, J.M.; Baker, R.C.; Steinkraus, K.H. Effects of antioxidants and chelators on the stability of frozen stored mechanically deboned flounder meat from racks after filleting. *Journal of Food Science*. 42(3):759-764; 1977.

The most effective treatment to retard rancidity, color deterioration, and the decrease of protein extractability in mechanically deboned flounder meat during frozen storage was a 1 minute dip of the racks, prior to deboning, in a pH 4.5 solution of 0.5% each of ascorbic and citric acids and 0.2% each of Na₂ EDTA and Kena (Calgon), followed by a post deboning addition of 0.3% each of ascorbic and citric acids and 0.2% each of Kena and Na₂ EDTA.

Moledina, K.H.; Regenstein, J.M.; Baker, R.C.; Steinkraus, K.H. A process for the preparation of dehydrated salted fish-soy cakes. *Journal of Food Science*. 42(3):765-767; 1977.

A method for producing a dehydrated, salted fish-soy product from mechanically deboned flounder meat from headed and gutted fish frames was developed. The meat was mixed with salt (30% of the meat weight) and soybean curd (20% of the meat weight).

Morais, C. de; Martins, J.F.P. Utilization of wastes from industrial fish processing in manufacture of food products. *Boletim do Instituto de Tecnologia de Alimentos*. 18(3):253-281; 1981.

Utilization of edible material from fish and shrimp wastes was discussed. Subjects included raw materials, composition, separation equipment, yields, advantages and disadvantages of deboned meat, uses, and industrial processing.

Moral, A.; Borderias, A.J.; Garcia Matamoros, E. Effects of additives on the stability of frozen minced fish. I. Minces of blue whiting (*Micromesistius poutassou*, Risso) obtained by the extrusion method with addition of protein protectors and antioxidants. Paper presented to the international congress of food science and technology. Kyoto, Japan; 1978 September 17-22. Available from: Cent. Exp. del Frio, Ciudad University, Madrid 3, Spain.

Minced blue whiting was subjected to 7 treatments: (i) control; (ii) antioxidant, sucrose and sodium alginate; (iii) antioxidant, sucrose and sodium tripolyphosphate; (iv) as (ii) plus lactic acid; (v) as (ii) plus tartaric acid; (vi) as (ii) plus ascorbic acid; (vii) as (iv) plus sodium glutamate. Results indicated that treatments (i) and (iii) provided the greatest extension of storage life.

Morehead, Bruce C. A report on the National Marine Fisheries Service comminuted fish cake survey. *Marine Fisheries Review*. 36(5):34-37; 1974.

Survey was aimed at the food service industry, in-plant feeders, hospitals, universities, and school lunch programs. Forty-three percent of all respondents indicated a willingness to buy the product, those establishments without prior experience with fish cakes reacting more favorable to the flavor than others. Ratings for texture, however, were lower than those for flavor.

Mori, Kazuo; Sawada, Harumichi; Nabetani, Osamu; Maruo, Shigeaki; Hirano, Tomoko. Studies on the spoilage of fish jelly products--I. Softening spoilage of film packaged kamaboko due to Bacillus licheniformis. Bulletin of the Japanese Society of Scientific Fisheries. 39(10):1063-1069; 1973. (In Japanese; English summary.)

The bacterial spoilage of film packaged kamaboko was investigated with respect to the properties of the isolated causative bacteria and the source of the contamination in the kamaboko. The isolated causative bacteria was identified as Bacillus licheniformis. It was proven that the addition of sucrose hastens this type of spoilage and that the use of some lower fatty acids is an effective means of preservation from spoilage.

Morris, D.M.; Dawson, L.E. Storage stability of mechanically deboned sucker (Catostomidae) flesh. Journal of Food Science. 44(4):1093-1096; 1979.

Freshly processed minced flesh from freshwater species harvested during different seasons of the year was treated with the antioxidants Tenor A[®], Tenox II[®], Tenox PG[®], and FreezGard[®]. After frozen storage (-18°C for 1-12 months), samples were analyzed for 2-thiobarbituric acid (TBA). FreezGard was the only antioxidant found to be effective in controlling lipid oxidation. For breaded, precooked, and raw patties treated with FreezGard, a seasoned binder, or an edible film and stored at -18°C for up to 10 months, FreezGard was found to be most effective in limiting oxidation (indicated by TBA) and resulted in improved flavor and firmness of cooked patties.

Motegi, S. Studies of the microflora of fish sausage from the viewpoint of food packaging technology. Bulletin of the Japanese Society of Scientific Fisheries. 45(1):79-87; 1979.

Studies were undertaken to investigate changes in microflora associated with the spoilage of 113 commercial fish sausages collected during 1962-1975. Changes were greatly affected not only by the adhesive character of the packaging film to the meat, but also by the heat processing conditions. Bacillus circulans and B. firmus were the most common isolates in spoilage involving softening inside the sausage, while B. coagulans accounted for 40.6% of isolates in spoilage causing formation of spots on outer surfaces of the sausage. All bacilli showed greatly reduced incidence in sausages cooked at higher temperature except B. coagulans.

Motegi, S. Effect of adhesiveness of packaging film to meat on growth of microorganisms responsible for deterioration of fish sausage. Bulletin of the Japanese Society of Scientific Fisheries. 45(1):89-92; 1979.

When the sausage was packaged in a film casing of poor adhesiveness, free water appeared in the space between the film and the fish sausage at an early stage of storage; *Bacillus firmus* dominated in the water to cause a form of spoilage characterized by weak gas formation. In sausage packaged in film of good adhesiveness, *B. circulans* became predominant.

Motohiro, T.; Numakura, T. Utilization of soy proteins in fish gel products. I. Optimum concentration of protein isolate in boiled-, fried-, and broiled-type products. Bulletin of the Faculty of Fisheries, Hokkaido University. 29(2):141-147; 1978.

Various fish gel products were prepared from frozen minced fish meat with the admixture of 0-10% of a soy protein isolate. There were few differences between controls and test samples containing 2% (boiled type) and 3% (fried and broiled types) protein isolate. Jelly strength decreased with increasing isolate concentration.

Motohiro, T.; Numakura, T. Utilization of soy proteins in fish gel products. II. Effects of starch and water on jelly strength of boiled-, fried-, and broiled-type fish gel products containing soy protein isolate. Bulletin of the Faculty of Fisheries, Hokkaido University. 29(4):392-398; 1978.

Various fish gel products were prepared containing soy protein isolate as partial replacement for frozen minced fish meat with potato starch (0-5%) and water (0-50%) added. Adding water decreased jelly strength and above certain levels of water the products containing soy protein were stronger than those without. A boiled gel product with starch and isolate had a high-quality jelly strength if no water was added, and a standard quality strength with 20-30% water. Similar levels were obtained with a broiled product containing starch and isolate with water addition.

Motohiro, T.; Numakura, T. Utilization of soy proteins in fish gel products. III. Effect of different salting processes on the texture of boiled-type fish gel products. Bulletin of the Faculty of Fisheries, Hokkaido University. 31(1):115-119; 1980.

The estimating of jelly strength was used to examine the effects of two salting processes on the texture of boiled-type fish gel products. Both a single and a double salting process were used on Alaska minced pollock and soy protein isolates.

Motohiro, T.; Numakura, T.; Mokudai, H. Utilization of soy proteins in fish gel products. IV. Change in the jelly strength of fish gel products by the addition of oil. Bulletin of the Faculty of Fisheries, Hokkaido University. 31(2):210-214; 1980.

The effect of soy proteins on the texture of fish gel products to which oil was added was studied. Minced Alaska pollock and soy protein isolate of different levels were mixed with cottonseed oil at different levels. Differences in jelly strength were recorded.

Motohiro, T.; Sugiura, S. Utilization of soy proteins in fish gel products. V. Emulsifying properties of a mixture of minced fish meat and isolated soy proteins. Bulletin of the Faculty of Fisheries, Hokkaido University. 31(3):252-258; 1980.

The emulsifying properties of minced Alaska pollock and soy protein isolates were tested. Different ratios of the soy protein isolate and soybean oil were used and the jelly strength of the gel of each was measured.

Motohiro, T.; Sugiura, S. Utilization of soy proteins in fish gel products. VI. Effect of sodium chloride on emulsifying properties of the mixture of minced meat of Alaska pollock and isolated soy proteins. Bulletin of the Faculty of Fisheries, Hokkaido University. 31(3):259-264; 1980.

The effect of NaCl on the emulsifying properties of minced Alaska pollock and soy protein isolates was studied. Ratios were recorded, as were emulsion stabilities.

Murray, B.P.; Stanley, D.W.; Gill, T.A. Improved utilization of fish protein--co-extrusion of mechanically deboned salted minced fish. Canadian Institute of Food Science and Technology Journal. 13(3):125-130; 1980.

Texture of co-extrudates produced from mixtures of soy and fish proteins by thermal extrusion depended strongly on the ratio of protein to water and of vegetable to fish protein. The addition of fish improved texture. Sensory evaluation data suggested that a standard meat loaf formulation using the co-extrudates would probably not be accepted by Canadian consumers due to the fishy flavor and odor present in the initial fish.

Nakamura, K.; Ishikawa, S.; Koshimizu, M. Studies on utilization of oval filefish. Bulletin of the Tokai Regional Fisheries Research Laboratory. 106:1-10; 1982.

The possible use of the oval filefish Navodon modestus was described. Studies included composition, changes during frozen storage, and the production of kamaboko, fish protein concentrate, and fish sticks.

Nakayama, T.; Niwa, E.; Hamada, I. Pipe transportation of minced fish paste. *Journal of Food Science*. 45(4):844-847; 1980.

A pipe system was designed in which an air cylinder forced minced fish paste from the wide portion of a pipe to the narrow portion where the paste was extruded. Agreement of rheological constants suggested that pressure loss was proportional to pipe length, except that disagreements appeared when the ratio of pipe length to pipe inside diameter was decreased. No constant shear rate was found: shear stress of minced fish paste ranged from 21000-29000 dyne cm^{-2} , but shear rate ranged from 20-240 sec^{-1} . Yield stress was approximately 20000 dyne cm^{-2} .

Nakayama, T.; Yamamoto, M. Physical, chemical and sensory evaluations of frozen-stored deboned (minced) fish flesh. *Journal of Food Science*. 42(4):900-905; 1977.

Changes in TBA values, texture, color, taste and odor were monitored at monthly intervals in samples of deboned flesh from underutilized fish species and stored at -20°C over a 6-month period. Surface TBA values tended to increase steadily, then decline after 4 or 5 months, while core TBA values remained relatively constant for most species examined; core TBA values were always substantially lower than surface TBA values in all samples.

National Marine Fisheries Service. U.S. Standards for grades of frozen minced fish blocks. *Federal Register*. 50CFR Part 264. 44(110):32388; 1979 June 6.

National Oceanic & Atmospheric Administration. Fish-extended frankfurters and meat patties found acceptable by students. Department of Commerce, NOAA. SEN 84; 1979. 4 pp.

No significant differences in flavor, texture, and overall product acceptability in frankfurters and meat patties with 10-15% of the beef having been replaced by an equal weight of minced Alaska pollock flesh were noted by high school students when compared with the all-beef product. The nutritional values of the extended product were said to meet requirements for meals in the National School Lunch Program.

Nelson, Richard W.; Dassow, John A. Resources for minced fish production in the Northeast Pacific and eastern Bering Sea. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981:38-49.

Resources for minced fish production in the Northeast Pacific Ocean and the eastern Bering Sea can be divided into 3 groups: (1) Whole

fish harvested or sorted from bottomfish catches to be processed at sea or ashore into frozen minced fish, (2) Edible trimmings or frames from filleting or other processing operations at sea or ashore, (3) Fishery resources of unknown magnitude or feasibility for harvest that provide a future reserve for raw material as the minced fish production increases. The potential and problems of each resource group were discussed.

Nelson, Richard W.; Patashnik, Max; Groninger, Herman S. Underutilized bottomfish species of the northeast Pacific--current problems and use concepts. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981:208-215.

The Northeast Pacific Ocean including the Gulf of Alaska and the Bering Sea offers more potential for development of underutilized species than any other area accessible to U.S. fishermen. The species with the most opportunity for development, based on the resource availability, are Alaska pollock and Pacific whiting. Lesser but significant quantities of other species including rockfishes, Pacific cod, and several varieties of flatfishes are also worthy of development.

Newman, D.A. Reforming of fish products with texture from frozen fish--the Comitrol flake cutting system. Keay, James N. (ed.) Conference: the production and utilisation of mechanically recovered fish flesh (minced fish), 1976, proceedings. Ministry of Agriculture, Fisheries and Food, Torry Research Station, Aberdeen; 1976:31-33.

An alternative method of comminuting finfish and shellfish flesh to uniformly thin particles, or flakes, was described. The texture in each flake was retained, and the resultant reformed products had a texture more closely resembling fish flesh.

Nickelson, R., II; Finne, G.; Hanna, M.O.; Vanderzant, C. Minced fish flesh from nontraditional Gulf of Mexico finfish species; bacteriology. Journal of Food Science. 45(5):1321-1326; 1980.

Fresh and frozen minced fish flesh was prepared from sheepshead, croaker, black drum, sand trout, tilapia, and mullet. Aerobic plate counts (APC, at 25°C) of fresh mince ranged from 1.2×10^5 /g (sheepshead) to 2.6×10^8 /g (tilapia), those of frozen mince (2-months at -20°C) from 7.9×10^3 /g (sheepshead) to 7.9×10^6 /g (tilapia). Counts usually increased during flesh/bone separation. Coliform counts of frozen minced flesh ranged from 11.2 to >1100/g. Fecal coliform bacteria were detected in the frozen mince of tilapia, croaker, and black drum (range 1.2-254.3/g), coagulase positive staphylococci in tilapia, sheepshead, and mullet (range 3.6-200/g).

The microbial types present in the freshly minced product were similar to those present in the whole fish. Moraxella-Acinetobacter sp. were the most prevalent microbial types in the fish before, during, and after processing into minced fish flesh.

Nielsen, Jette. Studies on fish waste. Frozen and dried products from meat recovered from backbones. Paper presented to the 10th meeting of the Western-European Fish Technologists' Association (WEFTA). Goteborg; 1980. Available from: Technological Laboratory, Ministry of Fisheries, Lyngby, Denmark.

Mince from control cod frames was compared with mince from frames which had the upper part of the backbone removed. Washing the frames before separation was tried and suggested, while washing with different amounts of ice water at neutral pH and at pH 5 was also tested. The mince was dewatered in a basket centrifuge and in a screw press. During a 5-month storage period, the influence of BHA, cheese, whey powder, sage, soybean oil, skim milk powder, ascorbic acid and soy protein on DMA formation and on texture was examined. Successful production of laminated blocks was carried out with up to 20% v-cut mince, 10% pasteurized frame mince and 0.5% soya isolate.

Niki, H.; Deya, E.; Kato, T.; Doi, T.; Igarashi, S.; Hayashi, H. Development of active fish protein powder. Paper presented to the international congress of food science & technology. Kyoto, Japan; 1978 September 17-22. Available from: Technical Research Institute, Naebo-cho, Higashi-ku, Sapporo, Japan.

Development of a storage-stable raw material from Alaska pollock for production of kamaboko was described. The product was reconstituted with 5 vol. of water and had excellent functional properties, being stable for 4 months at 5% moisture content, at 5°C in air or at 30°C after deoxygenation.

Niscolo, Wilson; Frank, Hilmer A. Bacterial spoilage of kamaboko during refrigerated storage. Food Technology. 20(7):114-117; 1966.

Studies done at the University of Hawaii on kamaboko during refrigerated storage indicated presence of visible slime when surface microflora concentration reached 5×10^7 per sq. in. At 10°C, slime appeared after 5-6 days; spoilage was delayed for 3 additional days by lowering the storage temperature to 5°C.

Nishida, K.; Fukano, S.I.; Ushio, F.; Doguchi, M. Quality of commercially marketed kamaboko, a fish jelly product. Annual Report of Tokyo Metropolitan Research Laboratory of Public Health. 29(1):279-282; 1978.

Fifty commercial samples of kamaboko were studied for calorific value, pH, jelly strength, consistency, and composition.

Nishimoto, Jun-ichi; Koreeda, Noboru. Protein denaturation and the change of gel-forming capacity in the rinsed fish muscle during frozen storage. Bulletin of the Japanese Society of Scientific Fisheries. 45(8):989-993; 1979. (In Japanese; English summary.)

The myofibrillar protein denaturation and the gel-forming capacity variations in the rinsed mackerel muscle were compared with those in the unrinsed muscle during the frozen storage. The most effective method for keeping the gel-forming capacity of the frozen mackerel muscle was ascertained to be the following three processes: first, to freeze and store the fish muscle whole; second, to thaw the frozen muscle before the preparation of "Surimi"; and third, to rinse the muscle immediately after thawing.

Nishimoto, Jun-ichi; Miki, Hidemasa. Studies on utilization and processing of the muscle of the unexploited elasmobranchs--1. Heat-induced gelation of comminuted muscle of elasmobranchs. Memoirs of the Faculty of Fisheries, Kagoshima University. 29:1-9; 1980. (In Japanese; English summary.)

Studies were conducted to obtain information on the possible utilization of the trash fish such as small elasmobranchs (shark) from Amami Ohshima fishing ground. Conclusions included: (1) The texture of the heated gel of comminuted elasmobranch muscles (trash fish) was shown to have low value. The muscles were not found to be good materials for Kamaboko of high quality. (2) Sensory evaluation revealed that frozen elasmobranch muscle could be used as material for fried foods such as Satsuma-age and fish stick.

Niwa, Eiji. Role of hydrophobic bonding in gelation of fish flesh paste. Bulletin of the Japanese Society of Scientific Fisheries. 41(8):907-910; 1975. (In Japanese; English summary.)

The binding capacity of 8-anilino-1-naphthalenesulfonate (ANS) for actomyosin (AM) extracted from flatfish was studied in order to clarify the role of hydrophobic bonding in the gelation of fish flesh paste.

Niwa, E.; Nakajima, G. Differences in protein structure between elastic kamaboko and brittle one. Bulletin of the Japanese Society of Scientific Fisheries. 41(5):579; 1975.

To describe differences in protein structure among different types of gels, fish sol was divided into 3 parts, each undergoing a different heat treatment. Jelly strength for each treatment was determined.

Niwa, E.; Sato, K.; Hamada, I. New gelling properties of Alaska pollack frozen mince induced by urea. Bulletin of the Japanese Society of Scientific Fisheries. 48(5):629-631; 1982.

A mixture of Alaska pollock frozen mince and urea was heated until dissolved, dialysed, frozen and tested for gel reactions. The addition of the urea-treated mince did not improve the Alaska pollock mince.

Niwa, Eiji; Miyake, Masato. Physico-chemical behavior of fish meat proteins--I. Behavior of polypeptide chains of proteins during setting of fish meat paste. Bulletin of the Japanese Society of Scientific Fisheries. 37(9):877-883; 1971. (In Japanese; English summary.)

The purpose of this series was to clarify the mechanisms of the setting (Suwari) and deterioration (Modori) phenomena, which take place in the course of processing of "Kamaboko". This paper deals with changes in the conformation of fish meat protein on setting which is induced by heat treatment of viscous fish meat containing sodium chloride at relatively low temperature. Physico-chemical constant, i.e. X-ray diffraction pattern, infrared spectrum and optical rotation dispersion curve were measured.

Niwa, Eiji; Miyake, Masato. Physico-chemical behavior of fish meat proteins--II. Reactivities of side groups of polypeptide chains during setting of fish meat paste. Bulletin of the Japanese Society of Scientific Fisheries. 37(9):884-890; 1971. (In Japanese; English summary.)

The reactivities of the side groups of polypeptide chains in relation to gel formation during the setting of fish meat paste were investigated. Based on the results, the formation of a protein network during the setting process of fish meat paste was discussed.

Niwa, Eiji; Mori, Bunji; Miyake, Masato. Retardative mechanism of protein denaturation by addition of saccharides during cold storage of minced fish meat (Surimi)--I. Behavior of electrolytes in sucrose solution. Bulletin of the Japanese Society of Scientific Fisheries. 39(1):61-67; 1973. (In Japanese; English summary.)

To clarify the retardative mechanism of protein denaturation by the addition of saccharides during cold storage of minced fish meat (Surimi), the behavior of electrolytes in sucrose solution was studied by the electrochemical method.

Niwa, Eiji; Nakajima, Gozo; Hagiwara, Nobuhide; Miyake, Masato. On the retardation of modori in kamaboko processing. Bulletin of the Japanese Society of Scientific Fisheries. 41(12):1293-1297; 1975. (In Japanese; English summary.)

In order to clarify the mechanism of modori in kamaboko processing, the effects of physical and chemical factors on modori were investigated.

Niwa, Eiji; Nakayama, Teruo; Hamada, Iwao. Attempt to determine the state of water in fish gel by IR technique. Bulletin of the Japanese Society of Scientific Fisheries. 46(7):863-866; 1980.

In order to investigate the state of water in fish gel, differential spectrum was illustrated from two IR spectra recorded before and after dehydration of samples of flatfish, jack mackerel, carp, and big eye.

Niwa, Eiji; Nakayama, Teruo; Hamada, Iwao. Effect of setting on the network structure of protein in fish flesh gel. Bulletin of the Japanese Society of Scientific Fisheries. 49(2):245-249; 1983.

The hardening of kamaboko by preheating the surimi at a relatively low temperature (setting) was studied. The effect of setting on the network structure of protein in the fish flesh gel was discussed. With setting, the proteins form a finely dispersed network structure which is kept after heating the set gel to shape the fish flesh gel; and such a structure was thought necessary for the elasticity of the gel.

Noguchi, Satoshi F. Product development in Japan. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981:383-391.

The presentation dealt with the introduction of conventional dishes and commercial products made from fish meat in Japan and Asia, and new processing techniques of frozen surimi made from small pelagic fishes, of "marine beef" or meat textured FPC, of "shoniku" and mixed fillet/minute products, and of freeze dried surimi.

Noguchi, Satoshi; Matsumoto, Juichiro J. Studies on the control of the denaturation of the fish muscle proteins during the frozen storage--I. Preventive effect of na-glutamate. Bulletin of the Japanese Society of Scientific Fisheries. 36(10):1078-1087; 1970.

The effect of the monosodium glutamate on the frozen-storage denaturation of the fish muscle actomyosin was studied by an in vitro model test of the isolated actomyosin as well as by a frozen-storage test of the washed mince of the fish meat. Besides the Na-glutamate-free control group, glucose-added and urea-added groups were examined for comparison.

Noguchi, Satoshi; Matsumoto, Juichiro J. Studies on the control of denaturation of fish muscle proteins during frozen storage--III. Preventive effect of some amino acids, peptides. Acetylamino acids and sulfur compounds. Bulletin of the Japanese Society of Scientific Fisheries. 41(2):243-249; 1975.

The preventive effect of some amino acids, acetyl amino acids, peptides, and sulfur compounds on the freezing denaturation of carp actomyosin at -30°C for 4 to 8 weeks was examined by using an in vitro test system. The rate of denaturation was followed by estimating solubility and superprecipitation.

Noguchi, Satoshi; Matsumoto, Juichiro J. Modification of thermal and non-thermal gelation of carp actomyosin by additive compounds. Bulletin of the Japanese Society of Scientific Fisheries. 44(3):273-278; 1978.

When dilute carp actomyosin solution was heated gradually the mixture became a jelly beyond 40°C in the presence of Na-glutamate or Na-EDTA, while the control mixture aggregated into fine particles. These additives were also found to be effective in raising the viscosity and in suppressing the change in ATPase activity and turbidity.

Noguchi, Satoshi; Oosawa, Koji; Matsumoto, Juichiro J. Studies on the control of denaturation of fish muscle proteins during frozen storage--VI. Preventive effect of carbohydrates. Bulletin of the Japanese Society of Scientific Fisheries. 42(1):77-82; 1976.

The preventive effect of carbohydrates on freezing denaturation at -30°C for 4 to 7 weeks was examined by using an in vitro model test system of the isolated carp actomyosin. The rate of denaturation was followed by estimating solubility, viscosity, ATPase activity as well as the degree of superprecipitation.

Noguchi, Satochi, Shinoda, Ekisei; Matsumoto, Juichiro J. Studies on the control of denaturation of fish muscle proteins during frozen storage--V. Technological application of cryoprotective substances on the frozen minced fish meat. Bulletin of the Japanese Society of Scientific Fisheries. 41(7):779-786; 1975.

In order to study their effect on the quality of Kamaboko jelly, the cryoprotective additives found in previous model tests were added to the washed mince of fish meat which was then processed into Kamaboko after frozen storage. The effect of 6 amino acids, 7 carboxylic acids, sorbitol and glucose on the salt-added and salt-free frozen horse mackerel meat mince was examined.

Nowlan, Sandra S.; Dyer, W.J. Effect of mincing on glycolytic activity in prerigor Atlantic cod (Gadus morhua) muscle stored in ice or frozen. Journal of the Fisheries Research Board of Canada. 31(4):473-476; 1974.

Mincing was found to have no apparent stimulatory effect on glycogen or ATP breakdown in prerigor Atlantic cod if the muscle is frozen immediately after being minced. During large-scale production of minced muscle from prerigor fish, however, some glycolysis will occur depending on the time delay and holding temperature before freezing.

Nozaki, Y.; Kanazu, R.; Tabata, Y. Frozen storage of lizardfish for kamaboko preparation. Refrigeration. 53(608):473-480; 1978.

Kamaboko forming ability of lizardfish (Saurida wanieso) stored at -25°C for 20 days was normal, but that of fish stored at -5°C for 15 days was poor. There was a negative correlation between the concentration of dimethylamine in fish meat and the breaking strength of kamaboko.

Nunes, M.L.; Geromel, E.J. Tilapia protein hydrolysate. Determination of some processing conditions. Ciencia e Tecnologia de Alimentos. 2(2):164-179; 1982.

Manufacture of fish protein concentrate from mechanically-deboned tilapia meat was described, including extraction process, composition of product, and microbial count. Production of a protein hydrolysate was also described.

Ohta, F.; Itoyama, M. Inhibitory effect of phosphate buffer on denaturation of fish muscle actomyosin by freezing. Memoirs of Faculty of Fisheries, Kagoshima University. 30:395-399; 1981.

Potassium and sodium phosphate buffers were studied for their inhibitory effect on freeze-denaturation of carp muscle actomyosin

and in minced salt-added horse mackerel. A comparison was made with sorbitol and sodium glutamate, known denaturation-inhibitors. Jelly product from phosphate-added mince was judged superior in texture to that from the sorbitol and glutamate-added mince.

Okada, M. Effect of sodium citrate on the keeping quality of frozen surimi (frozen fish paste). Kreuzer, Rudolf (ed.). Freezing and irradiation of fish. London, England. Fishing News (Books) Ltd. 1969: 312-314.

It was found that the reason salted surimi (cold-water washed, crushed fish meat ground with 3 percent sodium chloride and 10 percent sugar to sticky paste) could not be used for kamaboko after 4 or 5 months' storage at -25°C was because of the jelling of the myofibrillar proteins and that the addition of sodium citrate in combination with sugar significantly improved the keeping quality of the product by retarding this jelling action.

Okada, M. The gel-forming capacity of some hake species from South America. FAO Fisheries Report No. 203, Supplement 1. Technical Consultation on the Latin American Hake Industry. 1978:153-160.

The fish proteins of frozen-stored Merluccius hubbsi, M. australis, Macruronus magellanicus, Merluccius gayi, and Macruronus novaezealandiae rendered kamaboko with excellent elasticity, good texture, and acceptable white color, while frozen Micromesistius australis gel-forming capacity was slightly poorer. Frozen dressed M. magellanicus and M. australis had poorer gel-forming capacity than whole frozen. South American hake was deemed acceptable as raw material for kamaboko.

Okada, Minoru. Application of setting phenomenon for improving the quality of kamaboko. Bulletin of Tokai Regional Fisheries Research Lab. 24:67-72; 1959. (In Japanese; English summary.)

In manufacturing process of kamaboko, sticky paste produced by grinding fish meat with salt often turns to an elastic jelly. This is known as a setting phenomenon. In this work, it was ascertained that Kamaboko with strong jelly strength can be obtained by setting fish paste prior to the cooking.

Okada, Minoru. Influence of cooking conditions on the jelly strength of Kamaboko. Bulletin of Tokai Regional Fisheries Research Lab. 24:73-79; 1959. (In Japanese; English summary.)

Jelly strength of Kamaboko usually became greater with increasing temperature up to 75°C - 85°C . It was recommended that a two-step heating, i.e., cooking first at 45°C - 50°C . and then at 75°C ., is effective to secure a good quality for kamaboko.

Okada, Minoru. Effect of washing on the jelly forming ability of fish meat. Bulletin of the Japanese Society of Scientific Fisheries. 30(3): 255-261; 1964. (In Japanese; English summary.)

Work was carried out to examine the belief that the washing process is also good, in addition to improvement in color and flavor, for increasing the jelly forming ability of fish meat.

Okada, Minoru. Hardening of fish sausage on aging. Bulletin of Tokai Regional Fisheries Research Lab. 41:71-78; 1965. (In Japanese; English summary.)

It was found that non-ionic surface agents such as monoglycerides, sugar monoesters or polyoxyethylen sorbitan monosterates did not prevent the hardening of fish sausage during aging.

Okada, Minoru. Fish processing and utilisation in Japan. Food Technology in Australia. 27(1):24-27; 1975.

Tuna, kamaboko, and surimi were discussed for their importance in Japanese tradition and for their potential adaptation to other countries.

Okada, Minoru. Utilization of small pelagic species for food. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981:265-273.

Investigations conducted on the development of processing technology in Japan for small pelagic fish such as sardine and mackerel were reviewed. Topics included characteristics as raw material for processed foods (rapid protein denaturation, high content of sarcoplasmic proteins, high proportion of dark muscle, and high fat content) and product development (frozen blocks).

Okada, Minoru. Antarctic krill utilization studies in Japan. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981:395-414.

The results of investigations on systematic exploitation of Antarctic krill as a protein source were reviewed. Subjects included estimate of the stock, fishing methods and catch, chemical and nutritive characteristics of krill, raw material characteristics, and product development.

Okada, M.; Noguchi, E. Trends in the utilization of Alaska pollock in Japan. Kreuzer, Rudolf (ed.). Fishery products. Surrey, England. Fishing News (Books) Ltd. 1974:189-193.

The annual catch of Alaska pollock by Japan increased remarkably since early 1960, reaching 2,360,000 tons in 1970, and was accompanied by an expansion of the utilization of this fish. The chemical characteristics and keeping quality of the species were given. Many cured products from Alaska pollock were listed, and the importance of the species as material for fish jelly production was examined.

Okada, Minoru; Iwata, Kazushi. Relationship between freshness before freezing and cold storage deterioration in the North Pacific Alaska pollock--III. Changes in the kamaboko forming capability. Bulletin of Tokai Regional Fisheries Research Lab. 60:179-184; 1969. (In Japanese; English summary.)

For Alaska pollock frozen for periods of 1 to 1 1/2 months at -20°C, those frozen pre rigor indicated a much higher kamaboko forming capability than those frozen in rigor or post rigor.

Okada, Minoru; Iwata, Kazushi; Suzuki, Noriaki. The effect of adjustment of pH of the washing medium on the jelly forming ability of fish meat. Bulletin of Tokai Regional Fisheries Research Lab. 44:55-59; 1965. October. (In Japanese; English summary.)

Adjustment of pH of an initial washing medium between 6.0 and 6.5 was suitable not only for the washing process but also for enhancing jelly forming ability of fish meat.

Okada, Minoru; Komori, Ichiro. Application of lactones to fish meat jelly as acidifying agents. Bulletin of Tokai Regional Fisheries Research Lab. 41:79-88; 1965. (In Japanese; English summary.)

Arabono-gamma-lactone appeared to be superior to glucono-delta-lactone as an acidifying agent for fish meat jelly.

Okada, Minoru; Miyauchi, David; Kudo, George. "Kamaboko"--the giant among Japanese processed fishery products. Marine Fisheries Review. 35(12):1-6; 1973.

In 1970, over 1 million metric tons of "Kamaboko"-type products were produced in Japan. To make "Kamaboko," the fish muscle is separated mechanically from skin and bones, washed, and mixed with other ingredients while being ground into a sticky paste, which is then shaped and heat-pasteurized. The authors described the manufacturing procedure and factors affecting the quality of "Kamaboko."

Okada, Minoru; Nakayama, Masao. The effect of oxidants on jelly strength of Kamaboko. Bulletin of the Japanese Society of Scientific Fisheries. 27(2):203-208; 1961. (In Japanese; English summary.)

Adding oxidants such as potassium bromate to kamaboko rendered an elastic jelly out of fish meat with low jelly-forming ability. A small decrease in solubility of meat protein in 3% NaCl solution was observed after the addition of bromate even when Na-tripolyphosphate was added to the mixture.

Okada, Minoru; Suzuki, Akimi. Evaluation of Argentine coastal fish for processing into Kamaboko. Bulletin of Tokai Regional Fisheries Research Lab. 65:67-73; 1971.

Kamaboko forming capability of 10 Argentine coastal fish caught by the R.V. Kaiyo-maru was evaluated after 5 months cold storage at -40°C. Fish belonging to the superior group were merluza H, merluza A, merluza de cola and ōtoragisu. Minami-dara, king and ōguchi belonged to the intermediate group, and akadara, hokake and barracouta belonged to the inferior group. Dressed frozen fish produced poorer Kamaboko than whole frozen fish.

Okada, Minoru; Takesue, Hisaya. The effect of acidification by addition of lactone on the keeping quality of fish sausage. Bulletin of the Japanese Society of Scientific Fisheries. 31(8):628-633; 1965. (In Japanese; English summary.)

The effect of lowering the pH of fish sausage on the shelf life of the product by application of arabono gamma lactone was studied. With the use of chemical preservatives such as sorbic acid or nitrofurazone, acidification of the fish sausage resulted in significant prolongation of the shelf life of the product.

Okada, Minoru; Yamazaki, Atsuko. Relationship between jelly strength and chemical composition of fish meat jelly. Bulletin of Tokai Regional Fisheries Research Laboratory. 24:85-90; 1954. (In Japanese; English summary.)

Along with the organoleptic method, jelly strength was measured with the Miyake gelometer, a penetrometer constructed to determine breaking stress (force required to press a ball into jelly) and breaking strain.

Okada, Minoru; Yamazaki, Atsuko. Action of polyphosphates in fish sausage products--I. Influence of processing conditions on the effects of phosphates. Bulletin of Tokai Regional Fisheries Research Lab. 21:49-59; 1958. (In Japanese; English summary.)

Two combinations of phosphates were added to mixtures of ground meat, water, and sodium chloride. Binding or "ashi", of fish sausage was indicated by jelly strength, breaking strain, and expressible water.

Okada, Minoru; Yamazaki, Atsuko. Enhancing effect of starch on jelly strength of fish meat jelly--V. Application of modified starch to Kamaboko manufacture. Bulletin of the Japanese Society of Scientific Fisheries. 25(6):448-450; 1959. (In Japanese; English summary.)

Reinforcing ability of starch was strengthened by aldehyde treatment, a method of preparing thick boiling starch. Thin boiling starch such as oxidized or acid modified starch was suitable for large amount addition without lowering the quality of Kamaboko.

Okamura, Kazuhiro; Kodama, Mituko; Sonoda, Hiroko; Yamada, Jyunko. Studies on the "Kamaboko" and fish sausage products--XIX. Influence of an added salt upon the water intake and the protein solubility of water-washed raw fish flesh. Bulletin of the Japanese Society of Scientific Fisheries. 32(1):80-88; 1966.

As already reported, Okamura found that water affinity of fish flesh as appraised by the factor of water intake he proposed was reduced to a minimum by a certain small addition of salt. In the present work, the authors, employing a refrigeratory centrifuge further determined the salt concentration which suppressed the protein solubility of fish flesh to a minimum.

Okamura, Kazuhiro; Matuda, Tosio; Yokoyama, Mitio. Studies on the action of phosphates on "Kamaboko" and fish sausage products--V. The effect of phosphates on the jelly strength of "Kamaboko" and the "Dare", plastic flow, of raw fish paste. Bulletin of the Japanese Society of Scientific Fisheries. 24(12):986-993; 1959.

In the previous papers, I-IV, it was reported that, while Na-pyrophosphate (P.P.Na), Na-tripolyphosphate (T.P.Na) and a certain phosphate mixture composed of them were most effective in increasing the jelly strength of "Kamaboko", these salts were attacked by fault of increasing the "Dare", i.e., plastic flow of raw fish paste. It was concluded that $P.Na_2$ has the ability of preventing the "Dare" of raw fish paste effected by addition of other phosphates, but this ability is so weak that $P.Na_2$ is scarcely available for preventing the strongest "Dare" produced by addition of mixture salt which was prepared from six parts of P.P.Na and 4 parts of T.P.Na.

Okamura, Kazuhiro; Niitsu, Yozo. Studies on the "Kamaboko" and fish sausage products--XVI. The special concentration of salt impeding the kamaboko formation (Part 7). Effects of sodium citrate, di-ammonium citrate and potassium sodium tartarate. Bulletin of the Japanese Society of Scientific Fisheries. 27(8):742-747; 1961.

Succeeding previous experiments with phosphates and other inorganic salts, there were examined in the present work the effects of tri-sodium citrate, di-ammonium citrate and potassium sodium tartarate on jelly-strength of Kamaboko. Addition of the citrates more or less strongly enhanced the jelly-strength of Kamaboko.

Okazaki, E.; Kanna, K.; Suzuki, T. Meat-textured fish protein concentrate as a new food material. III. Manufacture of meat-textured fish protein concentrate from sardine. Bulletin of the Japanese Society of Scientific Fisheries. 46(6):727-732; 1980.

The sardine Sardinops melanosticta was used to make a meat-textured fish protein concentrate of good quality. Characteristics and composition of the MT-FPC were given. Taste tests of hamburg steaks with the MT-FPC indicated the possibility of replacing red meat by as much as 70%.

Oku, T. Changes in the amino acid content of γ -irradiated kamaboko during storage. Bulletin of the College of Agriculture and Veterinary Medicine, Nihon University. 34:108-116; 1977.

Under storage at 25°C, changes in the amino acid content of kamaboko extract were observed after 9 days in irradiated kamaboko and after 6 days in unirradiated kamaboko. After 14 days of storage at 25°C there were no clear differences of decrease or increase in the amino acid content between irradiated and unirradiated kamaboko. It was concluded that the degradation of protein of irradiated kamaboko occurred after 28 days of storage at 8-10°C and after 9 days of storage at 25°C.

Omura, H.; Takata, M.; Ishida, H.; Aramaki, T.; Matsumoto, M.; Joo, K.J. Examination of some staple processed foods in the market of Fukuoka Prefecture. VIII. Fish jelly products (2) 'Kamaboko', 'Chikuwa' and 'Satsuma-age'. Science Bulletin of the Faculty of Agriculture, Kyushu University. 31(2/3):69-75; 1976.

Three kinds of fish jelly products; 'kamaboko' (fish cake), 'chikuwa' (rolled fish cake) and 'satsuma-age' (fried fish cake) were evaluated organoleptically and analysed for (i) moisture (ii) protein, (iii) fat, (iv) ash, (v) sugar, (vi) starch, (vii) calorific value, (viii) saccharin, and (ix) sorbic acid. Results (average) were: kamaboko

(i) 77.3%, (ii) 10.3%, (iii) 0.2%, (iv) 2.7%, (v) 6.3%, (vi) 3.3%, (vii) 81 kcal, (viii) not detected, (ix) 0.8g/kg; chikuwa (i) 68%, (ii) 12.8%, (iii) 0.2%, (iv) 3.4%, (v) 12.5%, (vi) 3.4%, (vii) 116 kcal, (viii) not detected, (ix) 0.8g/kg; satsuma-age (i) 68.7%, (ii) 10.4%, (iii) 3.6%, (iv) 2.7%, (v) 8.3%, (vi) 6.2%, (vii) 132 kcal, (viii) not detected, (ix) 0.82g/kg, peroxide value, 109.9 m-equiv./kg. Artificial colors Red No. 106 and/or Yellow No. 5 were detected in some kamaboko samples. Sensory tests revealed a preference for the high protein kamaboko relative to the high starch and low cost samples.

Otake, Shiego; Fukui, Koichi; Teraoka, Kazuaki; Yoshida, Hisaho. Electrocoagulating treatment of waste water from fish paste-manufacturing factories. Bulletin of the Japanese Society of Scientific Fisheries. 43(8):975-981; 1977. (In Japanese; English summary.)

Waste water was passed in a continuous flow through the electrocoagulating vessel from the bottom upwards. Conditions required to obtain the most favorable results, i.e., 95.8% recovery of the crude protein (CP) and 61.1 and 62.3% reduction of COD and SS, respectively, were listed.

Ou-Yang, M.; Meinke, W.W.; Mattil, K.F. Composition, nutritive value and sensory evaluation of fish sticks prepared from TSP minced flesh. Paper presented at the 37th annual meeting of the Institute of Food Technologists, Philadelphia, Pa.; 1977 June 5-8.

Textured soy flour (TSP)-supplemented minced flesh was formulated into battered and breaded fish sticks. Control of moisture and TSP contents of the minced flesh/TSP blends was of chief concern from sensory, compositional, and nutritional viewpoints. The blended fish sticks exhibited protein efficiency ratios (PERs) significantly better than casein and equal in PER to original minced flesh.

Park, E.Y.; Brekke, C.J.; Branen, A.L. Use of Pacific hake (Merluccius productus) in a frankfurter formulation. Journal of Food Science. 43(6):1637-1645; 1978.

Studies using minced flesh of Pacific hake as partial replacement for red meat in a frankfurter formulation showed that increased percentages of hake resulted in decreased ratings for all sensory parameters. Sensory panel evaluations showed no significant differences in ratings for odor, flavor, or appearance and color for 0% vs. 10% hake frankfurters, but 10% hake formulations received significantly lower ratings in texture, juiciness, and color and appearance. Inconsistent results were observed on a weekly basis during the 8-week storage at 2°C. TBA numbers increased, shear values decreased with increased hake percentages, and microbial analyses showed low counts for all formulations.

Partmann, Walter. Contractability of muscle fibres and extractability of fibrillar muscle proteins of fish after freezing, thawing and mincing. *Lebensmittel-Wissenschaft and Technologie*. 7(3):186-189; 1974. (In German; English summary.)

For frozen lateral body muscles of carp, cod and coalfish the influence of thawing, and of mincing by the meat grinder on the contractability of muscle fibres and the extractability of the fibrillar proteins was investigated. When compared with the intact fillet of the same fish after mincing and renewed freezing of the muscle, amounts of the extracted actomyosin fraction were about 10% lower for carp and cod and about 30% for coalfish. Final turbidity values of the fibre homogenates after ATP-addition showed a considerable loss in muscle fibre contractability for coalfish. It was suggested that the effects observed were mainly caused by thawing processes in the course of mincing. During frozen storage, differences in extractability of the fibrillar proteins between minced and intact material became smaller with increasing storage time.

Patashnik, M.; Kudo, G.; Miyauchi, D. Smooth, white spread from separated fish flesh forms a base for flavored dips, snack items. *Food Product Development*. 7(6):82-91; 1973.

Wet comminuted fish muscle has excellent functional properties and can therefore compete with other proteins in fabricated foods.

Patashnik, M.; Kudo, G.; Miyauchi, D. Bone particle content of some minced fish muscle products. *Journal of Food Science*. 39(3):588-591; 1974.

The gravity-flotation method was used as an objective determination of bone particle content. It appeared to be more discriminatory than sensory evaluation, and was therefore recommended as a quality control tool.

Patashnik, Max; Miyauchi, David; Kudo, George. Controlling bone particle content in minced fish muscle. *Marine Fisheries Review*. 36(8):37-38; 1974.

The amount of bone content in minced fish muscle depends on size of extrusion opening, type of equipment and its adjustment, and the species used. The simple rapid method for quantifying bone content presented involves (1) shredding the flesh with low-speed stirrer and (2) gravity-separation of the bone, cartilage, and other high-density components from the lower-density muscle fibers.

Patashnik, Max; Miyauchi, David; Kudo, George. Objective evaluation of texture of minced black rockfish (*Sebastes spp.*) during frozen storage. *Journal of Food Science*. 41(3):609-611; 1976.

Objective measurements (shear values and drip loss) were made to characterize changes in texture of frozen binder-modified blocks of minced black rockfish as part of a continuing study. The effect of variation in water content on sensory texture scores of washed-modified blocks was also determined.

Petrichenko, L.K.; Beloglazova, L.K. Microbiological characteristics of fish mince. *Izvestiya Vysshikh Uchebnykh Zavedenii, Pishchevaya Tekhnologiya*. 6:133-135; 1981.

Several forms of raw fish--unwashed, washed, after gutting, mince, and waste--were tested for bacterial counts. When mince was produced, contamination decreased.

Podeszewski, Z.; Zarzycki, B. Identification of fish species by testing the minced-meat tissue. *Nahrung*. 22(4):377-384; 1978.

Since the sarcoplasmic protein fractions of different fish species behave differently during starch gel electrophoresis, minced muscle tissue from one fish specie can be detected when added to that of another. The detection technique can be used not only to identify cases of adulteration but, since a heterogeneous lipid composition facilitates rancidity, also to determine the shelf life and quality of fish tissues.

Poulter, N.H. Canned, frozen and dried products from by-catch fish. Fish by-catch...bonus from the sea. Report of a technical consultation on shrimp by-catch utilization held in Georgetown, Guyana; 1981 October 27-30; International Development Research Centre, Ottawa, CA; 1982: 96-98.

Products developed from deboned minces from Gulf of California shrimp by-catch were described. They included spreads, sausages, fish sticks, croquettes, soup, and snack products.

Poulter, N.H.; Trevino, J.E. Effects of acetic-acid aided evisceration on deboned minces from by-catch fish. Fish by-catch...bonus from the sea. Report of a technical consultation on shrimp by-catch utilization held in Georgetown, Guyana; 1981 October 27-30; International Development Research Centre, Ottawa, CA; 1982:77-80.

Minces prepared from fish which were cleaned semiautomatically with 4% aqueous acetic acid were compared with those prepared from

manually cleaned fish. Amount of recovered meat and composition were similar; a color difference existed. Use of acetic acid was reported as a possible effective way to improve the utilization of the by-catch.

Poulter, R.G.; Disney, J.G. Development of novel products from tropical fish species. Nickelson, Ranzell, H (ed.). Proceedings of the second annual tropical and subtropical fisheries conference of the Americas. 1977 April 17-20; Biloxi, MS; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-78-101. 1978:43-51.

A method for manufacturing salt/fish cakes from four species of mechanically separated waste fish, with the optimum added salt content being between 10 and 15%, was described. Little chemical or microbiological change was detected in cakes stored at ambient temperatures (20-25°C) for 6 months.

Poulter, R.G.; Disney, J.G. Preparation of protein concentrates from waste fish. Paper presented at Indo-Pacific Fishery Commission/FAO conference on fish utilization, technology and marketing in the IPFC region. Manila, Philippines; 1978 March.

It was concluded that although many problems remain, the production of salted/dried fish minces and concentrates offers potential for utilizing waste fish for human food. Controlling rancidity when fatty fish is used and possible health risks when incorporating fish intestines were recommended for evaluation.

Raccach, M.; Baker, R.C. Microbial properties of mechanically deboned fish flesh. *Journal of Food Science*. 43(6):1675-1677; 1978.

Mechanical deboning of fish frames and headed and gutted fish increased the microbial count tenfold. Shelf life at 2° and 12°C was 5 and 3 days respectively with total bacteria count of $1.0-5.0 \times 10^8/g$. Little or no change resulted in bacterial and coliform counts during frozen storage. The same final bacterial count occurred in frozen minced fish samples thawed from -25° to 2°C at thawing rates of 1.2, 1.6, 5.0, and 12.5°C/hr. At 12°C psychotrophic bacterial growth in a beef-fish mixture was slower than in beef or fish alone.

Rasekh, J.; Metz, A. Acid precipitated fish protein isolate exhibits good functional properties. *Food Product Development*. 7(8):18-24; 1973.

A method to produce a fish protein isolate with good functional properties was developed. The isolate's physical, chemical, and organoleptic properties were determined. The isopropyl alcohol extracted isolate was white and contained more than 90% protein.

Rasekh, Jamshyd; Sidwell, Virginia; Waters, Melvin. The effect of washing on color and texture of minced croaker. Cobb, Bryant F., III and Stockton, Alexandra B. (eds.). Proceedings of the first annual tropical and subtropical fisheries technological conference of the Americas. 1976 March 8-10; Corpus Christi, TX; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-77-105. 1977:585-586.

The color of minced croaker was improved by washing the minced flesh with cold tap water, the largest increase in lightness being after the first wash with 2 parts water and 1 part fish. No significant change occurred in the total microbial count of the samples during washing and after storage.

Rasekh, Jamshyd; Waters, Melvin; Sidwell, Virginia. The effect of frozen storage on the functional and organoleptic properties of minced fish made from several underutilized species harvested from the Gulf of Mexico. Nickelson, Ranzell, II (ed.). Proceedings of the second annual tropical and subtropical fisheries conference of the Americas. 1977 April 17-20; Biloxi, MS; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-78-101. 1978:103-108.

Average TBA numbers of all six species were between 3 and 5 (mg/kg) except for mullet and cutlassfish which increased to above 8 after the second month of storage (at -10°C). Shear values, water holding capacity, and cooking loss increased for all species during storage, while color did not change very much. Taste panel results showed that croaker, whiting, and trout were acceptable even after 9 months of storage.

Rasekh, Jamshyd G.; Waters, Melvin E.; Sidwell, V.D. The effect of washing on the quality characteristics of minced fresh croaker, Micro-pogon undulatus, held in frozen storage. Marine Fisheries Review. 42(11):26-30; 1980.

Washed (2-min. tap water washing in ratio of 2:1 (w/w) of water to fish) and unwashed minced croaker flesh were prepared in blocks and evaluated periodically during 12-month frozen storage. The keeping quality of washed minced blocks was superior to that of unwashed blocks. Better flavor and odor scores of washed samples corresponded with lower TBA values, but there was no apparent difference in total aerobic plate counts between washed and unwashed fresh and frozen minced flesh. Objective measures showed that washing toughened texture in raw samples, while there was 5.4% loss of total solids after washing.

Ravichander, N.; Keay, J.N. The production and properties of minced fish from several commercially important species. Keay, James N. (ed.). Conference: the production and utilisation of mechanically recovered fish flesh (minced fish), 1976, proceedings. Ministry of Agriculture, Fisheries and Food, Torry Research Station, Aberdeen. 1976:18-24.

Yields were determined on six fractions (fillet, trimmings, frame, backbone, head, and skin) from cod, haddock, saithe, plaice, herring, and mackerel, commercially important species in the UK. Washing methods, color masking methods, and bleaching methods were used to help lighten the color of minces from frames and backbones of the lean fish. Fish fingers prepared from samples of mince from various mixed species (with or without NaCl to effect textural changes) were assessed by taste panel and instrumental method.

Regenstein, J.M. The Cornell experience with minced fish. Connell, J.J. (ed.). Advances in fish science and technology. Surrey, England. Fishing News (Books) Ltd. 1980:192-199.

Discussion of product development and marketing aspects of minced fish, including product formulations developed at Cornell and test market trials for minced fish in New York state supermarkets.

Regenstein, J.M.; Noyes, O.R. University involvement in the commercialization of new products. Food Technology. 36(9):86-88; 1982.

This article reviewed Cornell's work in producing and test marketing new products. Subjects included future development, particularly of a frozen minced fish product, along with the relationships of university, industry, and government.

Rekhina, N.I. The use of fish of lower market value for human consumption. Kreuzer, Rudolf (ed.). Fishery products. Surrey, England. Fishing News (Books) Ltd. 1974:295-296.

It was stated that in the U.S.S.R., Alaska pollock, Caspian kilka, capelin, hairtail, and some others were in limited demand although their flesh is of fairly high nutritive value. The utilization of these species was being developed along three main lines: frozen fish minces (pastes), protein hydrolyzates, and fish protein powder (FPP).

Rekhina, N.I.; Rambeza, E.F. Effect of formaldehyde on denaturation of frozen fish sausage meat during storage. Rybnoe Khozyaistvo. 4:68-71; 1981.

This study showed the relationship between formaldehyde content, formed in fish forcemeat during frozen storage, and protein breakdown. Levels of acceptability were given and it was determined that formaldehyde content may be one measure of quality of fish forcemeat.

Revankar, G.D.; Keshava, N.; Naidu, A.K.; Baliga, B.L. Fish mince - preparation and composition. *Indian Food Packer*. 35(4):20-24; 1981.

Eleven species of minced fish from shrimp by-catch were examined for characteristics, composition, and frozen storage properties. Yields, composition, and shelf-life were given, along with consumer preferences.

Riley, F.R. Expanding potential for the use of minced fish products. *South African Food Review*. 7(2):25, 27, 41; 1980.

Discussion of the potential use of minced fish products included: the nature of minced fish; the diversity of minced fish products and acceptance criteria; the Japanese minced fish market (Kamaboko and Surimi); high-technology development of minced fish products in the United Kingdom; American delicatessen minced fish products; minced fish as a basis for high protein fish cakes; instant food mixes based on underutilized marine resources; and dried salt minced fish.

Rodger, G.; Weddle, R.B.; Craig, P. Effect of time, temperature, raw material type, processing and use of cryoprotective agents on mince quality. Connell, J.J. (ed.). *Advances in fish science and technology*. Surrey, England. Fishing News (Books) Ltd. 1980:199-217.

Experimental results discussed relative to the following objectives: (1) using the quality assessment technique of salt solubility of protein (SSP), to study rate of quality loss of several different mince samples at various storage temperatures; (2) to compare the SSP assessment with those obtained from differential scanning calorimetry and texturometer studies; and (3) to explore the effect of washing and non-protein additives (lactose, monosodium glutamate, and sodium) in preventing quality loss in v-cut and frame minces. The work showed a dramatic drop in solubility during the first week of storage, a seemingly non-beneficial effect of washing on the technological properties, and only a marginal improvement in functional properties of minces with additives over the controls.

Roithmayr, Charles. Resources for minced fish production in the South Atlantic/Gulf of Mexico/South America. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh; 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries; 1981:55-66.

Available surplus marine fishery sources of the Gulf of Mexico, South Atlantic and Latin America were discussed for minced fish production. Topics emphasized were species association, physical characteristics, and areas of potential harvest.

Ronsivalli, L.J. The role of fish in meeting the world's food needs. *Marine Fisheries Review*. 38(6):1-3; 1976.

An assessment of the world's food situation and the available supply of marine resources was made. The two basic types of meat recovery machines were described.

Sadowska, M.; Sikorski, Z.E. Evaluation of technological suitability of fish meat by rheological measurements. *Lebensmittel-Wissenschaft und-Technologie*. 10(5):239-245; 1977.

Review included: rheology of comminuted fish minces; measurement of rheological properties of fish minces; factors influencing the rheological behavior of minces (chemical composition, fish species, post mortem changes in muscles, freezing and frozen storage, parameters of mincing, presence of salts, testing routine); and relation between the rheological properties of the fish sausage formulations and of the end products.

Sadowska, M.; Sikorski, Z.E. Role of rheological properties of raw seafoods in processing. *Przemysl Spozywczy*. 32(8):294-298; 1978.

Rheological characteristics of sea fish and invertebrates and their changes in storage were discussed. Emphasis was in effects of storage, rheological characteristics of connective tissue and collagen, rheological condition of fish-flesh sausage mixes, and possibilities of model representation of rheological properties of semi-manufactured and finished sea-food products.

Sakamoto, K.; Goto, T. Nutritive value of mixture of soy protein concentrate and pollock meat and its application to cooked food. *Japanese Journal of Nutrition*. 35(4):167-174; 1977.

Protein score, chemical score and amino acid score of soy protein concentrate were increased by mixing with an equal amount of pollock meat protein. Hamburg steak made with a mixture of the concentrate and pollock (5:5) proved favorable by the sensory test, while Kamaboko made with the above mixture (97:3) had favorable sensory and texture scores.

Sakasai, N.; Hayashi, K.; Nobuhara, A.; Yamamoto, J. Reduction in elasticity of kamaboko (boiled fish-paste) by some additives containing protease. *Journal of Japanese Society of Food Science and Technology*. 27(8):371-376; 1980.

The addition of plant materials, such as a tree-bark fungus, was studied for effect on kamaboko elasticity and proteolytic activity.

Saralaya, K.V.; Bhandary, H.M.; Desai, T.S.M.; Nagaraj, A.S. Studies on the canning of fish sausages. II. Manufacture, processing and quality aspects. *Mysore Journal of Agricultural Sciences*. 14(1):102-108; 1980.

Fish sausages were prepared from minces of pink perch, pink perch and shark, and pink perch, tuna, and shark. Some were put in casings; the others were packed in cans by dry pack, brine pack, and oil pack. Periodic examinations and organoleptic evaluations were made. Included in the results were reports about texture, color, canning methods, and composition. Canning was reported as a favorable method for the manufacture of fish sausages.

Saralaya, K.V.; Bhandary, M.H. Studies on canning of fish sausages. I. Heat penetration pattern and thermal process requirements. *Mysore Journal of Agricultural Sciences*. 12(3):479-484; 1978.

Feasibility of canning fish sausage instead of keeping it in synthetic casings with preservatives was studied. Fish sausage paste prepared from pink perch alone or together with shark or shark with tuna in different proportions was canned at (1) dry pack, (2) brine pack and (3) oil pack in (a) 8 oz. and (b) 1 lb. cans and the heat penetration pattern was studied.

Sasajima, M.; Matsushita, A.; Katayama, K.; Kobayashi, H.; Arai, K.; Yokoseki, M.; Mitsukawa, M. Effects of water activity and pH on shelf-life and the toxin production of fish sausage inoculated with spores of Clostridium botulinum type A. *Bulletin of the Tokai Regional Fisheries Research Laboratory*. 100:45-51; 1979.

Stored fish sausages inoculated with Clostridium botulinum type A were studied for pH, aerobic and anaerobic counts, organoleptic properties, and toxin presence. Procedures, formulations, and results were reported.

Sasayama, S.; Shiba, M.; Yamamoto, J. Irradiation preservation of fish meat jelly products. III. Effects of irradiation on kamaboko packaged in a plastics casing. *Bulletin of the Tokai Regional Fisheries Research Laboratory*. 82:97-104; 1975.

γ -irradiated samples of kamaboko had higher jelly strength scores and were whiter than non-irradiated samples. Storage life at 30°C was 3 days for irradiated and 1 day for non-irradiated; storage life at 10°C was about 100 days for irradiated and about 35 days for non-irradiated.

Satomi, K.; Sasaki, A.; Yokoyama, M. Lipid oxidation in fish sausage and its inhibition. II. Effect of light on the lipid oxidation in fish sausage. Bulletin of the Japanese Society of Scientific Fisheries. 47(11):1479-1483; 1981.

The effects of light on lipid oxidation in fish sausage were studied, along with changes in pigments and flavor of the sausage. The effects of light at various storage temperatures was reported, as were TBA values, content of nitroso-haem pigments and sensory evaluations.

Seligsohn, Melvin R. Food from the sea: wave of the future? Food Engineering. 46(6):57-59; 1974.

Domestic obstacles to imaginative developments with fish and other marine life as a possible protein source were discussed. Deboning was seen as a sensible way to take advantage of the sea's resources. Four fish deboners were featured.

Shibata, N.; Kinumaki, T. Factors influencing rancidity of oil mixed with fish meat. Bulletin of the Tokai Regional Fisheries Research Laboratory. 91:1-7; 1977.

An oxidation of fish oil mixed with minced fish meat was studied for the influence of various factors. Among them were species differences, meat type differences, cooked and raw meat, and the absence and presence of Fe^{3+} as a pro-oxidant. Results were recorded in graphs.

Shimizu, Y. The 'mouth feel' of kamaboko. New Food Industry. 23(9):65-76; 1981.

This review article discussed physical and organoleptic assessment of mouth feel/texture of kamaboko. Included are the effects of composition, as well as the chemical and physical aspects of texture.

Shimizu, Yutaka; Fujita, Isao; Simidu, Wataru. Water retention of fish muscle paste--II. Effect of pH on the water-holding capacity. Bulletin of the Japanese Society of Scientific Fisheries. 26(7):749-752; 1960. (In Japanese; English summary.)

The water-holding capacity of fish meat pastes with salt added or non-added was determined for fresh and heated pastes by using the filter paper method. The free water areas as a function of the pH of the meat pastes closely related to the solubility of the muscle proteins as a function of the pH of the extractants.

Shimizu, Yutaka; Hosokawa, Yasushi; Simidu, Wataru. Studies on "ashi" of kamaboko--XIII. Changes in viscosity of fish muscle sol during heating. Bulletin of the Japanese Society of Scientific Fisheries. 28(6):616-622; 1962. (In Japanese; English summary.)

The influence of heating on the viscosity of fish muscle sol was investigated. All viscosity measurements were carried out by using a Brookfield type viscometer after heating at different temperatures for various periods.

Shimizu, Yutaka; Ikeuchi, Tsuneo; Simidu, Wataru. Studies on jelly strength of kamaboko--V. Influence of freshness of material fish. Bulletin of the Japanese Society of Scientific Fisheries. 20(9):811-813; 1955. (In Japanese; English summary.)

Lizard fish and shark were found to decrease in jelly-forming ability with decline of freshness, and to be recovered with higher staleness.

Shimizu, Yutaka; Ikeuchi, Tsuneo; Simidu, Wataru. Studies on jelly strength of kamaboko--VII. Improvement of jelly strength of kamaboko with starch (2). Bulletin of the Japanese Society of Scientific Fisheries. 20(10): 898-901; 1955. (In Japanese; English summary.)

The enhancing effects of starch on the jelly strength of kamabokos made from lizard fish producing strong jelly and those of shark affording a relatively weak one, were compared. The jelly strength of non-starch kamaboko made from the latter was shifted by addition of water, but that of the former scarcely affected.

Shimizu, Yutaka; Machida, Ritsu; Takenami, Sei-ichi. Species variations in the gel-forming characteristics of fish meat paste. Bulletin of the Japanese Society of Scientific Fisheries. 47(1):95-104; 1981. (In Japanese; English summary.)

Temperature-gelation curves of meat paste (82% moisture, 3% NaCl, pH 6.8) were made for 49 species of fish including 4 species of fresh water fish and 4 species of cartilaginous fish, and 1 species each of squid, prawn, chicken and rabbit respectively.

Shimizu, Yutaka; Nishioka, Fujio. Species variations in heat coagulation properties of fish actomyosin-sarcoplasmic proteins systems. Bulletin of the Japanese Society of Scientific Fisheries. 40(3):267-270; 1974. (In Japanese; English summary.)

Heat coagulation in mixed solutions of actomyosin (AM) and sarcoplasmic extract at various mixing ratios was investigated in 6 fish species, and the contents of sarcoplasmic proteins (SP), coagulable SP (C-SP) and AM in muscle were determined in 8 species of fish. Variations in ratios seemed to be closely related to the gel-forming capacities of the respective fish meats.

Shimizu, Yutaka; Simidu, Wataru. Studies on jelly strength of kamaboko--IX. On influence of salts (2)--sodium chloride. Bulletin of the Japanese Society of Scientific Fisheries. 21(7):501-502; 1955. (In Japanese; English summary.)

The relation between the content of sodium chloride in kamaboko and its jelly strength was studied. Three peaks were found to appear in the curve of the jelly strength varying with the increase of concentration of salt, two peaks of them were considered to be caused by the existence of two kinds of protein in the fish muscle, and the increasing of the salt concentration seemed to raise the jelly strength of kamaboko.

Shimizu, Yutaka; Simidu, Wataru; Ikeuchi, Tsuneo. Studies of jelly-strength of kamaboko--II. Influence of pH on jelly-strength. Bulletin of the Japanese Society of Scientific Fisheries. 20(3):209-212; 1954. (In Japanese; English summary.)

Jelly-strength of kamaboko or fish cake measured with an equipment gelometer was found to increase the values rapidly from pH 5.0 to 7.0 of the mashed materials which were brought to different pH values by adding the phosphate buffer, NaOH or HCl.

Shimizu, Yutaka; Simidu, Wataru; Ikeuchi, Tsuneo. Studies on jelly-strength of kamaboko--IV. Influence of salts (1). Bulletin of the Japanese Society of Scientific Fisheries. 20(4):295-297; 1954. (In Japanese; English summary.)

The influence of three kinds of alkali-metal chloride on the jelly-strength of kamaboko was studied. Jelly-strength became larger with the increase of the concentration of these salts, tenderness seemed to increase with increase of jelly-strength, and jelly-strength intensity rose with the increase of solubility in the salt solutions of the protein in the material fishes.

Shimizu, Yutaka; Yoshimoto, Haruki; Simidu, Wataru. Studies on "ashi" of kamaboko--XII. Fall in gel-strength of kamaboko during cooking. Bulletin of the Japanese Society of Scientific Fisheries. 28(6):610-615; 1962. (In Japanese; English summary.)

The collapse of gel structure during cooking was observed. Lizard fish meat paste samples were used. Cooking was made in water bathes kept at various temperatures, and gel-strength was evaluated by the magnitude of the tensile strength of a ring-shaped specimen and also by organoleptic tests.

Sidwell, Virginia D. Nutritional quality of minced fish products. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute. 1981:477-491.

When fish flesh is finely minced, the intercellular and intracellular components can more easily react with each other to form new compounds. Exposing the minced tissue to air increases the oxidation process of the vitamins, and especially the unsaturated fats. These reactions reduce the nutritive value of the fish flesh. The rapidity of these reactions can be reduced by adding an antioxidant and by freezing. During storage these new compounds will combine with certain amino acids to reduce the nutritive quality of the protein. When the minced flesh is washed to improve the flavor and/or color, the water soluble nutrients, such as vitamins, minerals, soluble proteins and free fatty acids, are lost. Under good processing conditions the loss of nutritive quality can be held to a minimum.

Silberstein, D.A.; Lillard, D.A. Factors affecting the autoxidation of lipids in mechanically deboned fish. Journal of Food Science. 43(3): 764-766; 1978.

Mechanical deboning increased hemoglobin and nonheme iron contents in phosphate buffer (pH 7.1) extracts of mechanical and hand deboned mullet but had little influence on amount of myoglobin. Hemoprotein content had an influence on prooxidant activity of the buffer extracts as examined in oxygen uptake studies with oleic acid as a substrate. Myoglobin had a greater catalytic effect as a prooxidant than hemoglobin on oleic acid oxidation. It was suggested that hemoglobin to myoglobin ratio should be considered when determining the influence of hemoproteins on oxidative stability.

Simov'yan, S.V.; Iserovich, I.T. Thermophysical properties of fish sausage meat. Izvestiya Vysshikh Uchebnykh Zavedenii, Pishchevaya Tekhnologiya. 6:48-50; 1978.

Heat capacity, thermal conductivity, and density of fish sausage meat emulsions from cod, scomber, hake, horse mackerel, and Alaska pollock were studied.

Skachkov, V.P.; Yudina, O.P. Storage of comminuted meat from small fish. *Rybnoe Khozyaistvo*. 6:54-55; 1975.

Studies on the keeping quality of frozen comminuted sardine and sprat meat packaged in polyethylene bags and stored at -18°C were presented. Spoilage was found to start at the end of the 2nd month or the start of the 3rd month of storage.

Slavin, Joseph W. Overview of minced fish utilization in developing countries. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981:451-456.

Projections by the Food and Agriculture Organization of the United Nations indicate that the share of the developing countries in world fisheries consumption is expected to increase by about 30% by the turn of the century. It is expected that the developing countries, particularly the Latin American region, will play an increasingly important role in the utilization of fisheries resources. The use of minced and comminuted fish has potential in providing a mechanism for using the shrimp by-catch, for upgrading fisheries resources not generally used for food, and intermingling species of similar characteristics to provide fish products that meet the specific demand of a certain region. The developing countries in the Latin American region are in an excellent position to take advantage of the advances made in minced fish technology.

Slavin, Joseph W. Minced fish to bolster supply of seafoods as world demand leaps by year 2000. *Quick Frozen Foods*. 43(10):90-93; 1981.

This article presented as assessment of potential for minced fish technology and utilization in meeting the world demand for food.

Smith, J.G.M.; Howgate, P.; Whittle, K.J. Frozen storage of recovered flesh from horse mackerel (Trachurus trachurus). *Refrigeration Science and Technology*. 1981-4:401-407; 1981.

Storage stability of frozen whole horse mackerel, minced horse mackerel, and fish fingers was evaluated. The whole fish showed negligible deterioration, while the minced fish and fish fingers showed significant deterioration in the same six months period.

Soo, H.M.; Costello, M.; Sander, E.H. Formulation of an intermediate moisture, shelf stable minced fish stick. Paper presented at the 36th annual meeting of the Institute of Food Technologists, Anaheim, CA. 1976 June 6-9. (Abstract only.)

Minced blue whiting fish, textured soy protein, and other ingredients were mixed to formulate a fish stick composition which was extruded into stick shapes, battered, breaded, and deep-fat fried. Chemical and physical changes were evaluated during 12-weeks storage and were shown not to affect fish stick acceptability.

Soo, Hong-Ming; Davis, Eugenia A.; Sander, Eugene H. Application of scanning electron microscopy to texture definition in natural and fabricated shrimp. *Journal of Food Science*. 43(1):202-204; 1978.

The microstructure of shrimp from waters surrounding India and the Gulf of Mexico, binding matrix agents and their mixtures were investigated using SEM. Microstructural differences were related to Instron textural characteristics of cooked shrimp patties. Singular matrix agent cooked gels showed slight differences among microstructures. Differences in microstructures of shrimp-matrix agent mixtures related to textural parameters and matrix agent choice.

Soo, Hong-Ming; Sander, Eugene H. Prediction of sensory response to textural parameters of breaded shrimp shapes using Instron texture profile analysis. *Journal of Food Science*. 42(1):163-167; 1977.

A method for objective measurement of textural parameters of fabricated comminuted shrimp-binding matrix agent mixtures using the universal testing machine (Instron) was developed. An abbreviated Instron texture profile analysis of fabricated cooked shrimp patties was used to predict sensory textural scores on subsequent mechanically extruded shrimp shapes.

Soo, Hong-Ming; Sander, Eugene H. Textural and mechanical shaping characteristics of comminuted shrimp-binding matrix agent compositions. *Journal of Food Science*. 42(6):1522-1526; 1977.

As protein level of shrimp increased, Instron texture profile analysis showed increased springiness values for cooked patties prepared from shrimp-matrix agent compositions. Use of a silent cutter technique which minimized particulate retention resulted in highest springiness values. Using isolated soy protein as the matrix agent produced highest Instron springiness values for cooked shrimp patties while the lowest values were obtained when a starch-gum base matrix agent was used.

Soo, Hong-Ming; Sander, Eugene H.; Kess, Douglas W. Definition of a prediction model for determination of the effect of processing and compositional parameters on the textural characteristics of fabricated shrimp. *Journal of Food Science*. 43(4):1165-1171; 1978.

Prediction equations developed to investigate the effects of processing and compositional parameters on cooked shrimp patties showed no significant interaction effect between the two kinds of parameters, but mixing temperature had a greater effect on texture than did mixing time. Directional derivatives of response surface and contour plots, used to examine the compositional effects, showed sodium tripolyphosphate (STP) causing greater change in response than NaCl and isolated soy protein. Optimum level of STP depends on the isolated soy protein level. A non-linear program was used to obtain calculated optimum processing and compositional parameters for fabricated shrimp texture that agreed with the measured values.

Sorensen, Torben. The assessment of the textural characteristics of separated fish mince by objective measurements. Paper - Technological Laboratory. 1975; 15 p. Available from: Ministry of Fisheries, Technical University, Lyngby, Denmark.

The binding strength was evaluated from the elasticity (Young Modulus) and the breaking stress of the samples. An organoleptic texture assessment scheme, developed independently and defining structural characteristics of heat gelled fish minced in a series of fundamental terms, was used.

Sorensen, Torben. Relationship between rigor mortis and changes which occur during the storage of frozen fish mince. Paper - Technological Laboratory. 1976; 42 p. Available from: Ministry of Fisheries, Technical University, Lyngby, Denmark.

Work was undertaken to find if rigor mortis, or freshness of the fish before processing, was in any way related to the change in texture and extractable protein which takes place in frozen mince. The effect of adding sugars and phosphates was also investigated.

Sorensen, Torben. Effect of additives in frozen separated fish mince. Paper presented at the 7th meeting of the West-European Fish Technologists' Association (WEFTA); Dublin; 1976. Available from: Technological Laboratory, Ministry of Fisheries, Technical University, Lyngby, Denmark.

Protective effects of additives such as soya protein, dextrose, sodium alginate, polyphosphate, and sodium pyruvate were evaluated experimentally. Deteriorative effects found in separated mince were compared to changes which occur in frozen fish fillets and belly flaps.

Sorensen, Torben. Effect of frozen storage on the functional properties of separated fish mince. Keay, James N. (ed.). Conference: the production and utilisation of mechanically recovered fish flesh (minced fish), 1976, proceedings. Ministry of Agriculture, Fisheries and Food, Torry Research Station, Aberdeen. 1976:56-65.

It was concluded that the effects of frozen storage were unacceptable. Frozen mince became tough and rubbery and had poor binding properties due to the loss of extractable protein. The addition of sugars aided in retaining some of the properties, but they were only effective at moderately high concentrations. Although phosphates have been shown to enhance water-holding capacity, this work showed that they increased the loss of extractable protein. Heating the mince prior to freezing has been found to be most effective in reducing the changes occurring during frozen storage.

Sorensen, Torben. Biological and processing factors affecting the properties of fibrous minced fish. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh; 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981:154-177.

The biological factors affecting minced fish blocks intended for fish fingers were briefly reviewed. It was shown that the most difficult blocks to handle are prepared from fish in which formaldehyde is formed during frozen storage. The use of additives was shown to have a limited effect on the textural properties important in fish finger blocks. Addition of phosphates resulted in slight improvement in water holding capacity. It was shown that the functional properties of fibrous minced blocks relate to all operations of processing from the point of catching. Particular emphasis was placed on the preparation of the fish before it is separated.

Spinelli, J.; Koury, B.; Groninger, H., Jr.; Miller, R. Expanded uses for fish protein from underutilized species. Food Technology. 31(5): 184-187; 1977.

Minced fish muscle was processed by mixing it with 0.5% sodium chloride and 2% sodium tripolyphosphate and then applying the mixture directly onto a drum dryer. The investigators believed that with its higher protein content and nutritional superiority to cereal proteins, drum-dried fish could compete economically in the meat-extender market.

Steinberg, M.A.; Spinelli, J.; Miyauchi, D. Minced fish as an ingredient in food combinations. Paper presented at the conference on the handling, processing and marketing of tropical fish. London, U.K.; 1977. Available from: National Marine Fisheries Service, Seattle, Washington.

Fish muscle from a number of species was used as partial replacement for lean beef in commercially processed meat products. A trained taste panel could not distinguish between the extended sausages containing 5% hake and the all-meat control. Using fish produced softer sausages that were still acceptable.

Stephens, Samuel L.; Wu, C.M. Arnold. Quality and chemical stability of yu-sone made from different species of underutilized fish. Nickelson, Ranzell, II (ed.). Proceedings of the fourth annual tropical and subtropical fisheries technological conference of the Americas. 1979 April 22-25; St. Petersburg, FL; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-80-101. 1979:158-167.

Ten species of finfish were used in the production of yu-sone, each species possessing unique storage qualities such as potential for oxidative rancidity and off-flavor development. TBA assays and sensory evaluations were used to analyze these different qualities.

Stone, W.E.; Gould, W.A. Development of a fish stick product utilizing Lake Erie freshwater drum. Paper presented at the 37th annual meeting of the Institute of Food Technologists. Philadelphia, PA. 1977 June 5-8.

The underutilized freshwater drum (Aplodinotus grunniens) was comminuted and incorporated with several other ingredients, i.e., potato, formed into fish stick-type portions, and prepared as are conventional fish stick products. Evaluation showed that they were comparable in acceptance to several commercial fish stick products.

Strom, Terje. Pilot plant production of capelin mince. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh; 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981:216-223.

In Norway, capelin (Mallotus villosus), a small, fatty fish, is in quantity the most important species. It is used mainly for fish meal and oil production. An improved process was reported for industrial production of capelin mince. It includes (a) cutting the fish in pieces (1-2cm), (b) washing out the skin, the depot fat, dark pigments and viscera using either weak acid (pH4) at approximately 20°C or neutral conditions at 40°C, (c) separating the meat from the bone (spraying with pressurized water), (d) removal of the water by filter pressing. The yield of mince is approximately 35-40% from round fish.

Su, H.K.; Lanier, T.C.; Lin, T.S. Determination of the origin of heat stable protease in minced fish. Paper presented at the fourth annual tropical and subtropical fisheries technological conference of the Americas. St. Petersburg, FL. 1979 April 22-25.

Evidence was given which rules out a bacterial origin for the heat-stable alkaline protease present in minced tissue prepared from Atlantic croaker (Micropogon undulatus). Studies indicate that improper washing of eviscerated fish prior to mincing may result in inclusion of residual tissue from internal organs then a concomitant increase in protease activity in the minced tissue. The tissue fraction incriminated in the increased proteolytic activity when added to properly washed fish tissue was found to cause increased degradation of the fish tissue upon cooking at 60°C.

Su, H.; Lin, T.S.; Lanier, T.C. The contribution of retained organ tissues to the alkaline protease content of mechanically separated Atlantic croaker (Micropogon undulatus). *Journal of Food Science*. 46(6):1650-1653; 1981.

The significantly higher protease activity in mechanically separated fish tissue as opposed to manually separated tissue can contribute to the greater texture breakdown in gel-type products from the minced flesh. Increased protease activity and degradation of the fish tissue during comminuting and cooking at 60°C result from the retention or addition of kidney and liver tissue in deboned tissue from thoroughly washed eviscerated fish. Retention of these tissues during deboning contributed markedly to heme pigment content of minced flesh.

Su, H.; Lin, T.S.; Lanier, T.C. Investigation into potential sources of heat-stable alkaline protease in mechanically-separated Atlantic croaker (Micropogon undulatus). *Journal of Food Science*. 46(6):1654-1656; 1981.

The high specific enzymatic activity of alkaline proteases, characterized by optimal pH, thermal stability, and column chromatography, present in fish tissues from kidney, liver, and alimentary canal compared to that of skin and muscle tissue suggests that even small amounts of residual kidney, liver, and visceral tissue could contribute significantly to total activity in fish mince.

Sun, C.T.; Cheng, S.H.; Wang, H.H. Inhibition of polyols on the growth of low a_w tolerant bacteria found in fish balls. *Journal of the Chinese Agricultural Chemical Society*. 17(3/4):167-171; 1979.

To improve the storage quality of fish balls by lowering water activity (a_w) to inhibit microbial growth, a low a_w tolerant bacterial isolate was found in 10 samples of fish balls taken from various areas of Taiwan with a glycerin-added nutrient agar at $a_w = 0.89$. The order of inhibitory effect of polyols on bacterial isolate survival was NaCl, butylene glycol, propylene glycol, sorbitol, glycerol; there was no growth at $a_w 0.88$.

Sun Pan, Bonnie; Lee, D.J.; Lin, L.P. Studies on a minced squid product. Effect of raw material and ingredients on the texture of the product. Connell, J.J. (ed.). Advances in fish science and technology. Surrey, England. Fishing News (Books) Ltd. 1980:232-236.

Squid mince stored at 5°C for various lengths of time was tested for freshness as indicated by actomyosin extractability, pH, and NH₃. When the mince deteriorated on the fourth day (pH had increased from 6.3 to 7.6 and NH₃ content had increased from 34.5 to 196.0 mg%), breaking force of the product was much less. It was shown that pH had a more dominant effect than NH₃ on texture of the product. The maximum concentration of salt to give maximal elasticity was 2.5%. Adding cassava starch (5%) increased the breaking force but slightly reduced deformation of the product. It was also suggested that compactness and uniformity of the protein matrix have an important influence on the textural quality of the minced squid product.

Suter, Dwayne A.; Hart, Katie E.J. Selected textural properties of cooked minced Atlantic cutlass fish sticks. Cobb, Bryant F., III and Stockton, Alexandra B. (eds.). Proceedings of the first annual tropical and subtropical fisheries technological conference of the Americas. 1976 March 8-10; Corpus Christi, TX; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-77-105. 1977:602-618. (vol. 2).

Comparisons of cooked minced fish sticks from Atlantic cutlass, a "trash fish," with cooked commercial grade minced cod fish sticks indicated (a) a significant difference between thickness of cod and cutlass fish sticks, (b) a larger force-deformation ratio for cutlass fish sticks, and (c) Kramer Shear Press cell was found to provide more indicators of textural properties than either compression or puncture apparatus.

Suzuki, T. Fish and krill protein: processing technology. London, England. Applied Science Publishers Ltd. 1981.

Characteristics of fish and shellfish proteins and production techniques were explained. Processing from raw material to finished product was discussed, including technology, quality requirements, and modern adaptations of traditional products.

Suzuki, T.; Okazaki, E.; Kanna, K.; Morita, N.; Watanabe, T.; Suzuki, M. Manufacture of meat-textured krill protein concentrate. Bulletin of the Japanese Society of Scientific Fisheries. 48(1):105-111; 1982.

The manufacture of meat-textured krill protein concentrate from six different forms of Antarctic krill was described. The pale pink

product had a shrimp-like flavor and good rehydration capacity. Comparative characteristics were discussed. It was concluded that MT-KPC may serve as a substitute for shrimp meat in some products.

Suzuki, Taneko; Kanna, Koichi; Okazaki, Emiko; Morita, Noriko. Manufacture of meat-textured fish protein concentrate from various fishes. Bulletin of the Japanese Society of Scientific Fisheries. 44(11):1275-1281; 1978. (In Japanese; English summary.)

The manufacture of meat-textured fish protein concentrate (MT-FPC), i.e., the FPC possessing the texture characteristic of livestock meat, was attempted from the following fishes: lizard fish, croaker, blue whiting, pampanito, sardine and mackerel. MT-FPC products of good rehydration capacity were obtained from the lizard fish, croaker and blue whiting.

Svensson, S. Frozen storage of minced fish. III. Stabilization of minced fish from gadoid species by pre-treatment of the fish. Sik Rapport. No. 422; 1977.

Minced blue whiting meat obtained from fillets or by mechanical deboning of whole fish was prepared without kidney tissue, with raw kidney tissue or with heat-treated kidney tissue and stored at -20°C for 11 weeks. Results showed that storage stability of minced fish samples without kidney tissue was better than that of samples with kidney tissue. Storage stability of samples with heat-treated kidney tissue was similar to that of samples with non-heat-treated kidney tissue.

Svensson, S. Stabilization of fish mince from gadoid species by pre-treatment of the fish. Connell, J.J. (ed.). Advances in fish science and technology. Surrey, England. Fishing News (Books) Ltd. 1980:226-232.

Frozen storage of blue whiting minces resulted in identical quality changes as measured by dimethylamine production and loss of protein functionality in mince obtained from fish with both heat-treated (80°C) and untreated kidney tissues. Adding minced cod muscle to heat-treated kidney tissue resulted in extensive reactivation and increased activity of the trimethylamine oxide-degrading enzyme when the ratio of fish muscle to kidney was approximately 2.

Tabata, Yoshiaki; Kanazu, Ryoichi. Determinations of breaking stress by curd meter of "kamaboko" on market. Bulletin of the Japanese Society of Scientific Fisheries. 41(2):233-241; 1975. (In Japanese; English summary.)

Panel tests concerning "ashi" (textural quality) of market "kamaboko" together with determination of the moisture content, water holding capacity, starch content, dissipation factor, jelly strength and breaking stresses were conducted.

Tabata, Yoshiaki; Kanazu, Ryoichi. Conditions for the measurement of breaking strength in kamaboko using a curd meter--I. Factors affecting reproducibility. Bulletin of the Japanese Society of Scientific Fisheries. 42(10):1137-1144; 1976. (In Japanese; English summary.)

Conditions necessary for obtaining reproducible breaking strength (C.V.) measurements for kamaboko were examined with various types of this food using a curd meter and a jello meter mounted with a disc circular plunger.

Tabata, Yoshiaki; Kanazu, Ryoichi. Conditions for the measurement of breaking strength in kamaboko using a curd meter--II. Effect of plunger diameter. Bulletin of the Japanese Society of Scientific Fisheries. 42(12):1381-1386; 1976. (In Japanese; English summary.)

The correlation of sensory values with breaking strength (C.V.) of "kamaboko" on the market was examined in relation to the plunger diameter. There existed a rough inverse proportionality between C.V. and plunger diameters.

Tableros, M.A.; Young, R.H. Acceptability and storage characteristics of frozen, minced products from Mexican by-catch. Fish by-catch... bonus from the sea. Report of a technical consultation on shrimp by-catch utilization held in Georgetown, Guyana; 1981 October 27-30; International Development Research Centre, Ottawa, CA; 1982:99-100.

The suitability for frozen minced products from some species from shrimp by-catch was studied. Processing, storing, and changes were discussed. It was suggested that deboned frozen minced products from shrimp by-catch are a potential source of human food.

Tagawa, Shōji; Kōchi, Masayuki; Ōba, Yasumasa; Yamada, Kinjiro; Kojima, Yoshio. A note on the removal of constituents of the wastewater discharged from "kamaboko" processing plants by the method of pH shifting. Journal of the Shimonoseki University of Fisheries. 24(1):37-46; 1975. (In Japanese; English summary.)

The removal of constituents of the wastewater discharged from "kamaboko" processing plants was examined by a pH shift method from the standpoint of pollution control. The wastewater was adjusted to a pH value around neutrality suitable for coagulation of proteinous substances after being shifted to acidic side.

Taguchi, Takeshi; Kikuchi, Kazuo; Oguni, Moritoshi; Tanaka, Munehiko; Suzuki, Kosaku. Heat changes of myosin B Mg^{2+} -ATPase and "setting" of fish meat paste. Bulletin of the Japanese Society of Scientific Fisheries. 44(12):1363-1366; 1978.

The effect of heat on fish muscle myosin B Mg^{2+} -ATPases was examined in connection with the "setting" ability of the meat paste. Results suggested that the "setting" of fish paste is associated with the interaction between myosin and actin.

Takagi, Ichiro. On rheological properties and structure of kamaboko--VII. Influence of suwari upon viscoelastic properties and structures of fish muscle paste and kamaboko. Bulletin of the Japanese Society of Scientific Fisheries. 39(3):299-305; 1973.

When brayed meat containing sodium chloride is incubated at room temperature, gelation, usually called "suwari" in Japan, occurs. The creep behavior of brayed meat undergoing suwari and the stress relaxation behavior of kamaboko prepared from such brayed meat were determined and the mechanism of suwari was discussed.

Takagi, Ichiro. On rheological properties and structure of kamaboko--VIII. Influence of modori upon viscoelastic properties and structure of fish muscle paste. Bulletin of the Japanese Society of Scientific Fisheries. 39(5):557-562; 1973.

The shearing creep behavior of modori-brayed-meat was determined, and the mechanism of modori was discussed.

Takagi, Ichiro. On rheological properties and structure of kamaboko--IX. Influence of modori of fish muscle paste upon viscoelastic properties and structure of kamaboko. Bulletin of the Japanese Society of Scientific Fisheries. 39(5):563-567; 1973.

The tensile stress relaxation behavior of kamaboko prepared from brayed meat undergoing modori of various degrees was determined, and viscoelastic network structure of such kamaboko was discussed.

Takagi, Ichiro. On rheological properties and structure of kamaboko--XI. Frequency dependence of dynamic viscoelastic properties of kamaboko in the very-low range of oscillation. Bulletin of the Japanese Society of Scientific Fisheries. 39(6):661-665; 1973.

The frequency dependence of the dynamic viscoelastic properties of kamaboko, such as storage rigidity, loss rigidity, dynamic viscosity and dissipation factor, was determined in the very-low range of oscillation with a modified Plazek's damped free oscillation apparatus at 25°C.

Takagi, Ichiro. On rheological properties and structure of kamaboko--XII. The dependence of the stress relaxation moduli on myofibrillar protein concentration in kamaboko. Bulletin of the Japanese Society of Scientific Fisheries. 39(7):777-781; 1973.

The dependence of the reduced tensile stress relaxation moduli on the concentration of myofibrillar proteins in kamaboko was studied and results were analysed.

Takagi, Ichiro. On rheological properties and structure of kamaboko--XIII. Relation between λ and distribution function of relaxation times for kamaboko. Bulletin of the Japanese Society of Scientific Fisheries. 39(7):783-786; 1973.

The tensile relaxation modulus reduced to 25°C in the time scale range from 3×10^{-2} sec to 1×10^6 sec was determined, and the relaxation spectrum was calculated for kamaboko.

Takagi, Ichiro; Simidu, Wataru. On rheological properties and structure of kamaboko--I. Application of rubber elasticity theory to kamaboko. Bulletin of the Japanese Society of Scientific Fisheries. 38(3):299-303; 1972.

Elastic behavior in both cases of extension and compression of kamaboko was expressed well in application of the rubber elasticity theory. The relation between stress and strain of kamaboko which does not contain starch does not depend upon the kinds of raw fish or the moisture content of kamaboko.

Takagi, Ichiro; Simidu, Wataru. On rheological properties and structure of kamaboko--II. Influence of starch contents upon stress-strain relation of kamaboko. Bulletin of the Japanese Society of Scientific Fisheries. 38(5):471-474; 1972.

The stress-strain relations of kamaboko which contains various amounts of starch were considered. An experiment concerning the influence of difference of raw fish on this relation was also included.

Takagi, Ichiro; Simidu, Wataru. On rheological properties and structure of kamaboko--III. Thermodynamical components in elastic force of expanding kamaboko. Bulletin of the Japanese Society of Scientific Fisheries. 38(5):475-479; 1972.

The thermodynamical construction of the elastic force of kamaboko expanded at a constant extension ratio in the range $1.00 \leq a \leq 2.00$ was studied by the stress-temperature measurement.

Takagi, Ichiro; Simidu, Wataru. On rheological properties and structure of kamaboko--IV. Influence of starch contents upon thermodynamical components in elastic force of expanding kamaboko. Bulletin of the Japanese Society of Scientific Fisheries. 38(7):769-772; 1972.

Two thermodynamical components of the elastic force and their occupying ratios were determined for kamaboko containing starch. It was shown that with increasing starch content the entropy force component decreases while the energy force component increases proportionately.

Takagi, Ichiro; Simidu, Wataru. On rheological properties and structure of kamaboko--V. Characteristics of stress relaxation behavior of kamaboko. Bulletin of the Japanese Society of Scientific Fisheries. 38(7):773-777; 1972.

Tensile relaxation and shear relaxation in kamaboko were examined.

Takagi, Ichiro; Simidu, Wataru. On rheological properties and structure of kamaboko--VI. Temperature dependence of tensile stress relaxation behavior and thermo-rheological simplicity for kamaboko. Bulletin of the Japanese Society of Scientific Fisheries. 38(8):865-868; 1972.

It was concluded that kamaboko is a rubber-like cross-linked, thermo-rheologically simple material. The simple expression of WLF-form on the shift factor is not applicable in the temperature range of 45°C-65°C.

Takagi, Ichiro; Watanbe, Hitoshi. On rheological properties and structure of kamaboko--X. Correlative relation between ashi and the intensity of textural parameters for kamaboko. Bulletin of the Japanese Society of Scientific Fisheries. 39(6):653-659; 1973.

Textural parameters such as hardness, cohesiveness, chewiness and gumminess showed positive correlation with the strength of ashi except for adhesiveness which was negative.

Takama, K.; Hatano, M.; Zama, K. Developments in the protein utilization of abundantly caught fatty fish. V. Effects of pressure treatments on eliminated lipids and recovered proteins of fish. Bulletin of the Faculty of Fisheries, Hokkaido University. 30(1):73-83; 1979.

The application of high pressure to minced sardine flesh eliminated some lipids and appeared to promote protein solubilization. This was therefore considered as a potential means of protein recovery for food uses. Methods were described.

Tan Sen Min; Fujiwara, T.; Ng Mui Ching; Tan Ching Ean. Processing of by-catch into frozen minced blocks (surimi) and jelly products. Fish by-catch...bonus from the sea. Report of a technical consultation on shrimp by-catch utilization held in Georgetown, Guyana; 1981 October 27-30; International Development Research Centre, Ottawa, CA; 1982:89-92.

Frozen surimi and fish jelly products were made from the by-catch of shrimp trawling. Training courses in the technology were offered in Southeast Asia.

Tanikawa, Eiichi. Fish sausage and ham industry in Japan. Chichester, C.O.; Mrak, E.M.; Stewart, G.F. (ed.). Advances in Food Research. New York. Academic Press. 1963:367-424. (vol. 12).

History - Raw Material - Manufacture - Prevention of putrefaction - Origins of bacteria - Effects of preservatives on sterilization - Food poisoning - Sanitary measures - Storage - Aging - Official quality standards.

Tanikawa, Eiichi. Marine products in Japan. Koseisha-Koseikaku Company. Tokyo. 1971.

Size, technology, and research of the fishery industry and fishery processed products in Japan. Manufactured, canned, dried marine products. Fish-salting industry - fish sausage and ham industry - Japanese style fish meat pastes. Inedible fishery products.

Tanikawa, E.; Motohiro, T.; Akiba, M. Development of fish products with particular reference to frozen minced fish muscle (surimi). Kreuzer, Rudolf (ed.). Freezing and irradiation of fish. London, England. Fishing News (Books) Ltd. 1969:304-311.

Experiments were performed in manufacture of surimi from squid, cod, Alaska pollock, and Atka mackerel using additives such as polyphosphates, sugars, starches, egg-white, shortening oils, etc., to decrease thaw drip and improve elasticity of the final cooked paste. Sugar and polyphosphate improved keeping quality, egg-white improved raw fish pastes of low elasticity, and leaching prior to freezing was effective.

Teeny, F.M.; Miyauchi, D. Preparation and utilization of frozen blocks of minced black rockfish muscle. Journal of Milk and Food Technology. 35(7):414-417; 1972.

The underutilized black rockfish can be successfully processed into a modified minced fish block containing additives and an antioxidant mixture of BHA/BHT to inhibit rancidity.

Tomaszewski, F.; Toloday, D.; Matthews, R.F.; Deng, J.C. Effect of salt, tripolyphosphate and sodium alginate on the texture quality of fish patties. Nickelson, Ranzell, II (ed.). Proceedings of the fourth annual tropical and subtropical fisheries technological conference of the Americas. 1979 April 22-25; St. Petersburg, FL; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-80-101. 1979:218-233.

Deboned and washed minced mullet and croaker were mixed with various combinations of sodium chloride, tripolyphosphate, and sodium alginate to formulate a seafood patty. Results from breaking force determinations indicated that as the alginate level increased, the patties became softer. However, the patties became firmer as either the salt concentration or tripolyphosphate levels were increased. Sensory evaluation data was correlated with instrumental analysis.

Toyomizu, M.; Hanaoka, K. Lipid oxidation of the minced ordinary muscle of fish during storage at -5°C and susceptibility to lipid oxidation. Bulletin of the Japanese Society of Scientific Fisheries. 46(8):1007-1010; 1980.

Minced flesh from both fatty and lean fish was frozen and stored, and lipid oxidation was then evaluated by thiobarbituric acid (TBA). Lipids of fatty fish oxidized during cold storage; those of lean fish showed little oxidation. There was considerably less oxidation in round fish.

Toyomizu, M.; Hanaoka, K.; Nakamura, T. Lipid oxidation in the skin during storage of fish in the round at -5°C and the susceptibility predictable for lipid oxidation. Bulletin of the Japanese Society of Scientific Fisheries. 46(8):1011-1017; 1980.

Earlier study on the use of TBA values of minced frozen fish to predict lipid oxidation showed higher TBA values in the skins. The relationship between TBA of skins and lipid oxidation during storage was shown.

Tretsven, Wayne I. The separation of crab meat from shell & tendon by a centrifugal process. Commercial Fisheries Review. 33(5):48-49; 1971.

A solid-bowl centrifuge machine designed for separating sediment material was fed with chopped crab or crab shell in a saturated brine slurry. Dungeness crab body and leg sections, blue crab claws, and snow crab legs and bodies were used. In all cases, the meat was free from shell and tendon, and the shell was free from meat.

Tsao, C.Y.; Chou, K.C.; Jiang, S.T.; Lee, T.C. Studies on the denaturation of muscle proteins of mackerel and amberfish during frozen storage. Paper presented at the 41st annual meeting of the Institute of Food Technologists, Atlanta, Georgia. 1981. June 7-10. (Abstract only).

The freezing tolerance, change in freshness and denaturation of muscle proteins of mackerel and amberfish during 6 months of frozen storage at -20°C and -40°C were studied. For amberfish, no distinct change in freshness was observed between those stored at -20°C and -40°C (assessed by VB-N and K-value). The muscle proteins denatured gradually during 6 months of frozen storage and the velocity of denaturation in those stored at -20°C was faster than those at -40°C (evaluated by actomyosin extractability, Ca^{++} -ATPase activity and water-holding capacity). The freezing tolerance (assessed by measuring the gel-forming ability of muscle) was stable during 3 months of frozen storage at -20°C and 6 months at -40°C . Mackerel has been shown to be similar to amberfish, both in changes in freshness and in denaturation of muscle proteins, but the freezing tolerance of mackerel proteins was not stable at either storage temperature.

Tseo, C.L.; Deng, J.C. Washing temperature effect on fish muscle protein. Paper presented at the 41st annual meeting of the Institute of Food Technologists. Atlanta, Georgia. 1981. June 7-10. (Abstract only).

Effect of washing temperature on fish muscle proteins in the washing treatment of minced fish mullet was studied. A higher amount of non-protein nitrogen was found in the wash water at 35° , 50° and 65°C than in other wash water temperature. Quantitative change in sodium dodecyl sulfate (SDS)-polyacrylamide gel patterns and quantitative evidence in densitometric scanning diagram showed that 35°C water leached out more proteins than any other water temperature.

Tseo, C.L.; Deng, J.C.; Cornell, J.A.; Khuri, A.I.; Schmidt, R.H. Effect of washing treatment on quality of minced mullet flesh. *Journal of Food Science*. 48(1):163-167; 1983.

The effect of different washings on the quality of minced mullet was studied. TBA values were given in relation to washing temperatures and water pH. Response surface analysis, cooking loss, and springiness were also determined.

Tsukuda, N. Lipids in kamaboko of sardine and mackerel flesh. *Bulletin of the Tokai Regional Fisheries Research Laboratory*. 103:99-104; 1980.

Kamaboko made from sardine or mackerel was studied for lipids and lipid changes. Data included acid, peroxide, TBA, and iodine values, and conditions of lipid hydrolysis and lipid oxidation.

Tuorila, H. Sensory evaluation of minced Baltic herring products. *Kemia-Kemi*. 6(12):762; 1979.

Consumer panel sensory tests were performed on products made of minced Baltic herring flesh. Most consumers, especially younger ones, rated breaded products higher than unbreaded. Although herring product color was darker than cod or pollock products, color was still acceptable.

Uchiyama, S.; Uchiyama, M. Free radical production in protein-rich food. *Journal of Food Science*. 44(4):1217-1220; 1979.

γ -irradiation and heating of kamaboko resulted in the formation of free radicals ($g=2.0030-2.0049$) which were chiefly retained in protein and increased with rise in dose of γ -ray or temperature. The radical productivity of amino acid by heating was high in L-lysine, L-tryptophan and L-phenylalanine.

Uchiyama, Sadao; Uchiyama, Mitsuru. γ -irradiation of 5'-inosinic acid in fish meat cake. *Journal of Food Science*. 44(3):681-684; 1979.

The radiolysis of 5'-inosinic acid (5'-IMP) was investigated to evaluate the wholesomeness of γ -irradiated fish meat cake. 5'-IMP in a phosphate buffer (pH 6.5) decomposed at 3.12 of G(-M) by γ -irradiation to hypoxanthine. Hypoxanthine, purine base, decomposed almost at the same rate as 5'-IMP. Protein and unsaturated fatty acid had a markedly protective effect on 5'-IMP against γ -irradiation. In an actual fish meat cake, kamaboko, 5'-IMP was kept stable even at a high dose of γ -ray. The solvent extract from irradiated kamaboko with or without 5'-IMP and hypoxanthine showed no mutagenicity in the mutation assay using Salmonella typhimurium.

Ueda, Tadao; Shimizu, Yutaka; Simidu, Wataru. Studies on muscle of aquatic animals--XXXXII. Species difference in fish actomyosin (Part 2). Relation between heat-denaturing point and species. *Bulletin of the Japanese Society of Scientific Fisheries*. 31(4):352-356; 1964.

The behavior of heat denatured actomyosin purified from several species of fishes was investigated by means of viscosity measurement and the results were compared among different species.

Ueda, Tadao; Shimizu, Yutaka; Simidu, Wataru. Species difference in fish actomyosin--III. The velocity and mechanism of heat-denaturing reaction. *Bulletin of the Japanese Society of Scientific Fisheries*. 34(4):351-356; 1968.

The velocities of heat denaturation of actomyosin for three kinds of fishes were determined and the heat-denaturing mechanism of fish actomyosin was discussed.

Ueda, Tadao; Shimizu, Yutaka; Simidu, Wataru. Species difference in fish muscles--I. The gel-forming ability of heated ground muscles. Bulletin of the Japanese Society of Scientific Fisheries. 34(4):357-361; 1968.

When ground yellow-tail muscle was heated at 20-50°C for 30 minutes, increases and decreases in the gel-strength were found over the temperature ranges 30-35°C and 45-50°C, respectively.

Ueno, Saburo. Industries of fish sausage and meat sausage in Japan. Kureha Chemical Industry Co., Ltd. Laboratory of Food Processing. Tokyo. 1968.

The pamphlet described history and yield; sausage plant; raw materials, additives; manufacturing process; preservability.

Umemoto, Shigeru; Kanna, Koichi; Iwata, Kazushi. Studies on the quality of frozen stored Alaska pollock surimi--II. Changes in extractable protein of surimi during cold storage. Bulletin of the Japanese Society of Scientific Fisheries. 37(11):1100-1104; 1971. (In Japanese; English summary.)

In order to investigate the process of protein denaturation, gel filtration and ultracentrifugal analyses were conducted on protein extracts from the surimi. Results indicated that both the actomyosin and myosin fraction proteins in the frozen surimi are insolubilized during cold storage.

Umemoto, Shigeru; Okada, Minoru; Migita, Masao. Setting phenomenon of fish muscle--V. A gradation method of setting ability of fish meats. Bulletin of the Japanese Society of Scientific Fisheries. 20(4):313-318; 1954. (In Japanese; English summary.)

Eight different kinds of meat pastes were prepared by grinding the sample with specified salts and kept at 20°C for 15-20 hours. The grade of jellification was estimated organoleptically and jelly strength was determined by a gelometer.

Valyavskaya, M.E.; Asebedo, B.; Kaushanskaya, L.S.; Troigo, T.V.; Dobrobabina, L.I.; Demidenko, T.V. Heat processing of preserves from comminuted meat of fish from the sea of Azov/Black Sea basin. *Rybnoe Khozyaistvo*. 8:55-56; 1979.

Sterilization of canned Black Sea Engraulis and Clupeonella was studied. The fish were processed into products containing (1) 30% comminuted meat, 22% rice, 39% tomato juice and (2) 75% comminuted meat, 7.5% rice. Optimum sterilization techniques were given.

Varga, S.; Sims, G.G.; Michalik, P.; Regier, L.W. Growth and control of halophilic microorganisms in salt minced fish. *Journal of Food Science*. 44(1):47-50; 1979.

The nature of the quick salting technique and the quality of curing salt render the low halophilic bacteria content of salt minced fish. The shelf stability of the salt minced fish at 35°C was obtained by reducing water activity to 0.7 or by adding 0.3% sorbic acid into the minced flesh along with the curing salt.

Verkhoturova, F.I.; Rekhina, N.I.; Bidenko, M.S. Influence of some additives on nitrous compounds in meat during production of smoked sausage. Proceedings of the European meeting of meat research workers. Kaliningrad, U.S.S.R.; 1979:25,12.15:955-12.15:960.

Effects of nitrous substances in special fish muscle mince on nitrous substances in beef meat during production of smoked sausages were studied. Soluble nitrous substances in a meat-fish combination sausage and all-meat sausage during smoking were found to be similar.

Wada, S.; Koizumi, C.; Nonaka, J. Comparison of lipid deterioration in minced and sliced cod flesh during storage at 0°C. *Bulletin of the Japanese Society of Scientific Fisheries*. 43(5):595-599; 1977.

Deterioration of lipids of minced cod flesh and sliced cod flesh stored at 0°C were compared. Column chromatography results showed that by mincing the cod flesh the oxidation of lipids seemed to be prevented to some extent in the early stage of storage while hydrolysis of lipids was promoted.

Warrier, S.B.; Ninjoor, V. Fish protein concentrate (FPC) from Bombay duck isolated by radiation-heat combination procedure: functional and nutritional properties. *Journal of Food Science*. 46(1):234-238; 1981.

A process involving gamma-irradiation (200 Krad) and heat treatment (60°C, 10 min.), for the preparation of fish protein concentrate (FPC) from a tropical fish, Bombay duck (Harpodon nehereus) enabled the precipitation of 75% of proteins from the fish muscle which accounted for 80% of myofibrillar proteins. The solubility of FPC was 3% in water

and 15% in 5% NaCl. However, the preparation could be solubilized by treatments with alkali (0.2N NaOH) or proteolytic enzymes. Among the enzymes tested for FPC solubilization, pronase was found most effective with respect to the extent and rate of hydrolysis. The FPC displayed good functional properties in terms of emulsifying capacity and wettability. The PER was better than that obtained for casein when fed to rats at 11% protein level.

Watanabe, T.; Higuchi, Y.; Umehara, T.; Otake, S. Effect of the treatment of the stomach of mackerel with chemical reagents on the kamaboko-forming ability of the muscle. Bulletin of the Japanese Society of Scientific Fisheries. 45(7):913-917; 1979.

Results obtained by optical microscopy showed that rapid softening of stomach muscle was inhibited by injecting alkaline solution but that kamaboko-forming ability was not affected. Injection of NaCl and CaCl₂ solutions into the stomach increased kamaboko-forming ability relative to controls and other treatments.

Watanabe, Tomoaki; Otake, Shigeo. On the storage of ground and dressed meat of mackerel and mud dab in an alkaline solution. Bulletin of the College of Agriculture and Veterinary Medicine. Nihon University. 38:316-320; 1981. (In Japanese; English summary.)

Dressed meat only and ground meat of mackerel (Scomber japonicus) and mud dab (Limanda yokohamae) immersed in an alkaline buffer solution (I=0.05, pH 7.5) were stored at 4°C, and the Ca²⁺-ATPase activities and the kamaboko-forming abilities were measured at determined periods of time.

Webb, Neil B. Functional properties influencing texture. Cobb, Bryant F., III and Stockton, Alexandra B. (eds.). Proceedings of the first annual tropical and subtropical fisheries technological conference of the Americas. 1976 March 8-10; Corpus Christi, TX; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-77-105. 1976:587-601. (vol. 2).

A review of the status of the relationship of functional property measurements on raw minced fish tissue to finished product texture was presented. Studies have indicated a relatively high correlation between selected character notes identified by a sensory texture profile panel and the combined instrumental methods of shear energy, product modulus, and hysteresis loop. An extensive bibliography containing 36 references on compositional characteristics was included.

Webb, N.B.; Hardy, E.R.; Giddings, G.G.; Howell, A.J. Influence of mechanical separation upon proximate composition, functional properties and textural characteristics of frozen Atlantic croaker muscle tissue. *Journal of Food Science*. 41(6):1277-1281; 1976.

Mechanically-separated (MS) fish muscle tissue was compared with hand-separated (HS) tissue to determine their relative effects upon functional properties and final product texture. Proximate analyses revealed that HS muscle tissue was significantly higher in moisture content than MS tissue. MS tissue had significantly higher quantities of sarcoplasmic and nonprotein nitrogen than HS tissue. No significant difference was found between the level of myofibrillar protein for the two treatments.

Webb, N.B.; Thomas, F.B. Development of seafood patties utilizing mechanically separated fish tissue. N.C. Agricultural Experiment Station. UNC Sea Grant Program. Publication No. UNC-SG-75-03. Technical Bulletin No. 235. 1975.

It was concluded that mechanically separated fish muscle tissue can be effectively used to prepare catfish and seafood patties provided supplemental ingredients are used in the formulations. Texture and flavor can be improved through addition of steamed and flaked fish tissue, selection of a desirable species, and application of a surface glaze to the frozen patty.

Weddle, R.B. Texture profile panelling: a systematic subjective method for describing and comparing the textures of fish materials particularly partial comminutes. Connell, J.J. (ed.). *Advances in fish science and technology*. Surrey, England; Fishing News (Books) Ltd; 1980:409-417.

The sensory differences between intact and comminuted fish, along with texture deterioration during storage, were studied. Samples included fillets, comminuted fillets, and commercial mince. Species were cod, coley, plaice, and salmon. Comparisons included texture and moisture.

White, David. Resources for minced fish production in the North Atlantic/Europe. Paper presented at the third national technical seminar on mechanical recovery & utilization of fish flesh. Raleigh, N.C. 1980. December 1-3.

The availability and utilization of North Atlantic species for the production of mechanically recovered fish flesh between 1974 and 1979 were reviewed and future trends identified. V-cuts and trimmings from fillets of traditional ground fish species have been most commonly utilized. In Canada, production of minced flesh from ground fish species, mainly cod, has increased. Resource projections to 1985 were reviewed by species, species group stock, and geographic area.

Whittle, K.J.; Borderias-Juarez, A.J.; Howgate, P.; Keay, J.N.; Mills, A.; Young, K.W. Some factors affecting the sensory properties of minced fish. Martin, Roy E. (ed.). Third national seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981:224-243.

In terms of consumer acceptability, important functional properties of minced fish flesh can be grouped under the headings texture, flavor, and color. Some of the experiences of Torry researchers on the ways in which these properties can be affected by species, seasonal variation among the fish, history and treatment of the flesh prior to mincing, and aspects of the flesh recovery stage itself are reported. The results related to surimi and to minces prepared for portion products such as fish fingers.

Whittle, K.J.; Robertson, I.; Keay, J.N. Alternatives to the production of fish portions from frozen fillet blocks. Connell, J.J. (ed.). Advances in fish science and technology. Surrey, England; Fishing News (Books) Ltd; 1980:250-255.

Small fish portions were formed by directly forming the portions from fresh fillets and mince, rather than from the traditional large frozen blocks. Direct forming was reported to be technically feasible. Advantages and disadvantages of both methods were given.

Williams, Sally K.; Bacus, J.N. Engineered seafood products. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981:349-356.

Work was described which developed formulations and processes to incorporate Alaskan pollock into several food products including breaded products, snack foods, and fish-textured soy protein chunks. Research to develop potentials for use of Alaskan pollock as a partial replacement for red meat in frankfurters and other meat formulations has indicated that beef fat and fish protein perform well in combination in sausage emulsions.

Wojtowicz, M.B.; Dyer, W.J. Processing of rock crab by meat separators. Environment Canada, Fisheries and Marine Service. Halifax Laboratory New Series Circular No. 49. 1975. 10 p.

Tests of meat separators indicated their potential for processing small hard shell rock crabs and obtaining the white fibrous product from shoulder and leg fractions.

Wojtowicz, M.B.; Fierheller, M.G.; Legendre, R.; Regier, L.W. A technique for salting lean minced fish. Fisheries and Environment Canada, Fisheries and Marine Service. Technical Report No. 731. 1977. 15 p.

A salt to fish ration of 1:3 rapid mixing at 35°C, full and fast salting of protein, and complete release of water in the form of saturated brine provided optimum conditions for salting lean minced fish. Depending on initial total solids content in the minced fish, the amount of removed brine (from draining and application of centrifugal force or pressing) determines moisture and salt content and stability, which can reach 1 year at temperatures of 25-35°C in air-tight pouches. The product is resistant to bacterial spoilage if dried to 18-22% of moisture content.

Wojtowicz, M.B.; Fierheller, M.G.; Regier, L.W. Making "instant" salt minced fish. Fisheries and Oceans Canada. Technology Branch, Halifax Laboratory New Series Circular No. 68. 1978. 13 p.

Summary of production procedure for salt minced fish from lean species, including mincing, salting, cooling and holding, brine separation, shredding, drying, and packaging.

Wong, J.; Barnes, Audrey; Lau, Y.C.; Yamamoto, M. Quality and quantity of deboned flesh recovered from underutilized fish. Environment Canada, Fisheries and Marine Service. Technical Report No. 575. 1975. 10 p.

Several species of frozen rockfish, flatfish, and other locally available but under-exploited fish were examined for deboned flesh yield, protein, lipid, moisture, bone fragment content, and quality. Yield figures ranging from 32 to 43% for rockfish species and from 25 to 45% for flatfish were less than those reported elsewhere because of yield sacrifice for quality. Rockfish species provided better quality deboned flesh than flatfish species.

Wong, J.; Lau, Y.C.; Yamamoto, M. Mechanical fish deboners: influence of various perforation sizes on bone content and texture of minced fish flesh. Journal of Food Science. 43(3):807-814; 1978.

Pacific herring, widow rockfish, and pollock were fed into a Bibun (SD x 16) flesh-bone separator with the orifices on the interchangeable stainless steel drums set for 2-, 3-, 5-, and 7-mm diameters. The texture of the minced fish flesh, after cooking, was highest in flesh obtained from drums with larger orifices while bone and scale content were lower in flesh obtained from drums with narrower orifices. Drums with 5- and 7-mm orifices produced minced herring flesh containing large numbers of long fine bones.

Wu, C.M. Arnold; Stephens, Samuel L.; Chen, Jiann C.; Scott, Paul M. Pilot plant production of sauteed fish flakes (Yu-sone) for export. Nickelson, Ranzell, II (ed.). Proceedings of the fifth annual tropical and subtropical fisheries technological conference of the Americas. 1980 April 27-30; Charleston, S.C.; Texas A & M University-Sea Grant College Program. Publication No. TAMU-SG-81-101. 1981:11-23.

Pilot plant operation for mechanized production of Yu-sone, a semi-dried, seasoned fish flake product, showed that mechanized approaches can be adapted to the minced fish industry with the additional requirement of minimal shearing of fish fibers for Yu-sone. Species yields for raw materials used in this study were 7.86% from mullet, 26.96% from shark slabs, and 12.90% from ray wings. An example of a unitized production system was given.

Wu, C.M. Arnold; Stephens, Samuel L.; Gates, Keith W. Development of a seasoned dry fish flakes product made from minced fish for Asian markets. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute; 1981: 372-381.

The chemistry and microbiology of an exportable dry fish flake product had been studied. It had shown great shelf stability because of its low moisture content. The fat rancidity problem was controlled by the antioxidants present in vegetable oil, which is a major ingredient. Due to its unique product form and stability, many underutilized fish available in the U. S. were found to be suitable for this product. Among these, shark, sting ray, croaker, and mullet were judged as excellent raw materials. Based on these findings on quality, formulation, and processing parameters, a capital intensive processing system was developed so that it can be feasibly adapted by the food industry in the U. S.

Yamamoto, A.; Nagao, K. Studies on the cationic protein in surimi. Paper presented to the international congress of food science & technology. Kyoto, Japan; 1978 September 17-22. Available from: Food and Nutrition Laboratory, Teikoku Women's University, Thoda-cho, Moriguchi City, Osaka 570, Japan.

Studies were made of the yield of extracted protein, pH, ATPase activity, solubility, presence of charged protein, and sulphhydryl and disulphide residues.

Yamamoto, M.; Barnes, Audrey; Lau, Y.C.; Wong, J. Consequences of washing deboned fish flesh upon appearance and on protein loss. Environment Canada, Fisheries and Marine Service. Technical Report No. 580. 1975. 10 p.

Deboned flesh from eight species of frozen rockfish, four species of frozen flatfish, and a few miscellaneous species of frozen groundfish were washed and de-watered by centrifugation. Water-soluble protein losses were approximately 20% for rockfish, and considerably more for flatfish. In spite of appreciable improvements in color and appearance, the high protein and flavor losses indicated that the washing of deboned flesh could not be recommended for the preparation of deboned fish products for the traditional North American fish cake market.

Yamamoto, M.; Wong, J. A research note: simple chemical method for isolating bone fragments in minced fish flesh. *Journal of Food Science*. 39(6):1259-1260; 1974.

As an alternative to physical separation, a simple and inexpensive chemical method was described. The procedure takes advantage of the solubilizing action of urea on proteins in addition to the well-known effect of aqueous alkaline solutions on flesh.

Yamanaka, H.; Shiomi, K.; Miyahara, M.; Kikuchi, T. Aldehydes produced by the reaction between amino acids and hydrogen peroxide in foods. *Journal of the Food Hygienic Society of Japan*. 20(4):270-275; 1979.

Kamaboko and other fish products as well as noodles which had been pretreated with H_2O_2 during commercial processing were found to have 2-8 carbonyl components. Fundamental chemical reactions were investigated.

Yamazawa, M.; Murase, M.; Shiga, I. Improvement of the quality of retorted kamaboko. I. Influence of heating conditions on the quality of kamaboko. *Bulletin of the Japanese Society of Scientific Fisheries*. 45(2):187-192; 1979.

The influence of heating conditions on the quality of kamaboko was examined. The most prominent off-flavor component of retorted kamaboko in both chemical and sensory tests was H_2S . Browning occurred above $115^\circ C$. Production of H_2S and browning increased with time at $120^\circ C$, and jelly strength and water holding capacity were decreased. However, the higher temperature more effectively prevented kamaboko deterioration if the F_0 value of the process was maintained at 4.

Yamazawa, M.; Murase, M.; Shiga, I. Improvement of the quality of retorted kamaboko. II. Influence of the quality of raw fish-meat on the production of hydrogen sulphide in retorted kamaboko. *Bulletin of the Japanese Society of Scientific Fisheries*. 46(2):191-195; 1980.

Lizard fish (Saurida undosquamis), white croaker (Argyrosomus argentatus), and frozen surimi (frozen meat paste from Alaska pollock, (Theragra chalcogramma) were all used as experimental raw meat sources for kamaboko production. H₂S levels in retorted kamaboko increased with higher pH in washed meat of white croaker and was directly related to the pH of raw meat in all species. Formaldehyde generated from trimethylamine oxide in Alaska pollock and lizard fish played a significant role in inhibiting the production of H₂S in retorted kamaboko.

Yarish, J. A discussion of the concerns of government regulatory agencies in the area of comminuted fishery products. Paper presented at Pacific fisheries technological conference. Portland, Oregon. Fisheries and Marine Service, Environment Canada. Vancouver, B.C., Canada. 1975. March 3-5.

The inherent bacteriological hazards involved in producing minced flesh for human consumption were emphasized.

Yokoyama, Michio. Studies on adhesion of fish meat products on casing in fish sausage and kamaboko--II. Effect of different species of fish and their grade of freshness on the rate of adhesion. Bulletin of the Japanese Society of Scientific Fisheries. 35(2):199-205; 1969. (In Japanese; English summary.)

Investigation was undertaken to measure the rate of meat adhesion on casing in boiled fish cake made of different species and various grade of freshness of fish.

Yokoyama, Michio. Studies on adhesion of fish meat products to casing in fish sausage and kamaboko--VI. The effect of different starches on degree of meat adhesiveness to the casing. Bulletin of the Japanese Society of Scientific Fisheries. 41(11):1197-1201; 1975. (In Japanese; English summary.)

Investigation was undertaken to measure the degree of meat adhesiveness to casing when different kinds of starch were added to fish meat products (Kamaboko). The meat adhesiveness of kamaboko to which were added separately three different kinds of starch was compared.

Yoshinaka, Reiji; Shiraishi, Masato; Ikeda, Shizunori. Effect of ascorbic acid on the gel formation of fish meat. Bulletin of the Japanese Society of Scientific Fisheries. 38(5):511-515; 1972.

The addition of L-ascorbic acid (AsA) and dehydro-L-ascorbic acid (DAsA), after adjustment to pH 6.4 and 4.3 with sodium hydroxide

respectively, to Alaska pollock brayed meat caused increase in the strength of the gel.

Young, R. Minced fish--product development in Europe. Martin, Roy E. (ed.). Third national technical seminar on mechanical recovery & utilization of fish flesh. 1980 December 1-3; Raleigh, N.C. Washington, D.C. National Fisheries Institute. 1981:415-421.

The fish resources of the ocean can be utilized much more effectively if the fish are used in the form of minced flesh. There is also a commercial incentive to utilize fish in this way, since minced fish is significantly cheaper than fish flesh in fillet form. Despite this, however, the number of products developed from this material in Europe over the past twenty years has been disappointing. The reasons for the lack of relative success in developing products from minced fish flesh in Europe over the past 20 years and some suggestion on how to counteract it were discussed. A number of successful products based on minced fish were also discussed.

Young, R.H. Development of a salted, minced product from Mexican shrimp by-catch. Fish by-catch...bonus from the sea. Report of a technical consultation on shrimp by-catch utilization held in Georgetown, Guyana; 1981 October 27-30; International Development Research Centre, Ottawa, CA; 1982:93-95.

Deboned mince was salted, cooked, and dried to form a stable, low-cost food. Microbiological and organoleptic quality was maintained, as was protein quality. The product was reconstituted by soaking and boiling.

Young, R.H. Financial projections for industrial production of minced by-catch fish. Fish by-catch...bonus from the sea. Report of a technical consultation on shrimp by-catch utilization held in Georgetown, Guyana; 1981 October 27-30; International Development Research Centre, Ottawa, CA; 1982:110-112.

On the basis of studies, it was determined that industries for by-catch retrieval and processing could be economically viable. Plans included pilot plant factories.

Yu, S.Y. Production and acceptability testing of fish crackers (keropok) prepared by the extrusion method. Refrigeration Science and Technology. 1981-4:449-455; 1981.

Keropok produced by extrusion was studied, using a blend of tapioca and minced fish. The product was similar to traditionally prepared keropok.

Zain, Asiah M. Spice minced fish from tilapia. Connell, J.J. (ed.). Advances in fish science and technology. Surrey, England. Fishing News (Books) Ltd. 1980:223-226.

An underutilized freshwater fish, tilapia, can be used as high-protein food at low cost, especially in developing countries, by adding salt and spices to the deboned fish, mixing, pressing, drying, grinding, and packaging.

Zaleski, S.; Fik, A. Optimization of methods for isolation of microorganisms from frozen minced fish. II. Total bacterial and proteolytic counts. *Medycyna Weterynaryjna*. 32(3):176-178; 1976.

(i) total bacteria counts and (ii) counts of proteolytic microorganisms were carried out on samples of fresh frozen cod minced after defrosting and on samples of frozen minced unspecified fish. 6 different agar media were compared for the purpose, the customary solid agar medium being used as a standard. It was concluded from tabulated relative values that TGEA medium (beef extract 0.3, tryptone 0.5, glucose 0.1, and agar 1.5g/100ml) was the most suitable for total bacterial counts and that for counts of proteolytic microorganisms, gelatin agar (yeast extract 0.3, tryptone 0.5, gelatin 0.4, and agar 1.5g/100ml) and milk agar (top layer, TGEA in synthetic sea water; bottom layer, 2g dried skim milk and 1.5g agar/100ml) should be used in parallel.

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Gaudio, E.L.; Holt, S.K., inventors; Ralston Purina Co., assignee; Vegetable protein ingredient for kamaboko products containing a polysaccharide. U.S. Patent 4 173 657. 1979.

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