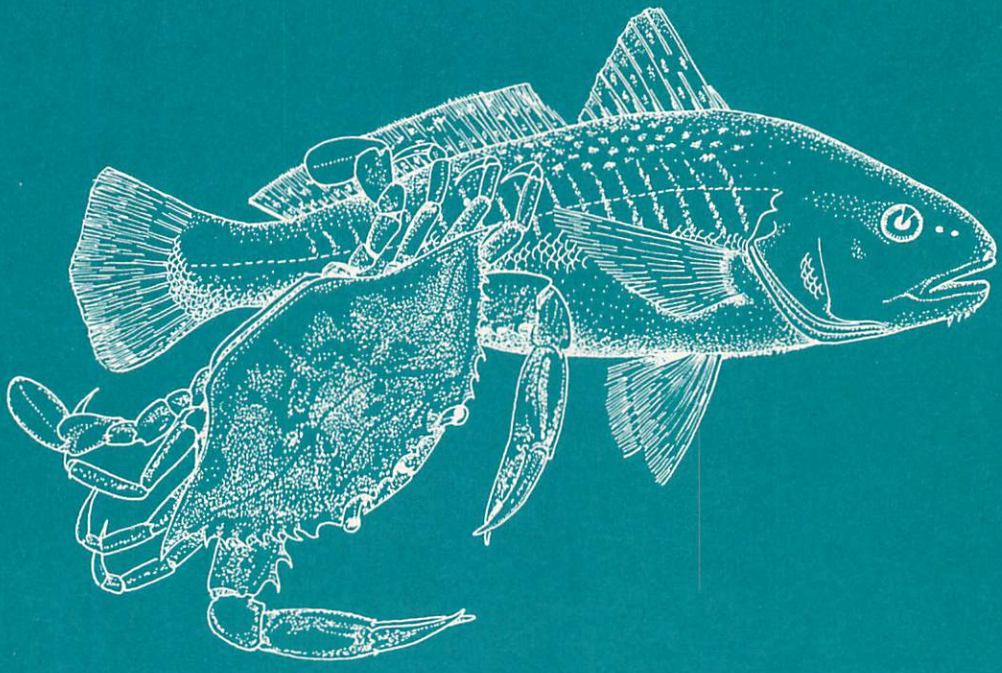
An annotated bibliography On mechanically separated Finfish and crustacea meats

By Freda Ramey



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AN ANNOTATED BIBLIOGRAPHY

ON MECHANICALLY SEPARATED FINFISH AND CRUSTACEA MEATS

Author: Freda A. Ramey

Advisers: Joyce A. Taylor, Frank B. Thomas, T. M. Miller

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INTRODUCTION

The study of deboned fish flesh at North Carolina State University began in 1970. Since that time our contributions to the literature, along with the contributions from others, have indicated a need to bring together the current literature. During the summer of 1977 a compilation of relevant available literature on the subject of mechanically deboned finfish and crustacea meats was begun.

The literature was reviewed and annotated to form a ready source of information gathered in a single collection. The bibliography is to be used as a preliminary reference for those unfamiliar with what has been published concerning minced fish flesh technology. For those who have participated in investigative studies on mechanical deboning, this material may add new dimensions.

Efforts centered on reputable publications, trade journals, and selected technological conferences, the proceedings of which were readily available to our facility. Many popularized articles were not used and some conferences were undoubtedly overlooked due to the limited time alloted to this initial review. References to patents were not included. 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 known to have ongoing work in this field, National Marine Fisheries Service technological laboratories, Environment Canada Halifax Laboratory, Torry Research Station, fishery attaches, and other foreign 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 particular work. Also provided are listings of meetings and symposiums, as well as abstract and index sources not extensively consulted in this study.

It is the hope of those producing this bibliography that it will provide a valuable guide to the present literature, summarize the state of the art, and point out the needs for future areas of emphasis.

Frank B. Thomas, Ph.D.

Extension Professor - Seafoods

REFERENCES

Amano, Keishi.
1965. Fish sausage manufacturing, pp. 265-280. In Georg Borgstrom [ed.] Fish as food, vol. 3, processing: part 1. Academic Press, New York.

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

Amano, K.
1969. Inspection and quality assessment of Japanese comminuted fish products, pp. 119-124. In Rudolf Kreuzer [ed.] Fish inspection and quality control, 1971. Fishing News (Books) Ltd., London, England.

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.

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

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.

Anonymous.
1975. 8 firms offer deboning machines; how they work. The National Provisioner, vol. 172, no. 14, pp. 12-50, (11 p.).

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

Babbitt, Jerry K., David L. Crawford, and Duncan K. Law.
1972. 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, vol. 20, no. 5, pp. 1052-1054.

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., D. K. Law, and D. L. Crawford.
1976. Improved acceptance and shelf life of frozen minced fish with shrimp. Journal of Food Science, vol. 41, no. 1, pp. 35-37.

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.
1976. A review of the resources available to British fisheries, with particular reference to minced fish technology, pp. 9-17. In James N. Keay [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.

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, R. C., J. M. Regenstein, and J. M. Darfler.
1976a. Development of products from minced fish: 1. seafood chowders. New York Sea Grant Institute, 32 p.

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., J. M. Regenstein, and J. M. Darfler.
1976b. Development of products from minced fish: 2. seafood crispies. New York Sea Grant Institute, 24 p.

Seafood crispies, bite-sized, battered, breaded, and fried for serving as hors d'oevres 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.

Blackwood, C. M.
1973. Utilization of mechanically separated fish flesh--Canadian experience, pp. 325-329. In Rudolf Kreuzer [ed.] Fishery products, 1974. Fishing News (Books) Ltd., Surrey, England.

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

Blomo, Vito J.
1976. Market potential for fish as an extender in meat products, pp. 645-659. In Bryant F. Cobb III and Alexandra B. Stockton, Proceedings of the first annual tropical and subtropical fisheries technological conference, vol. 2. Texas A & M University-Sea Grant College, Publication No. TAMU-SG-77-105.

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.

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

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 comsition," "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).

Cann, D. C., and Lesley Y. Taylor.
1976. The bacteriology of minced fish prepared and stored under experimental conditions, pp. 39-45. In James N. Keay [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.

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., and F. J. King.
1971. Fish scrap offers high quality protein. Food Engineering, vol. 43, no. 1, pp. 75-76.

Potential uses of comminuted fish flesh were briefly outlined. Short explanation of how meat/bone separation works.

Cheng, C. S., D. D. Hamann, and N. B. Webb.
1977. Effect of thermal processing on minced fish gel texture. Paper presented at the 37th Annual Meeting of the Institute of Food Technologists, Philadelphia, Pa., June 5-8. Abstract only.

Rapid heating to higher internal temperatures improved the textures of fish gels; however, these thermal effects were species and harvest location dependent. It appeared that changes in muscle proteins during heating, apparently caused by unknown factors (active at 70°C or lower and

inactivated by rapid heating to 85°C) in the sarcoplasmic protein fraction; were related to the observed thermal effects on the gel textures.

Cheng, C. S., D. D. Hamann, N. B. Webb, and V. Sidwell.
1977. Effects of species and storage time on minced fish gel texture. Paper presented at the 37th Annual Meeting of the Institute of Food Technologists, Philadelphia, Pa., June 5-8. Abstract only.

Protein functionalities of mechanically deboned fish tissues of four species and frozen storage up to 12 months were studied. Differences in gel texture among species and the effects of frozen storage were evident. Fish gel texture was closely related to water-holding capacity and protein solubility of cooked gels.

Choy, A. A., W. W. Meinke, and K. F. Mattil.
1975a. 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., June 8-12, 16 p.

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., W. W. Meinke, and K. F. Mattil.
1975b. 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., June 8-12, 21 p.

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.

Cole, B. J., and J. N. Keay.
1976. The development of rancidity in minced herring

products during cold storage, pp. 66-69. In James N. Keay [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.

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.

Crawford, David L., Duncan K. Law, and Jerry K. Babbitt. 1972. Nutritional characteristics of marine food fish carcass waste and machine-separated flesh. Journal of Agricultural and Food Chemistry, vol. 20, no. 5, pp. 1048-1051.

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 ratio values for separated flesh fractions were significantly higher than values for whole carcass waste.

Crawford, D. L., D. K. Law, J. K. Babbitt, and L. S. McGill. 1972. Yield and acceptability of machine separated minced flesh from some marine food fish. Journal of Food Science, vol. 37, no. 4, pp. 551-553.

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.

Dagbjartsson, B.
1975. Utilization of blue whiting, Micromesistius poutassou, for human consumption. Journal of the Fisheries Research Board of Canada, vol. 32, no. 6, pp. 747-751.

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., and J. C. Deng.
1977. Development of a sausage-type product from minced mullet. Paper presented at the 37th Annual Meeting of the Institute of Food Technologists, Philadelphia, Pa., June 5-8. Abstract only.

Seventeen formulations using varying proportions of minced mullet, soy, water, and sodium tripolyphosphate were prepared and analyzed for water loss, shear force, and organoleptic acceptability. A surface response analysis and a short-term rancidity study were done to determine the optimum, most stable combination of ingredients.

Del Valle, F. R., J. Hinojosa, D. Barrera, and R. A. De La Mora.
1973. Bacterial counts and rancidity estimates of stored quick-salted fish cakes. Journal of Food Science, vol. 38, no. 4, pp. 580-582.

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., M. Padilla, A. Ruz, and R. Rodriguez.
1973. Pilot plant production of and large scale acceptance trials with quick-salted fish cakes. Journal of Food Science, vol. 38, no. 2, pp. 246-250.

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.

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

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

Dingle, J. R., and J. A. Hines.
1975. Protein instability in minced flesh from fillets and frames of several commercial Atlantic fishes during storage at -5C. Journal of the Fisheries Research Board of Canada, vol. 32, no. 6, pp. 775-783.

Minced flesh of Atlantic cod and pollock suffered a rapid loss of protein solubility during storage at -5C, 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 witch 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., Barbara Lall, and R. A. Keith.
1976. The mixing of minced flesh of different fish may be risky. Environment Canada, Fisheries and Marine Service, Halifax Laboratory New Series Circular No. 59, 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.

FAO Department of Fisheries.
1977. Drafted code of practice for minced fish. Prepared by Fish Production and Marketing Service, Fishery Industries Division, 32 p.

This international code contained technological and essential hygiene requirements for the preparation of high-quality minced fish products, and was based on established and recognized good commercial practices.

Finch, Roland.
1977. Whatever happened to fish protein concentrate? Food Technology, vol. 31, no. 5, pp. 44-53.

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.

Food and Agriculture Organization.
1975. Expanding the utilization of marine fishery resources for human consumption. FAO Fisheries Report No. 175, 47 p.

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.

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

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

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

Harrison, A. P., II, D. A. Suter, B. J. Cobb, III, W. A. LePori, and E. R. Jones.
1977. Mechanical processing of Atlantic cutlassfish, p. 12. In Abstracts of the second annual tropical and subtropical fisheries conference of the Americas. Texas A & M University-Sea Grant College, 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 precooked 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, and Rudolf Kreuzer [ed.].
1962. Fish in nutrition. Fishing News (Books) Ltd., London, England, 447 p.

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, Lars.
1976. Production of separated fish mince for traditional and new products in Denmark, pp. 82-83. In James N. Keay [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.

New minced fish products for the Danish market were discussed.

Herborg, L.
1969. Quality control and inspection of European comminuted products, pp. 124-128. In Rudolf Kreuzer [ed.] Fish inspection and quality control, 1971. Fishing News (Books) Ltd., London, England.

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, Lars, and Karin Pedersen.
1974. Classification of minced fish. Paper, Technological Laboratory, Ministry of Fisheries, Technical University, Lyngby, Denmark, 7 p.

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.
1977. 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., 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., B. S. Lall, D. W. Lemon, and W. J. Dyer.
1976. 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, vol. 33, no. 10, pp. 2560-2567.

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 CO_2 retarded the onset of bacterial spoilage in RSW-held fish. Spoilage otherwise developed more rapidly than in iced fish.

Hing, Francisco S., Nora Yu-Ang Tang, and Catherine G. Cavaletto.
1972. Stability of fish sausage at low temperature storage. Journal of Food Science, vol. 37, no. 2, pp. 191-194.

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.

Howgate, Peter.
1976. The sensory properties of minced cod and herring, pp. 49-53. In James N. Keay [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.

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.

Ikkala, Preben.
1975. The organoleptic assessment of the texture of minced fish (method to determine texture profiles). Paper, Technological Laboratory, Ministry of Fisheries, Technical University, Lyngby, Denmark, 10 p.

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

Ishii, S., and K. Amano.
1973. Reprocessing fish into composite products, pp. 281-283. In Rudolf Kreuzer [ed.] Fishery products, 1974. Fishing News (Books) Ltd., Surrey, England.

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.

Jarenback, L.
1976a. Frozen storage of fish mince - I. Quality changes in minced flesh from different parts of cod during frozen storage. SIK-The Sedish Food Institute, Report No. 409, 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.
1976b. 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, 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°C before freezing, the sooner the texture of the corresponding product deteriorated during frozen storage.

Jauregui, C. A., and R. C. Baker.
1977. Discoloration of mechanically deboned fish. Paper presented at the 37th Annual Meeting of the Institute of Food Technologists, Philadelphia, Pa., June 5-8. Abstract only.

Studies using a Hunter color difference meter on different species of fish showed changes in color up to four orders of magnitude greater during mechanical deboning than during storage. Skin pigments were found to be the source of the grayish discoloration observed.

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

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.
1974. Some marketing considerations with respect to minced fish products. Marine Fisheries Review, vol. 36, no. 12, pp. 18-20.

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.

Kaplan, H. J., and S. Constantinides.
1977. Utilization of underexploited marine species through comminuting and mixing. Paper presented at the 37th Annual Meeting of the Institute of Food Technologists, Philadelphia, Pa., 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.

Keay, James N. [ed.].
1976. Conference: the production and utilisation of mechanically recovered fish flesh (minced fish), 7/8 April 1976, proceedings. Ministry of Agriculture, Fisheries and Food, Torry Research Station, Aberdeen, 108 p.

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.

King, Frederick J.
1972. A list of companies offering meat-bone separators to the seafood industry. National Marine Fisheries Service, Atlantic Fishery Products Technology Center, Emerson Ave., Gloucester, Mass., Technical Note 6. (Fourth printing-June 16). 4 p.

A prepared list of seven manufacturers based on information available up to 1972. Revisions pending.

King, Frederick J.
1973a. Acceptability of main dishes (entrees) based on mixtures of ground beef with ground fish obtained from underused sources. Journal of Milk and Food Technology, vol. 36, no. 10, pp. 504-508.

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.
1973b. Improving the supply of minced blocks for the fish stick trade: a progress report. Marine Fisheries Review, vol. 35, no. 8, pp. 26-32.

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, F. J.
1977. Past, present, and future uses of minced fish. Marine Fisheries Review, vol. 39, no. 4, pp. 1-4.

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., and Joseph H. Carver.
1970. How to use nearly all the ocean's food. Commercial Fisheries Review, vol. 32, no. 12, pp. 12-21.

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., Joseph H. Carver, and Roy Prewitt.
1971. Machines for recovery of fish flesh from bones. The American Fish Farmer and World Aquaculture News, vol. 2, no. 11, pp. 17-21.

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

King, Frederick J., and George J. Flick.
1973. Beefish patties. Marine Fisheries Review, vol. 35, no. 7, pp. 31-33.

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., Fred Heiligman, and Eugen Wierbicki.
1974. Solubilized fish muscle as a food binding material. Marine Fisheries Review, vol. 36, no. 1, pp. 18-20.

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.

King, F. J., and J. J. Ryan.
1977. Development of a color measuring system for minced fish blocks. Marine Fisheries Review, vol. 39, no. 2, pp. 18-23.

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.

Koburger, John A., and Lloyd W. Regier.
1976. Salt-minced cod: microbial considerations, pp. 556-564. In Bryant F. Cobb III and Alexandra B. Stockton, Proceedings of the first annual tropical and subtropical fisheries technological conference, vol. 2, Texas A & M University-Sea Grant College, Publication No. TAMU-SG-77-105.

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.

Kreuzer, Rudolf [ed.].
1965. The technology of fish utilization. Fishing News (Books) Ltd., London, England, 282 p.

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.].
1969. Freezing and irradiation of fish. Fishing News (Books) Ltd., London, England, 527 p.

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.].
1971. Fish inspection and quality control. Fishing News (Books) Ltd., London, England, 290 p.

FAO Technical Conference, Halifax, Canada, July, 1969. Topics: The need for fish inspection - Fish inspection programmes - 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.].
1974. Fishery products. Fishing News (Books) Ltd., Surrey, England, 462 p.

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, Minoru Okada, and David Miyauchi.
1973. Gel-forming capacity of washed and unwashed flesh of some Pacific coast species of fish. Marine Fisheries Review, vol. 35, no. 12, pp. 10-15.

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.

Lall, B. S., A. R. Manzer, and D. F. Hiltz.
1975. Preheat treatment for improvement of frozen storage stability at -10C in fillets and minced flesh of silver hake (Merluccius bilinearis). Journal of the Fisheries Research Board of Canada, vol. 32, no. 8, pp. 1450-1454.

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.

Learson, R. J., G. Reierstad, and V. G. Ampola.
1972. The application of continuous centrifugation to seafood processing. Food Technology, vol. 27, no. 7, pp. 32-34.

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 1-3 cm deep held on the outside of the bowl.

Learson, R. J., B. L. Tinker, V. G. Ampola, and K. A. Wilhelm.
1976. Roller extraction of crab meat, pp. 621-630. In Bryant F. Cobb III and Alexandra B. Stockton, Proceedings of the first annual tropical and subtropical fisheries technological conference, vol. 2. Texas A & M University-Sea Grant College, Publication No. TAMU-SG-77-105.

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., B. L. Tinker, and L. J. Ronsivalli.
1971. Technical note: fish proteins as binders in processed fishery products. Commercial Fisheries Review, vol. 33, no. 2, pp. 46-50.

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, Chong M., and Romeo T. Toledo.
1976. Factors affecting textural characteristics of cooked comminuted fish muscle. Journal of Food Science, vol. 41, no. 2, pp. 391-397.

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, C. M., and R. T. Toledo.
1977. Degradation of fish muscle during mechanical deboning and storage with emphasis on lipid oxidation. Journal of Food Science, In press, 4 p.

Deterioration of mechanically separated fish flesh as measured by extent of lipid oxidation and color change was studied. Parameters studied included contact with iron surfaces, mechanical stress applied to muscle during deboning, temperature of deboning drum, washing of deboned fish flesh, and post-deboning treatments (including addition of antibiotic, sparging with nitrogen gas, cooking, freezing, and thawing).

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

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

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.

Martin, Roy E. [ed.].
1972. Mechanical recovery and utilization of fish flesh, Oak Brook seminar. National Fisheries Institute, Washington, D. C., 270 p.

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.].
1974. Second technical seminar on mechanical recovery and utilization of fish flesh, Boston, Massachusetts. National Fisheries Institute, Washington, D. C., 318 p.

Seminar by National Fisheries Institute and National Marine Fisheries Service, Boston, Mass., 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.
1976. Mechanically-deboned fish flesh. Food Technology, vol. 30, no. 9, pp. 64-70.

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

Mendelsohn, J. M.
1974a. 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, 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.
1974b. Minced fish in a new form. Marine Fisheries Review, vol. 36, no. 8, pp. 34-36.

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

Mendelsohn, J. M., T. J. Connors, and J. G. Callan.
1977. A machine for heading and eviscerating small fish. Marine Fisheries Review, vol. 39, no. 2, pp. 11-18.

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.

Miyauchi, David, George Kudo, and Max Patashnik.
1973. Surimi--a semi-processed wet fish protein. Marine Fisheries Review, vol. 35, no. 12, pp. 7-9.

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, D., G. Kudo, and M. Patashnik.
1977. Effect of processing variables on storage characteristics of frozen minced Alaska pollock. Marine Fisheries Review, vol. 39, no. 5, pp. 11-14.

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, Max Patashnik, and George Kudo.
1975. Frozen storage keeping quality of minced black rockfish (Sebastes spp.) improved by cold-water washing and use of fish binder. Journal of Food Science, vol. 40, no. 3, pp. 592-594.

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, and Maynard Steinberg.
1970. Machine separation of edible flesh from fish. Fishery Industrial Research, vol. 6, no. 4, pp. 165-171.

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., J. M. Regenstein, R. C. Baker, and K. H. Steinkraus.
1977a. Effects of antioxidants and chelators on the stability of frozen stored mechanically deboned flounder meat from racks after filleting. Journal of Food Science, vol. 42, no. 3, pp. 759-764.

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 Na_2 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 Na_2 EDTA.

Moledina, K. H., J. M. Regenstein, R. C. Baker, and K. H. Steinkraus.
1977b. A process for the preparation of dehydrated salted fish-soy cakes. Journal of Food Science, vol. 42, no. 3, pp. 765-767.

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).

Morehead, Bruce C.
1974. A report on the National Marine Fisheries Service comminuted fish cake survey. Marine Fisheries Review, vol. 36, no. 5, pp. 34-37.

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 favorably to the flavor than others. Ratings for texture, however, were lower than those for flavor.

Morris, D. M., and L. E. Dawson.
1977. Storage stability of mechanically deboned fish flesh. Paper presented at the 37th Annual Meeting of the Institute of Food Technologists, Philadelphia, Pa., June 5-8. Abstract only.

A commercial NaCl-Na tripolyphosphate preparation was the most effective antioxidant in storing mechanically deboned mullet at -18°C for 12 months. Vacuum packing of raw patties improved lipid stability, precooking increased stability especially with a binder present, a monoglyceride film was detrimental to product appearance, and the NaCl-Na tripolyphosphate antioxidant minimized flavor changes during storage.

Nakayama, T., and M. Yamamoto.
1977. Physical, chemical and sensory evaluations of frozen-stored deboned (minced) fish flesh. Journal of Food Science, vol. 42, no. 4, pp. 900-905.

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.
1975. Frozen minced fish blocks, proposed interim grade standards. Dept. of Commerce, 50 CFR Part 278, Federal Register 40 (50): 11729, March 13.

As a result of the two technical seminars held and the research and quality studies completed to this date, the National Marine Fisheries Service believed sufficient information was then available on which to base Proposed Interim Standards for Grades of Frozen Minced Fish Blocks.

Newman, D. A.
1976. Reforming of fish products with texture from frozen fish--the Comitrol flake cutting system, pp. 31-33. In James N. Keay [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.

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.

Niscolo, Wilson, and Hilmer A. Frank.
1966. Bacterial spoilage of kamaboko during refrigerated storage. Food Technology, vol. 20, no. 7, pp. 114-117.

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.

Noble, Jim.
1972. Wasteful processing robs producer of profits, the world of nutrients. The Fish Boat, vol. 17, no. 8, pp. 39-41, 64-65.

Processing at sea and more economical processing in general were discussed as they relate to the need for increasing productivity on an international scale.

Okada, M.
1967. Effect of sodium citrate on the keeping quality of frozen surimi (frozen fish paste), pp. 312-314. In Rudolf Kreuzer [ed.] Freezing and irradiation of fish, 1969. Fishing News (Books) Ltd., London, England.

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, Minoru, David Miyauchi, and George Kudo.
1973. "Kamaboko"--the giant among Japanese processed fishery products. Marine Fisheries Review, vol. 35, no. 12, pp. 1-6.

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, M., and E. Noguchi.
1973. Trends in the utilization of Alaska pollock in Japan, pp. 189-193. In Rudolf Kreuzer [ed.] Fishery products, 1974. Fishing News (Books) Ltd., Surrey, England.

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.

Ou-Yang, M., W. W. Meinke, and K. F. Mattil.
1977. 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., June 5-8, 23 p.

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., A. L. Branen, C. J. Brekke, and J. V. Spencer.
1977. Use of Pacific hake in a frankfurter formulation. Paper presented at the 37th Annual Meeting of the Institute of Food Technologists, Philadelphia, Pa., June 5-8, 13 p.

Results indicated that an acceptable frankfurter could be prepared when up to 15% fillet or minced flesh of Pacific hake (Merluccius productus) was used to replace the "meat" portion of the formulation. Some odor and flavor differences between products with 0% hake and 15% hake were detected, however, after 5 weeks of refrigerated storage.

Patashnik, M., G. Kudo, and D. Miyauchi.
1973. Smooth, white spread from separated fish flesh forms a base for flavored dips, snack items. Food Product Development, vol. 7, no. 6, pp. 82-91.

Wet comminuted fish muscle has excellent functional properties and can therefore compete with other proteins in fabricated foods.

Patashnik, M., G. Kudo, and D. Miyauchi.
1974. Bone particle content of some minced fish muscle products. Journal of Food Science, vol. 39, no. 3, pp. 588-591.

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, David Miyauchi, and George Kudo.
1976. Objective evaluation of texture of minced black rockfish (Sebastes spp.) during frozen storage. Journal of Food Science, vol. 41, no. 3, pp. 609-611.

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.

Poulter, R. G., and J. G. Disney.
1977. Development of novel products from tropical fish species, p. 6. In Abstracts of the second annual tropical and subtropical fisheries conference of the Americas. Texas A & M University-Sea-Grant College, Publication No. TAMU-SG-77-112. Abstract only.

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.

Raccach, M., E. J. Mulnix, R. C. Baker, L. R. Helwig, and J. M. Regenstein.
1977. Microbial properties of mechanically deboned fish flesh. Paper presented at the 37th Annual Meeting of the Institute of Food Technologists, Philadelphia, Pa., June 5-8. Abstract only.

Mechanically deboning fish of different species increased the microbial count by two to tenfold. The shelf life of the minced fish at 2° and 12°C was 5 and 3 days respectively with total counts of $1.0\text{-}5.0 \times 10^8$ per gram. Frozen

storage at -25°C up to 4 months caused a decrease in the microbial count by 50-90%. Mechanically deboned fish thawed to 2°C at 4.4°, 23°, and 38°C all had the same final total count.

Rasekh, J., and A. Metz.
1973. Acid precipitated fish protein isolate exhibits good functional properties. Food Product Development, vol. 7, no. 8, pp. 18-24.

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 percent protein.

Rasekh, Jamshyd, Virginia Sidwell, and Melvin Waters.
1976. The effect of washing on color and texture of minced croaker, pp. 585-586. In Bryant F. Cobb III and Alexandra B. Stockton, Proceedings of the first annual tropical and subtropical fisheries technological conference, vol. 2. Texas A & M University-Sea Grant College, Publication No. TAMU-SG-77-105.

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, Melvin Waters, and Virginia Sidwell.
1977. 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, p. 13. In Abstracts of the second annual tropical and subtropical fisheries conference of the Americas. Texas A & M University-Sea Grant College, Publication No. TAMU-SG-77-112.

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.

Ravichander, N., and J. N. Keay.
1976. The production and properties of minced fish from several commercially important species, pp. 18-24. In James N. Keay [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.

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.

Rekhina, N. I.
1973. The use of fish of lower market value for human consumption, pp. 295-296. In Rudolf Kreuzer [ed.] Fishery products, 1974. Fishing News (Books) Ltd., Surrey, England.

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).

Ronsivalli, L. J.
1976. The role of fish in meeting the world's food needs. Marine Fisheries Review, vol. 38, no. 6, pp. 1-3.

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.

Seligsohn, Melvin R.
1974. Food from the sea: wave of the future? Food Engineering, vol. 46, no. 6, pp. 57-59.

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.

Silberstein, D. A., and D. A. Lillard.
1977. Factors affecting the autoxidation of lipids in mechanically deboned fish. Paper presented at the 37th Annual Meeting of the Institute of Food Technologists, Philadelphia, Pa., June 5-8. Abstract only.

Samples of mullet exhibited higher total pigment concentrations after being mechanically deboned as opposed to similar samples which were hand deboned. The major increase was in the hemoglobin fraction of the pigment constituent. Free fatty acid compositions also differed between the samples.

Soo, H. M., M. Costello, and E. H. Sander.
1976. Formulation of an intermediate moisture, shelf stable minced fish stick. Paper presented at the 36th Annual Meeting of the Institute of Food Technologists, Anaheim, Cal., 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, and Eugene H. Sander.
1977. Prediction of sensory response to textural parameters of breaded shrimp shapes using Instron texture profile analysis. Journal of Food Science, vol. 42, no. 1, pp. 163-167.

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.

Sorensen, Torben.
1975. The assessment of the textural characteristics of separated fish mince by objective measurements. Paper, Technological Laboratory, Ministry of Fisheries, Technical University, Lyngby, Denmark, 15 p.

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 mince in a series of fundamental terms, was used.

Sorensen, Torben.
1976a. Relationship between rigor mortis and changes which occur during the storage of frozen fish mince. Paper, Technological Laboratory, Ministry of Fisheries, Technical University, Lyngby, Denmark, 42 p.

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.
1976b. Effect of additives in frozen separated fish mince. Paper, Technological Laboratory, Ministry of Fisheries, Technical University, Lyngby, Denmark, 20 p.

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.
1976c. Effect of frozen storage on the functional properties of separated fish mince, pp. 56-65. In James N. Keay [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.

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.

Spinelli, J., B. Koury, H. Groninger, Jr., and R. Miller. 1977. Expanded uses for fish protein from underutilized species. Food Technology, vol. 31, no. 5, pp. 184-187.

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.

Stone, W. E., and W. A. Gould. 1977. 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., June 5-8, 21 p.

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.

Suter, Dwayne A., and Katie E. J. Hart. 1976. Selected textural properties of cooked minced Atlantic cutlass fish sticks, pp. 602-618. In Bryant F. Cobb III and Alexandra B. Stockton, Proceedings of the first annual tropical and subtropical fisheries technological conference, vol. 2. Texas A & M University-Sea Grant College, Publication No. TAMU-SG-77-105.

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.

Tanikawa, Eiichi.
1963. Fish sausage and ham industry in Japan, pp. 367-424. In C. O. Chichester, E. M. Mrak, and G. F. Stewart [ed.] Advances in Food Research, vol. 12. Academic Press, New York.

History - Raw Materials - Manufacture - Prevention of putrefaction - Origins of bacteria - Effects of preservatives on sterilization - Food poisoning - Sanitary measures - Storage - Aging - Official quality standards.

Tanikawa, Eiichi.
1971. Marine products in Japan. Koseisha-Koseikaku Company, Tokyo, 507 p.

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., T. Motohiro, and M. Akiba.
1967. Development of fish products with particular reference to frozen minced fish muscle (surimi), pp. 304-311. In Rudolf Kreuzer [ed.] Freezing and irradiation of fish, 1969. Fishing News (Books) Ltd., London, England.

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., and D. Miyauchi.
1972. Preparation and utilization of frozen blocks of minced black rockfish muscle. Journal of Milk and Food Technology, vol. 35, no. 7, pp. 414-417.

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.

Tretsven, Wayne I.
1971. The separation of crab meat from shell & tendon by a centrifugal process. Commercial Fisheries Review, vol. 33, no. 5, pp. 48-49.

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.

Ueno, Saburo.
1968. Industries of fish sausage and meat sausage in Japan. Kureha Chemical Industry Co., Ltd., Laboratory of Food Processing, Tokyo, 23 p.

The pamphlet described history and yield; sausage plant; raw materials, additives; manufacturing process; preservability.

Webb, Neil B.
1976. Functional properties influencing texture, pp. 587-601. In Bryant F. Cobb III and Alexandra B. Stockton, Proceedings of the first annual tropical and subtropical fisheries technological conference, vol. 2. Texas A & M University-Sea Grant College, Publication No. TAMU-SG-77-105.

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 hysteris loop. An extensive bibliography containing 36 references on compositional characteristics was included.

Webb, N. B., E. R. Hardy, G. G. Giddings, and J. J. Howell.
1976. Influence of mechanical separation upon proximate composition, functional properties and textural characteristics of frozen Atlantic croaker muscle tissue. Journal of Food Science, vol. 41, no. 6, pp. 1277-1281.

Results from comparison of mechanically separated fish muscle tissue and hand separated tissue dealt with proximate analyses, nitrogen levels, moisture content, and texture.

Webb, N. B., and F. B. Thomas.
1975. Development of seafood patties utilizing mechanically separated fish tissue. N. C. Agricultural Experiment Station Tech. Bul. No. 235, UNC Sea Grant Program Publication UNC-SG-75-03, 23 p.

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.

Wojtowicz, M. B., and W. J. Dyer.
1975. Processing of rock crab by meat separators. Environment Canada, Fisheries and Marine Service, Halifax Laboratory New Series Circular No. 49, 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.

Wong, J., Audrey Barnes, Y. C. Lau, and M. Yamamoto.
1975. Quality and quantity of deboned flesh recovered from underutilized fish. Environment Canada, Fisheries and Marine Service, Technical Report No. 575, 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.

Yamamoto, M., and J. Wong.
1974. A research note: simple chemical method for isolating bone fragments in minced fish flesh. Journal of Food Science, vol. 39, no. 6, pp. 1259-1260.

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.

Yarish, J.
1975. A discussion of the concerns of government regulatory agencies in the area of comminuted fishery products. Paper presented at Pacific Fisheries Technological Conference, Portland, Ore., March 3-5. Fisheries and Marine Service, Environment Canada, Vancouver, B. C., Canada, 4 p.

The inherent bacteriological hazards involved in producing minced flesh for human consumption were emphasized.

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King, Carver, and Prewitt, 1971.
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c. Alternate Meat Separation Methods:
Learson, Reierstad, and Ampola, 1972.
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d. Additional Treatments:
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CC-ETAS (Current Contents, Engineering, Technology & Applied Sciences).

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Food Science and Technology Abstracts.

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Index to Scientific Reviews.

Industrial Development Abstracts.

Monthly Catalog of U.S. Government Publications.

NFAIS Newsletter (National Federation of Abstracting & Indexing Services).

NTIS Weekly Government Abstracts.

Oceanic Abstracts.

Readers' Guide to Periodical Literature.

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