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SECOND TECHNICAL SEMINAR on MECHANICAL RECOVERY AND UTILIZATION OF FISH FLESH

BOSTON, MASSACHUSETTS

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Edited by

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Director

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Washington, D.C.

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A C K N O W L E D G M E N T

This seminar, jointly sponsored by the National Fisheries Institute and the National Marine Fisheries Service/NOAA, Department of Commerce, is the second in a series designed to inform and update the technology of minced fish and mechanical recovery of fish flesh.

The first conference was held at Oak Brook, Illinois, September 21-11, 1972. Proceedings from that conference are still available and can be obtained by writing Roy Martin, National Fisheries Institute, 1730 Pennsylvania Ave., N.W., Washington, D.C. 20006.

Acknowledgment is also made to the NOAA Sea Grant program for the funding necessary to have these proceedings published.

The seafood industry gratefully appreciates the efforts of all those contributing to the success of this seminar.

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I. FOREWORD

Roy E. Martin
Director, Science and Technology
NATIONAL FISHERIES INSTITUTE
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The need to know is now; the need to analyze and evaluate is now. The need to use and implement may be sometime in the near future. This is technological advancement.

Calling new and unique technology to the forefront of imagineering, creativity, innovation and new product development has been one of the main purposes behind both the Oak Brook and Boston minced fish conferences. Another important function of these meetings is the opportunity, in open forum, to discuss standards as it relates to quality and to take those quality considerations and place them along side equipment performance, capital costs, and yield benefits.

What we do here will have a major influence and impact on the seafood industry over the next several decades.

A meeting of this type also presents an opportunity for a free exchange of ideas with a great many disciplines; the government, university researchers, foreign investigators and industry leaders.

We have also tried to put between the covers of these several volumes, a resource center for those actively engaged in current research and development; those anticipating use of this technology on a commercial scale and those that will follow, building on the knowledge accumulated to date.

Measurement and impact already are noticeable from the previous conferences, new research findings, added work with more species, new market penetrations and innovations and changes in equipment design. We no longer talk about a separator as a single unit, we now discuss the subject in terms of a processing system, integrated to aid us through to a finished raw material.

Our commitment is universal; to provide as much wholesome, nutritious seafood protein to an ever-growing population in forms readily acceptable and recognized by a consumer that is increasingly quality conscious.

Mechanical recovery and utilization of fish flesh is a true definition of maximum sustainable yield.

II. WELCOME AND INTRODUCTORY REMARKS

Murry Berger
President
Seabrook Foods, Inc.

I want to thank the National Oceanic and Atmospheric Administration/NMFS for joining with the National Fisheries Institute in sponsoring this national seminar on minced fishery products. I welcome to this meeting all the representatives of the National Marine Fisheries Service, as well as the many representatives of companies engaged in the processing of seafood products.

The United States commercial seafood industry makes significant contributions to the strength of this nation's ecomomy, having special significance to many coastal communities. The total industry also provides a significant portion of protein to the American public's diet; worldwide trade in fishery products is an important part of this nation's international relations and the industry's long history makes it part of our national heritage. It is fitting, therefore, that members of this industry work together to protect and advance their common interests.

The fundamental objective of the National Fisheries Institute is to do all that is possible and legally permissable to assure a continuing, growing supply of fish and seafood products for the American consumer. To achieve this goal, the National Fisheries Institute shall: a) represent and act for the commercial seafood industry of the United States before all divisions of the United States government and those public and private organizations whose activities affect the industry; b) present the views of our industry to the American public through public relations activities; and c) develop proper trade relations.

Seminars of the type you are attending today and tomorrow will bring private industry and government much closer together in realizing the goals of supplying the American public lower priced fish products that are high in protein. In unity we have strength; the meetings of today and tomorrow will prove that. We all have the same goals and by working together we will achieve success.

A former President of General Motors once stated, "What's good for General Motors is good for the country." I would like to state that "What is good for our country's fishing industry is good for each individual company that is represented here today."

I thank you for your contribution to the growth of the fishing industry of the United States and the world.

III.

OBJECTIVES AND ORGANIZATION OF SEMINAR

Joseph W. Slavin
Associate Director for Resource Utilization
National Marine Fisheries Service
Washington, D.C.

A warm welcome to all participants in this most significant conference.

I think all here will agree that a fundamental approach to providing fishery products for the future requires application of new technology to enable us to effectively utilize the wide variety of food resources of the ocean.

The challenge is to apply that technology in a manner so it will produce new products that will be demanded by consumers and which will yield a profitable return to the seafood industry.

What is this technology?

It is the topic of discussion here for the next two days.

You are all aware that this is the second technical seminar on minced fish technology and development, jointly sponsored by the National Fisheries Institute and the National Marine Fisheries Service. The single primary objective of this seminar is to provide an open forum for full and clear candid discussion of all the aspects of minced fish technology and the utilization of minced fish production. It is very important that we fully discuss the promising functional aspects of this technology as well as some of the problems we are experiencing. We have a lot of material to cover in a short time.

Dr. Blackwood of the Canadian Inspection Service will discuss the worldwide interest in minced fish from the FAO Technical Conference on fishery products in Tokyo last December. As you may know, Dr. Blackwood was appointed to head a working group on minced fishery technology at that meeting. Research is progressing rapidly in many phases of minced fish technology. Although it has been only a year and a half since our first meeting, there have been enough developments to make this meeting a timely update. Session I on research and development will consume most of our time today. We are most pleased to welcome researchers here from Canada, Iceland and Scotland as well as from several U.S. universities.

It is also particularly important to know as much as we can about the equipment that has brought on the minced fish revolution. Representatives from equipment manufacturers are here to discuss their equipment. Session II beginning this afternoon should provide some very valuable information in that regard.

The proof of the research comes in the marketing of the products. We start our discussions tomorrow morning with the marketing challenges and opportunities that minced fish offer.

The potential which exists, if the technology of minced fish is used constructively, is extremely great in benefits to consumers and the industry. Nearly as great is the danger of a "bust" by inappropriate or premature use of this technology such as considering minced fish as merely salvage operations for processing low quality fish. This latter situation must be avoided at all costs.

I think Session IV on standards and quality assurance is timely and very important. I believe all here will agree that a fundamental approach in providing fishery products for the future requires that we apply new technology to enable us to effectively utilize the wide variety of food resources from the oceans. The challenge is to apply the technology in a manner so it will provide new products that will be demanded by consumers and which will yield a profit to the seafood industry.

Some insight has already been gained as a result of this work on the minced fish standard, and I would like to give you some examples:

1. The development of rancidity and other off odors and flavors during frozen storage may appear more rapidly in minced products than in fillets.

2. Some species have a shorter storage life than others. For these species, antioxidants or other processing methods may be necessary.

3. Food additives and flavoring agents, when added, help with some species by enhancing texture, aiding water binding capacity, reducing drip, and changing flavor.

4. Mixtures of several species with similar or even dissimilar flesh characteristics can be used to produce products with exciting properties or other options.

We welcome your critical review of the proposed draft standard because we see it as a "pacesetter" for international industry guidance over the next several years. We also urge you to carefully and critically address the area of quality in manufacturing minced blocks because variability and/or poor quality will hurt your future sales. Remember that the effort and expense of capturing the fish and bringing it to the processor has already been completed and paid for. A little extra effort and attention to maintenance of quality will yield a handsome economic return.

I would like to draw your attention to the last session of the seminar, and urge you during the course of this meeting to carefully formulate your comments which may be helpful to us in our future work on minced fish.

In conclusion, I think that what we do here at this meeting in considering this technology will go a long way toward developing new products for the future and toward improving some of the institutional aspects of labeling and marketing that have for so long hampered full development of these fishery resources. There is much at stake, so we must be careful and do it correctly. When all is said and done, let it be recorded that what was done here was to promote a new technology that produced new quality seafoods for a quality conscious, consuming American public. It is up to all of us to make sure that this benefit is realized. I am confident with your enthusiasm and help it will be.

Thank you and I look forward to a very productive meeting.

IV.

SUMMARY OF DELIBERATIONS ON MINCED FISH AT FAO TECHNICAL CONFERENCE IN TOKYO - 1973

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It was with some misgiving that I accepted an invitation from FAO to prepare a paper on the utilization of mechanically separated fish flesh as a background for discussion of this subject at the FAO Technical Conference on Fisheries Products held in Tokyo last December. My misgivings were twofold. Firstly, I knew of course that a little knowledge can be dangerous to the would-be expert and certainly my knowledge on minced fish raised more questions than answers. Secondly, I had misgivings as to just how this subject would be received by such a mixed gathering of international industry and government administrators and technical experts as would be gathering at Tokyo.

In my favor, was a personal conviction that the fishing industry was ready to exploit the fascinating opportunities offered by minced fish; opportunities for increased raw material utilization and new product development using minced fish flesh as the highly nutritious base material to produce convenience, high quality new consumer products. I knew too that the leaders in the Canadian fishing industry were very much alert to the opportunities offered by this new fish technology. It was a most rewarding personal experience as together we prepared a technical paper on the "Canadian Experience" in minced fish.

The discussion on minced fish turned out to be a highlight of the Tokyo Conference. Obviously, the chairman of the session dealing with minced fish did not share my earlier misgivings. He was much better informed and knew full well that the time was right for such an international discussion on minced fish. I,of course,refer to Joe Slavin who did such a masterful job as chairman.

I am delighted to have this opportunity to review the more important points brought out in the discussion at Tokyo on mechanically separated fish flesh. Considerable interest was shown in minced fish processing, especially for the utilization of unfamiliar and neglected species. Many participants felt that products manufactured from minced fish flesh would be highly acceptable and popular in tomorrow's marketplace. Such products, using the latest technology would incorporate new ingredients such as texturizers, flavors, etc., to enhance consumer acceptability. The Conference, therefore, requested FAO to gather and disseminate information on problems of manufacturing and utilizing minced fish flesh and it drew up a list of headings under which detailed information could be collated. A little later I will elaborate on some of the information that is now available from a number of countries on this subject.

In view of the general interest in new products such as minced fish, the Conference felt there was a need for the Codex Committee on Fishery Products to pay increased attention to them, and indeed, the elaboration of a standard for fish blocks including minced fish is on this Committee's agenda for its next meeting in Bergen, Norway this fall. Similarly, the elaboration of a code of practice for the processing of minced fish is presently under active consideration by FAO Department of Fisheries.

Again, in relation to new products to be prepared from minced fish flesh, the Conference felt that some national legislation relating to them might be unnecessarily restrictive and thus could inhibit their further orderly development. In view of the great potential for such products, it was suggested that FAO make member governments aware of this danger so that they could adopt a more flexible approach in drafting new, or modifying old, legislation. At the same time, of course, it was recognized that governments should ensure that the consumer is not misled through inadequate information on the label regarding the composition and manufacture of such products.

There was strong support for the view that, to ensure high consumer acceptance and to provide for orderly marketing, it was urgent that special consideration be given now to problems associated with quality control, product standardization and product description and identity. The raw material for minced flesh must be of a quality suitable for marketing as fresh fish. This process must not become a salvage operation for fish otherwise unacceptable due to such factors as spoilage, certain abnormal physiological conditions and parasitic infestation.

It was pointed out that minced flesh offered great opportunity for the preparation of new, imaginative, high quality products tailored to the requirements of a wide range of consumers. Countries such as Japan and the U.S.S.R. are large processors of minced fish material. Japan has been investigating the possibilities of underutilized species for making surimi. Not very many years ago Alaskan pollock was such a species. Today, the catch by Japanese, Soviet and Korean ships is well over 3,000,000 tons a year. Species studied and found to have good potential for processing into surimi include croaker in the Gulf of Mexico, Pacific cod and hake (merluza) of Chile and Peru. Peru has a large potential of about 300,000 tons a year.

In the Soviet Union minced fish is prepared from Alaskan pollock, blue whiting and from offal obtained in processing grenadier and hairtail. The quality and yield of minced fish flesh are higher if it is prepared from fish at the rigor mortis stage or immediately after. A typical processing procedure, starting with headed and gutted fish with the black peritoneum thoroughly cleaned off, would be to pass this fish through a flesh separator. The coarse meat is then washed twice with fresh water in the ratio of one to three. After excess moisture is removed, the flesh is finely crushed and common salt, sugar, phosphates and other food additives are introduced to inhibit protein denaturation. The minced flesh is then packed in appropriate size blocks in polyethelene bags, frozen and stored at -20°C or lower for further processing into finished products. The storage life of the blocks is 6 to 9 months.

The Conference discussed the need for research in the field of minced products and it was recognized that there were many questions on quality standards, nomenclature and labeling yet to be settled. However, industry will not wait for the final answers to all of these questions. The opportunities offered by minced fish flesh as the base material to which can be added color and flavoring agents, texturizers and stabilizers to make a wide variety of products attractive to the consumer are irresistible to the fishing industry. It is important to industry and control agencies alike that no artificial barriers be placed in the path of utilizing new species of fish and that the marketing of the processed products should be orderly. It was predicted that minced products which are already popular in some countries will soon find wider world market applications.

During the discussion of the problems associated with the processing of minced fish flesh, it was stated that the process disrupted the cellular structure of the muscle and that blood, air, microorganisms and contaminants can be readily incorporated into the raw material, all of which may seriously affect spoilage and storage characteristics. The process also lends itself to the incorporation of additives about which there is little information at present as to their proper use and effectiveness. It was pointed out that sugars prevent denaturation of muscle proteins during cold storage as do some amino acids such as sodium glutamate. The rate of denaturation depends on the species of fish. There were many opinions expressed about the problems of discoloration of the flesh of fish especially in the minced form. It was generally agreed that such discoloration can be minimized by carefully preparing the raw material prior to its being passed through the flesh separator.

An important part of the discussion dealt with the development of new products and their adoption in the country of origin and elsewhere. For example, as pointed out by Japanese speakers, the development of frozen surimi has accelerated the growth of the Alaskan pollock fishery. This very large increase in surimi production is due mainly to the demand for Kamaboko, a traditional Japanese fishery food.

One particularly important aspect stressed is that traditional methods of production of food products is followed in Japan where it is not possible to change their basic manufacturing procedures. But, of course, those traditional methods are improved by the application of science and technology. This policy of following traditional methods and preferences means also that the products conform to the taste of the Japanese consumers and may not, therefore, suit other people. It was emphasized that this is a very important aspect especially for those many countries interested in adopting Japanese products and their processing methods. As a general rule when seeking to transfer such products from one country to another, it is better to study the principles of the methods involved, the equipment and the properties of the raw materials used rather than to attempt to adopt specific recipes. Such studies should indicate how the products and processes can be modified to meet the requirements of the consumers in the adopting country.

As previously mentioned, because of the great interest in minced fish flesh, an Ad Hoc Committee was set up at the Conference to review some of the problems which have to be solved in dealing with products made from minced material. The Conference accepted the recommendation of this Committee that a request be circulated by FAO to member countries for information on the manufacture and character of minced fish flesh, and drew up a list of headings under which this information could be gathered. Once the information was assembled, it would be sent to member nations as a guide to technical laboratories for identifying problems on which further research may be required. This information would also be useful to FAO Fisheries in developing a code of practice for the processing of minced fish flesh. Some preliminary information on responses from some member countries is shown in the following tables.

Finally, I would just like to say that I am looking forward with enthusiasm to today's and tomorrow's discussions. We are all very indebted to NOAA and NFI for making this seminar possible. The previous seminar at Oak Brook made a significant contribution to our present knowledge of minced fish utilization. I am sure that this one will provide a further important thrust towards new development and orderly marketing of minced fish flesh and consumer products manufactured from this excellent base material.

FIG 1 SUBJECT HEADINGS UNDER WHICH COUNTRIES WERE REQUESTED TO COMMENT ON MANUFACTURE OF MINCED FISH FLESH

1.	RAW MATERIAL	-	whole fish (common and scientific name) fillets, mixed species, fish frames, mixture of fillets and minced flesh, fish not suitable for normal processing.
2.	METHOD OF MANUFACTURE	-	brief description of types of machines used and methods employed in the manufacture of the product.
3.	PRODUCT COMPOSITION	-	water, protein, fat, ash, sugar, salt.
4.	QUALITY CRITERIA	-	colour, odour, flavour, texture, F.F.A., T.B.A., volatile acids and bases, bones, chitin, parasites. Note: It was suggested that a complete list of parasites found and methods of their identification in minced flesh should be submitted. Views on the presence and levels of parasites should also be included.
5.	MICROBIOLOGY	-	bacteriological counts and problems.
6.	ADDITIVES	-	phosphates, antioxidants, sodium glutamate, starch, stabilizers. Note: Technological justification should also be given for any additives, together with their levels of use.
7.	PRODUCT LABELLING	-	country policy and practice.

FIG 2 RAW MATERIAL AND METHOD OF MANUFACTURE

Type of raw material and method of manufacture	Reporting countries						
	Japan	New Zealand	Norway	Poland	South Africa	U.S.A.	Canada
RAW MATERIAL							
- Whole Fish	✓	✓		✓	✓	✓	✓
- Fillets	✓	✓			✓		
- Trimmings			✓	✓		✓	✓
- Frames		✓		✓		✓	✓
RAW MATERIAL PREPARATION							
- Thawing				✓			
- Scaling/washing	✓			✓		✓	✓
- Heading	✓			✓	✓	✓	✓
- Gutting	✓			✓	✓	✓	✓
- Washing	✓		✓	✓	✓	✓	✓
FLESH SEPARATORS	✓	✓					
- Baader					✓		✓
- Beehive							✓
- Bibun			✓	✓		✓	✓
- Paoli							✓
- Yahagiya				✓			
WASHING MINCED FLESH	✓					✓	
DEWATERING	✓					✓	
FLESH STRAINING	✓			✓			
INGREDIENTS AND ADDITIVES	✓	✓		✓	✓	✓	✓
PACKING IN BLOCKS	✓		✓	✓		✓	✓
FREEZING	✓			✓		✓	✓
STORAGE below	-20°C (- 4°F)			-25°C (-13°F)		-18°C (0°F)	-26°C (-15°F)

FIG 3. PRODUCT COMPOSITION

Composition	Reporting countries						
	Japan	New Zealand	Norway	Poland	South Africa	U.S.A.	Canada
WATER							
PROTEIN							
FAT							
ASH							
VITAMINS							
MINERALS							
SUGAR	✓						
SALT	1-3 %			1.5 %			
Equal to fillets			✓		✓		
Not reported		✓					

FIG 4 QUALITY CRITERIA

Criteria	Reporting countries						
	Japan	New Zealand	Norway	Poland	South Africa	U.S.A.	Canada
Colour	✓	✓	✓	✓	✓	✓	✓
Odour	✓	✓	✓	✓	✓	✓	✓
Flavour	✓	✓	✓	✓	✓	✓	✓
Texture	✓	✓	✓	✓	✓	✓	✓
Bones	✓		✓		✓	✓	✓
Blemishes	✓		✓			✓	✓
Parasites				✓			✓
Dehydration							✓
F.F.A.					✓		
T.B.A.					✓		
Volatile Acids/Bases	✓				✓		
Chitin (Grittiness)						✓	✓

FIG 5 MICROBIOLOGY

Type	Reporting Countries						
	Japan	New Zealand	Norway	Poland	South Africa	U.S.A.	Canada
TOTAL BACTERIAL COUNT		<.75 M/g		< 1 M/g			✓
E. COLI				0/1 mg			✓
FAECAL COLIFORMS		<1000/g					✓
SALMONELLA		0		0/25g			✓
SHIGELLA		0		0/25g			✓
STAPHYLOCOCI		< 100/g		0/0.1g			✓
SAME AS FILLET BLOCKS			✓		✓		

FIG 6 ADDITIVES AND INGREDIENTS

ADDITIVES AND INGREDIENTS	Reporting countries						
	Japan	New Zealand	Norway	Poland	South Africa	U.S.A.	Canada
SALT	✓			✓			
SUGAR	✓			✓			
WATER							
POLYPHOSPHATES	✓	✓			✓	✓	✓
TEXTURED VEGETABLE PROTEINS				✓		✓	✓
ASCORBATE		✓			✓	✓	✓
COLOURING AGENTS		✓				✓	
FLAVOURING AGENTS				✓		✓	✓
SPICES				✓			
STARCHES	✓	✓		✓			

FIG 7. PRODUCT LABELLING

Labelling requirements	Reporting countries						
	Japan	New Zealand	Norway	Poland	South Africa	U.S.A.	Canada
NAME OF PRODUCT		✓		✓			
-"(common name) FLESH BLOCKS"					✓		
-"MINCED (common name) BLOCKS"							✓
INGREDIENTS AND ADDITIVES		✓					✓
COUNTRY OF PRODUCTION		✓		✓			✓
NAME OF MANUFACTURER OR DISTRIBUTOR		✓		✓			✓
DATE OF PRODUCTION				✓			✓
NET WEIGHT		✓		✓			✓
QUALITY GRADE				✓			
NOT REPORTED	✓		✓			✓	

V.

CURRENT TECHNICAL STATUS

STORAGE STUDIES ON MINCED ROCKFISH

AND THE USE OF CARP IN MINCED PRODUCTS

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Pacific Fisheries Utilization Research Center
National Marine Fisheries Service
Seattle, Washington

At the Oakbrook Seminar on the "Mechanical Recovery and Utilization of Minced Fish Flesh" (September, 1972) a progress report on the experimental work underway at our research center was given, most of the storage tests were only six months old at that time. I would like to first present data on those tests that have now been completed; then give the results of some of our more recent work. In our earlier studies first reported at Oakbrook, we used a group of rockfish that is known commercially as "black rockfish" in contrast to another group that is called "red rockfish." The black rockfish group are from the Sebastes species and include those with the common names yellowtail rockfish, silvergray rockfish, and black rockfish. The fresh fillets of black rockfish are excellent tasting but, when frozen, become rancid in a few months and increasingly tough during extended frozen storage. These factors limit their marketing and consequently, their utilization. Thus in our minced flesh studies, we picked black rockfish as our experimental species because we believe that if we could solve their rancidity and toughening problems, we would be able to use the minced flesh from most other species.

In addition to the rancidity and toughening problems associated with black rockfish, we had to solve several other problems that are general to all minced fish. From past experience, we knew that minced or ground fish, when cooked as such, had poor palatability and poor mouth-feel. We found that we were able to prepare a highly acceptable block that we named a modified fish block by using a fish binder shown in Table 1.

Table 1. Formulation of binder to be used per 100 pounds of minced fish in modified blocks

Ingredients	Weight
	Pounds
Fish flesh	2.5
Salt	1.0
Sugar	1.0
Monosodium glutamate	0.3
Sodium tripolyphosphate	0.15
Water	Up to 5

The results of a comparison with respect to rancidity and texture ratings during 8 months of storage at 0°F between the unmodified block, which is made with only the minced fish flesh with no other ingredients, and the modified block, which is made with minced fish containing our fish-binder formulation, are given in Table 2. Upon initial examination, both types of blocks had about the same rancidity and texture scores, i.e., zero-to-trace

Table 2. Comparison of rancidity and texture scores of unmodified and modified minced black rockfish blocks during 8 months of storage at 0° F.

Minced blocks storage time at 0° F.	Mean rancidity score 1/		Mean texture score 2/	
	Unmodified	Modified	Unmodified	Modified
Months	5-pt. scale			
0	4.0	3.9	3.9	4.0
4	2.9	3.5	3.4	3.7
8	2.6	3.4	2.9	3.8

1/ Rancidity rating scale:

5 - no rancidity

4 - trace rancidity

3 - slight rancidity

2 - moderate rancidity

1 - excessive rancidity

2/ Texture rating scale:

5 - very good

4 - good

3 - fair

2 - borderline

1 - poor

rancidity and good texture ratings. At the 4- and 8- month examinations, the unmodified blocks were appreciably lower in rancidity and texture scores (moderately rancid in flavor and slightly dry and crumbly in texture), whereas the modified block showed only small changes. Thus, using our fish binder, with added ingredients, to prepare modified minced rockfish blocks significantly improves cold storage characteristics.

The data in Table 3 shows the results of two experiments to determine the effect of washing the minced muscle on flavor stabilit

Table 3. The effect of washing minced black rockfish muscle on the flavor stability during 12 months of storage at 0° F.

Months stored at 0° F.	Mean rancidity score	
	Unwashed flesh	Washed flesh
	5-pt. scale1/	
0	4.7	4.8
4	3.5	4.3
8	3.3	4.0
12	2.9	3.7
0	4.7	4.7
4	4.7	4.5
8	3.0	4.1
12	2.8	4.1

1/ Rancidity rating scale:

5 - no rancidity

4 - trace rancidity

3 - slight rancidity

2 - moderate rancidity

1 - excessive rancidity

during frozen storage. The flavor scores of the modified, washed blocks were significantly higher statistically at the 5% level than those of the modified, unwashed blocks at each examination during the one year storage test at 0°F, except the 4-month examination in experiment 2. In addition, the washed blocks were appreciably "whiter" in color than the unwashed blocks. The storage life of the unwashed blocks was between 8 to 12 months, whereas that of the washed blocks was greater than 12 months.

We designed another experiment to determine the effect of moisture content of dewatered washed black rockfish flesh on the texture of the subsequently-prepared modified blocks. By centrifuging the washed flesh for varying times from 2 to 30 minutes, we obtained minced flesh having a moisture content from 77.9% to 84%, as shown in Table 4. The sample on the top line (79.5% moisture)

Table 4. Effect of moisture content on texture scores of modified black rockfish blocks stored for 12 months at 0° F.

Centrifuge time	Moisture content	Texture score after:				
		0 mo.	3 mo.	6 mo.	9 mo.	12 mo.
Minutes	%	5-pt. scale1/				
0 (unwashed control)	79.5	4.0	3.8	4.0	3.7	3.7
2	84.0	4.2	4.0	4.2	3.8	3.9
10	81.9	4.2	4.0	4.0	3.8	4.0
30	77.9	3.8	3.7	3.5	3.3	3.4

1/ Texture rating scale:

5 - very good
4 - good
3 - fair
2 - borderline
1 - poor

represents the unwashed control sample. Modified blocks were prepared from the other washed flesh and stored at 0°F. At 3-month intervals, the blocks were made into breaded sticks, deep-fat fried, and evaluated for texture. The sample on the bottom line, in which the moisture content was reduced below that of the unwashed control sample by centrifuging for 30 minutes, received the lowest texture score among the various samples initially and throughout the one year storage test. The other two washed samples (centrifuged for 2 and 10 minutes, respectively) received slightly higher texture scores than the control sample throughout the storage test. For each of the four lots of samples, the changes in the texture scores during the 12 month test were slight. Our results show that the higher moisture content, modified minced black rockfish blocks had the highest texture scores.

In an experiment to determine how the texture is affected by the particle size of the minced fish, we obtained coarse minced flesh from a flesh separator having a drum with 7 mm diameter holes and finely minced strained flesh taken from a Bibun strainer having a screen with 1.4 mm diameter holes. Modified blocks were prepared from (1) 100% coarse minced flesh; (2) 100% strained flesh; and (3) a mixture of 50% strained flesh and 50% coarse minced flesh. At 3 month intervals, the three types of frozen modified blocks were cut, batter and breaded, deep-fat fried, and presented to our experienced sensory panel. The results are given in Table 5. The coarse minced samples received the highest texture score in the initial examination at 0 months; the strained sample the lowest score; and the mixture of equal parts of strained and coarse minced flesh received an intermediate score. For each of the three lots of samples, changes in texture during the 12 month test were small.

Table 5. Texture scores for black rockfish sticks prepared from 1.4-mm strained flesh and 7-mm coarse-minced flesh during 12 months of storage at 0° F.

Type of flesh	Texture scores[1/] after storage at 0° F. for:			
	0 mo.	6 mo.	9 mo.	12 mo.
100% coarse-minced	4.6	4.6	4.4	4.4
100% strained	3.9	3.4	3.6	3.7
50% strained and 50% coarse-minced	4.2	4.2	3.6	4.0

1/ 5-point rating scale:

5 - very good

4 - good

3 - fair

2 - borderline

1 - poor

Thus, from the standpoint of texture, the coarse-minced flesh is better than the finely-minced flesh.

In another phase of our study on utilization of minced flesh, we have been experimenting with carp, an example of the many underutilized freshwater species. In addition to seeking better utilization of these fish as food, we are looking ahead to the day when a carp-like species might be raised in a poly-aquaculture system. In our experiments, we have used wild carp from Minnesota, Wyoming and eastern Washington. Depending upon the area of catch, season, etc., carp flesh may have an unpleasant flavor. The challenge was what could we do about this off flavor and how could we utilize the minced carp flesh? Table 6 shows the minced-flesh-yield

Table 6. Minced flesh yield from headed-and-gutted carp passed through a Bibun separator having a drum with 5-mm holes

	Weight	Yield
	Pounds	%
Headed-and-gutted carp	574	----
1st-pass flesh	288	50.2
2nd-pass flesh	105	18.3
Waste	171	29.8
Loss	10	1.7

recovered from 574 pounds of headed-and-gutted carp. The yield of first-pass, high-quality flesh was 50.2%. An additional flesh yield of 18.3% was obtained by passing the carp through the separator a second time.

We found that we could reduce the intensity of the undesirable flavor of carp to an acceptable level by washing the minced flesh with cold water in a ratio of 4 parts of water to 1 part of minced carp. In one experiment, we started out with 45 pounds of minced carp having a moisture content of 74.3%. After washing and dewatering the minced carp muscle, we finished with 36.6 pounds of washed flesh having a moisture content of 82.2% as shown in Table 7. Our decrease in flesh yield was 18.7%.

With the washed carp flesh, we made two products for consumer-preference testing during our research center's Open House last October. We prepared modified minced carp blocks, having a moisture content of 81.7%. We also prepared a smoke flavored

Table 7. Flesh yield and moisture content after washing minced carp, ratio 4 water:1 flesh

	Weight	Yield	Moisture
	Pounds	%	%
Minced flesh	45	----	74.3
Washed and dewatered	36.6	81.3	82.2
Losses	8.4	18.7	----

carp spread (moisture content 79.7%).

The modified minced carp block was served as deep-fat-fried breaded portions. The results are given in Table 8. On the left

Table 8. Preference rating for deep-fat-fried, breaded carp portions (onion-flavored)

Hedonic rating scale	Number of ratings	Percent
9 Like extremely	47	35.9
8 Like very much	52	39.7
7 Like moderately	18	13.8
6 Like slightly	9	6.9
5 Neither like nor dislike	3	2.3
4 Dislike slightly	1	0.7
3 Dislike moderately	--	----
2 Dislike very much	--	----
1 Dislike extremely	1	0.7
Total	131	100.
Mean preference score	7.9	

is the 9-point hedonic rating scale. Six to nine represents various degrees of "like;" 1 to 4 various degrees of "dislike;" and 5 "neither like nor dislike." The middle column gives the number of our visitors rating the samples in each of the nine rating categories, and the last column gives the ratings in terms of percent. The overwhelming majority of visitors who were willing to taste a carp product rated the breaded portion in the "like" category. Table 9 shows the preference ratings on our smoke-flavored carp spread, which again were primarily in the "like" categories. In other tests with the unwashed minced carp, we successfully prepared a smoked sausage and breaded fish cake.

Table 9. Preference rating for smoke-flavored carp spread

Hedonic rating scale	Number of ratings	Percent
9 Like extremely	52	36.4
8 Like very much	70	48.9
7 Like moderately	14	9.8
6 Like slightly	4	2.8
5 Neither like nor dislike	1	0.7
4 Dislike slightly	1	0.7
3 Dislike moderately	--	----
2 Dislike very much	--	----
1 Dislike extremely	1	0.7
Total	143	100.
Mean preference score	8.1	

QUALITY AND UTILIZATION OF MINCED DEBONED FISH MUSCLE

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Several years ago, personnel at the OSU Seafoods Laboratory began to explore the use of a Yanagiya Fish Separator to increase the recovery of edible meat from fish. There are a number of various fish separators now available to the fisheries industry that can drastically increase the recovery of muscle from fish.

The minced muscle freed from bone and skin has been incorporated into various products. Rockfish and shad, in combination, can be mixed to form an excellent "fish" sausage and pepperoni. Smoked minced fish produces an excellent salami. Recently, small amounts of shrimp were found to not only improve texture and flavor of minced deboned fish muscle, but also enabled formulation of a fish portion where Pacific hake (Merlussius productus), true cod (Gadus macrocephalus), ling cod (Ophiodon elongatus), and rockfish (Sebastes species) could be used interchangeably to form a portion with excellent acceptance and a standard identity.

Although minced deboned fish muscle is an excellent source of protein, we have found that overall acceptance of minced fish portions is lower than portions prepared from fillets, especially when the minced fish portion is evaluated at the same time as the fillet portion (Tables 1 and 2).

Table 1. Over-all acceptance of deep-fat fried portions by a trained taste panel.

Species	Muscle form	Over-all acceptance A	B	C
Pacific hake	Fillet		5.13^{a}	5.75^{ab}
	Deboned	5.80^{a}	4.83^{a}	
Ling cod	Fillet		6.55^{b}	6.15^{abc}
	Deboned	5.70^{a}	5.28^{a}	
True cod	Fillet		5.18^{a}	7.15^{c}
	Deboned	6.60^{a}	5.48^{a}	
Flag rockfish	Fillet			6.48^{bc}

Range of scores: 9, "liked extremely", to 1, "disliked extremely".
Mean scores in a column with same exponent letter did not vary significantly ($P<.05$) from each other.

Table 2. Over-all acceptance of deep-fat fried portions by a trained taste panel.

Species	Muscle form	Treatment mean score Off-flavor	Desirability
Dover sole	Fillet	7.13	6.38
	Deboned	3.85	3.55
English sole	Fillet	7.78	7.00
	Deboned	5.73	4.93

Range of scores: 9, "liked extremely", to 1, "disliked extremely".

When minced deboned portions from various species (Panel A) were evaluated, no differences in overall acceptance were detected.

The scores, however, were slightly lower than those given to the fillet portion (Panel C). Distinct differences were noted when the minced and intact portions were evaluated simultaneously, particularly in the cases of Dover and English sole (Table 2). We were somewhat in disagreement as to what the causes were for the lower acceptance of minced muscle.

Current studies were undertaken to determine the proximate composition and changes that occur during frozen storage of deboned muscle from various fractions of fish. Four species were used in this study, Pacific hake (Merluccius productus), English sole, (Parophrys vetulus), rockfish (Sebastes pinniger) and ling cod (Ophiodon elongatus). Intact fillets and minced muscle from deboned fillets, deboned fillets with the skin left-on, deboned frames, and deboned whole fish were packed in 1 x 3.75 x 21 inch stainless steel trays and frozen at -30°F for 16 hours. The blocks were sawed into 5/8 x 1-1/4 x 3-3/4 inch portions (45-50 g), placed in 4 mil polyethylene bags and held at 0°F until examined.

The protein content of muscle from the cleaned frames was much lower than the corresponding fillet (Table 3). The protein content of muscle from the cleaned eviscerated whole fish was only slightly lower than the intact fillet and in the case of ling cod, was higher. The moisture content of all the deboned muscle was slightly higher except for the moisture content of muscle from deboned English sole frame and whole fish and ling cod frame and whole fish (Table 4).

Table 3. Protein content of intact and minced fish muscle.

Treatment	% Protein Rockfish	Hake	English sole	Ling cod
Intact fillet	18.40	16.50	16.00	16.55
Deboned fillet	18.57	16.51	15.94	15.20
Deboned fillet-skin	18.12	16.87	15.92	16.19
Deboned frame	15.00	14.77	13.82	15.07
Deboned whole	18.33	15.65	15.84	18.30

Table 4. Moisture content of intact and minced fish muscle.

Treatment	% Moisture Rockfish	Hake	English sole	Ling cod
Intact fillet	79.52	80.90	82.61	82.03
Deboned fillet	80.52	80.94	83.86	82.73
Deboned fillet-skin	80.10	81.34	83.35	82.03
Deboned frame	79.74	83.39	81.94	80.44
Deboned whole	78.77	81.65	81.52	79.59

The lipid content of minced deboned whole fish muscle was significantly higher than the corresponding intact fillet, except for Pacific hake (Table 5). This holds true for most fish species; however, the lipid content of deboned whole true cod has also been found to be lower than the intact fillet muscle. More important is the high level of lipid found in the deboned muscle from the cleaned frames. Surprisingly, the lipid content of muscle from frames of Pacific hake was much lower than the intact fillet.

Table 5. Lipid content of intact and minced fish muscle.

	% Lipid			
Treatment	Rockfish	Hake	English sole	Ling cod
Intact fillet	2.11	1.90	1.24	1.69
Deboned fillet	1.56	2.04	1.25	1.61
Deboned fillet-skin	1.54	2.01	1.35	1.65
Deboned frame	4.11	0.85	5.16	4.66
Deboned whole	3.14	1.40	2.48	2.10

Since the presence of microorganisms can greatly alter the quality of fish muscle, total aerobic plate counts were run to determine the viable number of microorganisms present in the various samples. The highest microbial counts were present in the muscle samples from ling cod (Table 6). This was probably due to the difficulty we had in passing the frame and cleaned whole fish through our mini-model Yanagiya Separator. Although the microbial counts were higher in the deboned samples, the counts would be considered very good on a commercial level.

Table 6. Standard plate counts of intact and minced fish muscle.

Species	Treatment (Microorganisms/gram muscle)				
	Intact fillet	Deboned fillet	Deboned fillet-skin	Deboned frame	Deboned whole
Rockfish	870	780	480	4,600	1,900
Hake	330	390	850	3,700	740
English sole	1,000	3,700	9,800	12,000	1,500
Ling cod	800	5,200	1,800	17,000	12,000

Table 7. Acceptance of intact and minced fish muscle held at 0°F.

Species	Over-all desirability (Scale 1-9)[1,2]				
	Intact fillet	Deboned fillet	Deboned fillet-skin	Deboned frame	Deboned whole
Pacific hake					
0 wk	6.98[a]	5.62[b]	4.32[c]	4.34[c]	4.68[c]
12 wk	5.78[a]	5.20[a]	4.16[b]	3.62[c]	4.42[b]
Ling cod					
0 wk	5.92[a]	4.60[b]	4.46[b]	3.38[c]	5.54[a]
12 wk	-	-	-	-	-
Rockfish					
0 wk	6.80[a]	5.66[b]	5.82[b]	4.08[c]	4.78[c]
12 wk	6.06[a]	4.56[b]	4.88[b]	3.58[c]	4.46[b]
English sole					
0 wk	5.66[a]	4.72[b]	4.32[b]	2.66[d]	3.44[c]
12 wk	6.12[a]	4.90[b]	4.52[b]	2.74[d]	3.80[c]

[1]Mean score in a horizontal row with same exponent letter did not vary significantly ($P<.05$) from each other.
[2]n = 25 taste panelists.

Mechanically breaking up the cellular integrity of the fillet had a marked effect on the overall desirability of the fish portions (Table 7). It is important to note that the various deboned samples of minced muscle were compared to the intact fillet at the same time by taste panelists. The samples were baked and presented to the taste panelists under red light to eliminate color differences between the deboned portions. Preference scores were analyzed by analysis of variance and the significance of means tested by the least significant difference method. The overall acceptance of minced deboned muscle from the cleaned frames was significantly lower than the minced deboned muscle from fillets. Muscle from English sole frames was discolored and distinctly off-flavored as reflected by the very low overall acceptance by the taste panels. Except for Pacific hake, passing the skin attached to the fillet through the Yanagiya separator had no effect on the overall desirability of the minced fish muscle. Although it was previously felt that the skin, particularly English sole, was the cause of the lower acceptance of minced deboned fish muscle, it can be seen that substance(s) from the backbone are responsible. The high levels of lipid may partially explain the lower preference scores for the deboned frame muscle. The lower overall acceptance scores after 12 weeks storage at $0^{o}F$ reveal that the minced deboned fish muscle, particularly the frame muscle, undergoes more rapid changes.

To monitor some of these changes a number of chemical parameter were measured. One system involved the breakdown of trimethylamine oxide (TMAO) to trimethylamine (TMA) or dimethylamine (DMA).

Trimethylamine has been linked to fishy odors and flavors and DMA has been suggested as perhaps a good quality index of frozen fish muscle. Trimethylamine oxide levels were highest in the Pacific hake samples and lowest in English sole (Table 8). It appears that TMAO levels were much lower in the deboned muscle from the various frames.

Table 8. TMAO content of intact and minced fish muscle held at 0°F.

	TMAO (mg TMAO/g sample)				
Species	Intact fillet	Deboned fillet	Deboned fillet-skin	Deboned frame	Deboned whole
Pacific hake					
0 wk	4.5	4.5	1.8	3.5	4.4
12 wk	4.7	4.3	4.4	3.3	4.3
Ling cod					
0 wk	3.8	3.6	3.7	3.1	3.4
12 wk	-	-	-	-	-
Rockfish					
0 wk	3.6	3.7	3.7	2.5	3.7
12 wk	3.5	3.2	3.4	2.3	2.8
English sole					
0 wk	2.6	2.3	2.1	1.2	2.2
12 wk	1.9	1.9	1.7	1.2	1.9

Mechanical deboning had a drastic effect on TMA and DMA concentrations in the minced fish muscle (Tables 9 and 10). Trimethylamine levels were 2 to 3 times higher in the deboned samples than the intact fillet. There is no relationship between microbial numbers and TMA concentrations and apparently the disruption of the muscle cells is responsible for the higher levels.

Table 9. TMA content of intact and minced fish muscle held at 0°F.

	TMA content (μg TMA/g sample)				
Species	Intact fillet	Deboned fillet	Deboned fillet-skin	Deboned frame	Deboned whole
Pacific hake					
0 wk	9.2	13.9	15.9	19.7	16.9
12 wk	13.2	15.3	10.7	19.2	15.9
Ling cod					
0 wk	6.7	12.4	37.2	31.7	12.8
12 wk	-	-	-	-	-
Rockfish					
0 wk	4.8	13.0	12.0	14.3	9.9
12 wk	5.0	15.0	11.1	12.8	7.2
English sole					
0 wk	13.1	17.4	39.0	25.2	26.5
12 wk	13.9	22.1	30.2	29.2	23.0

Table 10. DMA content of intact and minced fish muscle held at 0°F.

Species	DMA content (μg DMA/g sample)				
	Intact fillet	Deboned fillet	Deboned fillet-skin	Deboned frame	Deboned whole
Pacific hake					
0 wk	7.3	16.7	31.7	73.9	40.8
12 wk	63.0	80.7	86.2	322.8	260.2
Ling cod					
0 wk	1.4	3.1	6.2	5.5	2.4
12 wk	-	-	-	-	-
Rockfish					
0 wk	1.5	3.1	1.9	2.6	1.4
12 wk	2.8	4.9	4.5	4.7	3.6
English sole					
0 wk	1.9	2.5	4.3	3.1	2.3
12 wk	2.1	3.4	3.9	5.7	3.4

The changes in DMA concentrations during frozen storage of Pacific hake is typical of all gadidae species. Although mechanical separation increases the initial level of DMA in the deboned samples of rockfish, English sole, and ling cod, the relative levels of DMA remain constant during frozen storage. This is an interesting finding, and unlike the gadidae species, monitoring DMA concentrations would not be useful as a quality index.

The formation of malonaldehyde (TBA No.) was very rapid in the deboned muscle samples (Table 11). Apparently, changes in lipids may be occurring during the mechanical separation of muscle from skin and bone. The lipids being pressed from the backbone may be more easily degraded resulting in the much lower acceptance scores for the deboned frame muscle.

Table 11. TBA no. of intact and minced fish muscle held at 0°F.

Species	TBA No. (mg malonaldehyde/kg sample)				
	Intact fillet	Deboned fillet	Deboned fillet-skin	Deboned frame	Deboned whole
Pacific hake					
0 wk	0.33	1.02	0.62	0.52	0.67
12 wk	0.95	1.19	1.29	1.14	1.70
Ling cod					
0 wk	0.79	0.35	1.13	1.61	0.88
12 wk	-	-	-	-	-
Rockfish					
0 wk	0.68	2.59	1.18	2.51	1.23
12 wk	1.35	2.01	(11.47)	(3.48)	(7.05)
English sole					
0 wk	0.83	0.93	1.50	2.10	1.44
12	0.62	1.14	1.33	3.66	1.77

It should be pointed out that the chemical values reported as "O" time are only relative. The number of fish required for sampling, preparation of samples, length of chemical tests, and setting up taste panels prevented the immediate analysis of the samples. In all cases, the time span from actual preparation to completed analysis was 5 days.

In summary, minced fish muscle is a valuable source of nutrient

Generally, deboned muscle from cleaned whole fish and especially the frames were lower in protein and higher in total lipid than the fillet muscle. Interestingly, overall desirability of minced muscle from fillets was lower than the intact fillet. This may be attributed to the textural changes as well as perhaps chemical changes caused by the physical disruption of the cellular integrity of the minced muscle. In the case of deboned muscle from frames, substance(s) pressed from the backbone appear to drastically alter the overall acceptance.

Developing methods to utilize this valuable resource in our diets poses a challenge and a rewarding experience for the fisheries industry.

IMPROVEMENT OF TEXTURE, TASTE AND SHELF-LIFE IN MINCED ATLANTIC CROAKER

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Introduction

Bullis and Carpenter (1968) reported that the production of trash fish (fish caught incidental to shrimping) is over 43,300 metric tons in the Gulf of Mexico. They also reported that in addition to the 1967 yield of 43,762 metric tons of "trash fish," an estimated additional 660,317 metric tons of trash fish were caught and discarded during Gulf shrimping operations. A recent survey has shown that the unutilized fish which are killed and discarded from shrimp vessels on the Texas coast of the Gulf of Mexico amounted to 265,143 metric tons per year (Moffet, 1967). Of these trash fish, Atlantic croaker (Micropogon undulatus) constituted 50 to 55 percent of the total catch by weight (Anderson, 1968; Haskell, 1961). The 1962 figures showed a record production of 29,053 metric tons of M. undulatus in the Gulf of Mexico (Roithmayr, 1965). A recent survey shows that this species is still estimated to be available in the Gulf of Mexico at the rate of 30 to 50 percent of the total catch taken at about a 10-fathom depth (Compton, 1969).

Large croaker find a ready market while smaller croaker are discarded or utilized for cat food. Several commercial operations utilizing deboners have recently attempted to market minced croaker. However, initial marketing trials indicate a low level of consumer acceptability (Davies et al., 1973). Minced croaker is rejected both for poor taste and texture. Increasing the acceptability of minced croaker depends upon improvement of its texture and development of products more palatable to consumers.

Polyphosphates have been commonly used for texturizing minced fish. Phosphates, in common with all inorganic salts, are toxic to any organism ingesting excess quantities of the salts. Excess ingestion of any organic salt may upset mineral balance in body nutrients (Ellinger, 1972)-e.g. excess phosphate prevents absorption of calcium. The widespread use of phosphates in the food industry has caused concern among nutritionists that calcium deficiencies may develop because of excess phosphate consumption, particularly in pregnant or lacting women and children. Supplementation of foods with calcium phosphate salts, in contrast to sodium phosphate salts, appears to control dental cavities (Ellinger, 1972) and presumably other calcium deficiency symptoms such as bone malformations. If calcium phosphate could be used to firm minced croaker texture, the nutritional value would be increased rather than decreased as is the case with sodium phosphate salts.

The purpose of this investigation was:

1. To determine suitability of croaker for use in minced fish or sausage-like products.

2. To increase the firmness and desirability of minced croaker flesh by the addition of sodium chloride, calcium hydrogen phosphate and egg albumin.

3. To improve the acceptability of sausage-like products from croaker by the addition of various combinations of vegetable oil and starch.

4. To create from minced croaker a product stable to oxidation.

EXPERIMENTAL SECTION

Materials

Atlantic croaker (*Micropogon undulatus*) 15 to 25 cm long were collected from boats during shrimp trawling operations in Galveston Bay and the Gulf of Mexico. The fish were caught by Trawl, packed in ice and eviscerated within an hour of catch. Fillets were removed from fish and ground or minced into small pieces. Ground fish was stored at -20°C until used.

Methods

Chemical Analyses

Protein determinations were based on Kjeldahl nitrogen content x 6.25 (AOAC, 1970) or the biuret procedure (AOAC, 1965). Moisture was determined by heating to a constant weight in a drying oven at 100°C (AOAC, 1970). Fat content was determined by the rapid, modified Babcock method (AOAC, 1970). Ash content was determined by ashing in a muffle furnace at 550°C (AOAC, 1970).

pH Measurements

pH measurements were made with a Beckman Zeromatic SS-3 pH meter. The electrodes were placed directly into the ground sample and the observed values were recorded to the nearest one-tenth unit.

Fractionation of Fish Protein

Hegarty's procedure (Hegarty et al., 1963) was used for fractionation of myofibrillar and sarcoplasmic proteins. Relative amounts of the fractions were measured by the Kjeldahl procedure.

Hydration Estimation

The method of Sato and Nakayama (1970) was used to measure hydration of croaker proteins. Ten grams of minced croaker were placed in a centrifuge tube, covered with a cap, heated in a boiling water bath for 30 min, cooled with water, centrifuged at 10,000 rpm for 15 min, and filtered through a glass filter. The filtrate was weighed and the ration of the filtrate weight to the minced croaker weight was designated as F%. Since the percent of the total moisture in the minced croaker was expressed as W%, the hydration of the croaker meat was designated as (W - F)/W x 100%.

Emulsifying Capacity Estimation

The procedure of Carpenter and Saffle (1964) was follwed except that Wesson vegetable oil containing Oil Red O dye (1000ml:0.4g) was added at a speed of 0.25 ml per second. As the emulsification proceeded, the color of the blending mixture changed from light pink to dark pink. The end point was determined by observation of the color change from homogeneous dark pink to half dark pink and half dark red (W. H. Marshall, unpublished data).

Textural Measurement

Partially frozen minced fish were blended in a Waring blender with different additives, molded into patties using a 9-cm petri dish as a form, wrapped in aluminum foil, and cooked in an oven at 170°C for 40 min. Textural measurements were made at room temperature and 80°C. A "Precision" penetrometer with round head and 150 g weight applied was used for textural measurements. The change in penetrability (Δ penetrability) was defined as:

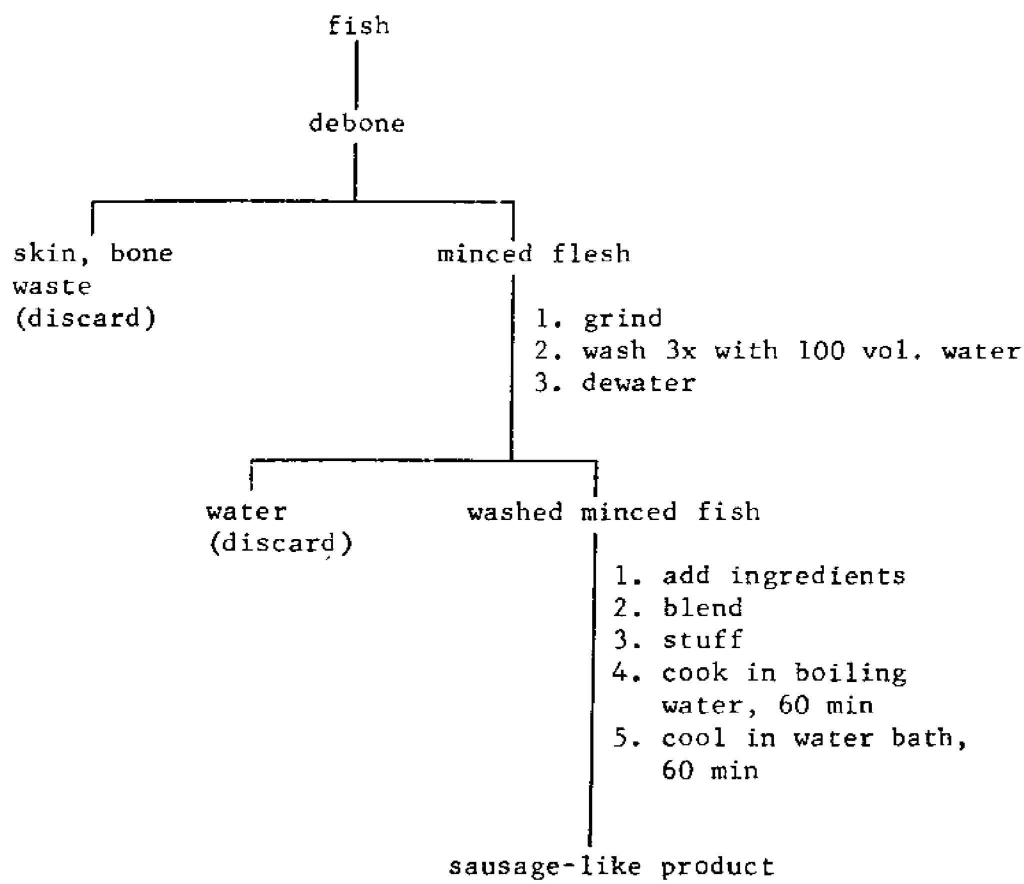
$$\Delta \text{ penetrability} = \text{penetration in control} - \text{penetration test sample}$$

Positive value of Δ penetrability indicated a firmer texture in test sample than in the control. A panel of trained judges was used to indicate differences in preference in texture.

Preparation of Sausage-like Product

Minced flesh was soaked in fresh water to remove blood and other undesirable materials. The bleached meat was dewatered by placing the washed flesh in a cotton cloth bag and pressing by hand. Spices, fat, additives and minced fish were blended in a Waring blender. The sausage emulsion was stuffed in cellophane casing and cooked in boiling water 60 min. Then the sausage was cooled by placing in a water bath at 10°C for 10 min. Figure 1 presents a flow chart of the process.

Figure 1.



Analysis of the Product

Organoleptic evaluation. A panel of five trained judges was used to indicate the difference of preference for the products. A three point hedonic scale (like, indifferent, or dislike) was used to indicate acceptability of the product.

Microbiological examination. Total aerobic and anaerobic count were carried out according to the "Recommended Methods for the Microbiological Examination of Foods" (APHA, 1969).

Oxidation of fat. Thiobarbituric acid (TBA) tests were performed on the product initially and at one week intervals during the refrigerated storage period to determine the extent of oxidation. The procedure of Wood and Hintz (1971) was used.

RESULTS AND DISCUSSION

Composition and pH

The composition and pH of the croaker muscle used in this investigation is listed in Table I. The protein to water ratios were low when compared with protein to water ratios calculated from protein-water data reported for other fish (Jocquot, 1961). The pH of croaker ranged from 6.67-7.00, values which should give fish jelly and presumably minced fish with good resiliency (Ikamura et al., 1959). Low protein to water ratios probably explain why minced croaker has a soft mushy texture.

Myofibrillar Protein

The distribution of nitrogenous components of minced croaker is shown in Table 2. The average distribution of nitrogenous components in croaker was: sarcoplasmic protein 22.4% (25.3% of total protein); myofibrillar protein, 59.1% (66.6% of total protein); connective tissue, 6.9% (7.8% of total protein); and non-protein nitrogen, 11.3%. Finch (1970) reported that sarcoplasmic proteins comprised 20 to 30% of the total protein in fish; the myofibrillar protein fraction, 65 to 75%; and stroma or connective tissue protein, to 10%. Non-protein nitrogen comprised 9 to 18% of total nitrogen in fish. The myofibrillar protein fraction in minced croaker in this study was lower than the average of fish, but higher than meat

Table 1 - Gross composition and pH of croaker muscle

Analysis	Batch			Average
	Batch I	Batch II	Batch III	
Protein[a b]	18.23	18.60	17.94	18.26
Fat[a]	1.71	0.60	0.83	1.05
Water[a]	79.37	80.31	80.23	79.97
Ash[a]	0.84	0.99	1.05	0.96
Protein/water	0.23	0.23	0.22	0.23
pH	6.67	7.00	6.80	6.82

[a]Expressed as percentage.

[b]Obtained by subtraction of non-protein nitrogen from total nitrogen.

Table 2 - Distribution of nitrogenous components in minced croaker muscle

Batch	Nitrogen-containing fraction (% of total N)			
	Sarcoplasmic	Fibrillar	NPN	Connective tissue
I	23.2	58.8	11.1	7.6
II	20.6	58.0	11.0	8.4
III	23.4	60.4	11.7	4.6
Average	22.4	59.1	11.3	6.9

muscle protein in which myofibrillar protein constituted 52-56% of total protein. It appears that at least 25% of the total protein would be lost during bleaching (washing with water).

Functional Properties of Minced Croaker

Hydration. Hydration (water holding capacity) of minced croaker is shown in Table 3. The average hydration of croaker used in this study was 67.8%. Table 4 lists hydration of other fish and animals. Fujumaki and Kurabayashi (1958) reported that the hydration of domestic animal meat decreased in the order: rabbit > ox > pig > chicken > horse muscle. Fujumaki and Nakajima (1958) also reported that the binding quality of sausage meat decreased in the order: rabbit > calf > pig > horse muscle. Hydration of croaker muscle protein was low for fish but higher than that of domestic animals.

Emulsifying capacity. Emulsifying capacity (emulsion stability) is one of the criteria for estimating the value of a meat as a potential sausage ingredient. The emulsifying capacity of the croaker muscle used is shown in Table 5. The average value of the emulsifying capacity of croaker in this study was 24.6 ml of oil emulsified per 100 mg of soluble protein.

Carpenter and Saffle (1964) reported the emulsifying capacity of various sausage meats ranged from 13.64 to 43.32. Although the emulsifying capacity of croaker was rather low when compared with other sausage meats, the hydration and salt soluble protein were considerably higher.

Table 3 - Hydration of minced croaker

Batch	Total moisture W(%)	Moisture liberated by heating[a] F(%)	Hydration (W-F)/W x 100%
I	79.4	24.0	69.8
II	80.3	28.0	65.1
III	80.2	25.4	68.4
Average	80.0	25.8	67.8

[a] 100°C, 30min.

Table 4 - Hydration of some fish and meats

meat	Hydration (%)
Fish[a]	
Skipjack	82.0
Spanish mackerel	81.0
Mullet	76.0
Carp	74.0
Dolphin	69.0
Beef[b]	55.7 - 70.5
Pork[b]	43.2 - 65.9
Veal[b]	51.0 - 53.2
Lamb[b]	47.9 - 49.1

[a] Del Valle, 1968

[b] Wierbicki, 1958

Table 5 - The emulsifying capacity of minced croaker

Batch	Grams of salt-soluble protein per 100g meat	ml of oil emulsified per 100mg of soluble protein
I	16.6	23.3
II	14.9	24.7
III	14.8	25.9
Average	15.4	24.6

Effect of Different Additives on Texture and Taste of Croaker

NaCl. Figure 2 shows the effect of NaCl on the firmness and taste panel score (texture) of minced croaker patties. Firmness of minced croaker patties was measured at different temperatures. The change in penetrability was more sensitive at higher temperatures. Firmness of croaker patties increased with increasing concentration of NaCl. The patty with 2% salt content was preferred for both taste and texture by the taste panel. When the use of NaCl exceeded 2%, the patties became too salty.

$CaHPO_4$. $CaHPO_4$ had a positive effect on the firmness of croaker patties (Fig. 3). The effect of $CaHPO_4$ on firmness was greater at 80°C than at room temperature. $CaHPO_4$ was not as effective as NaCl in improving the taste panel score. A flat taste was imparted if $CaHPO_4$ was used in quantities exceeding 3%.

Sugar. Figure 4 shows the effect of sugar on the firmness and taste of minced croaker. If the sugar content exceeded 2%, the patties were too sweet. Sugar slightly improved the texture.

Egg albumin. Figure 5 shows the influence of egg albumin on the firmness and taste panel score (texture) of croaker patties. The 2% level appeared to be optimum for addition of egg albumin. Egg albumin was more effective in improving the texture of croaker patties than other additives.

Starch. Figure 6 shows the effect of starch on the firmness of croaker patties. The addition of starch caused an initial decrease in firmness. Then firmness increased with increasing starch concentration, regaining the initial firmness at about

Figure 2

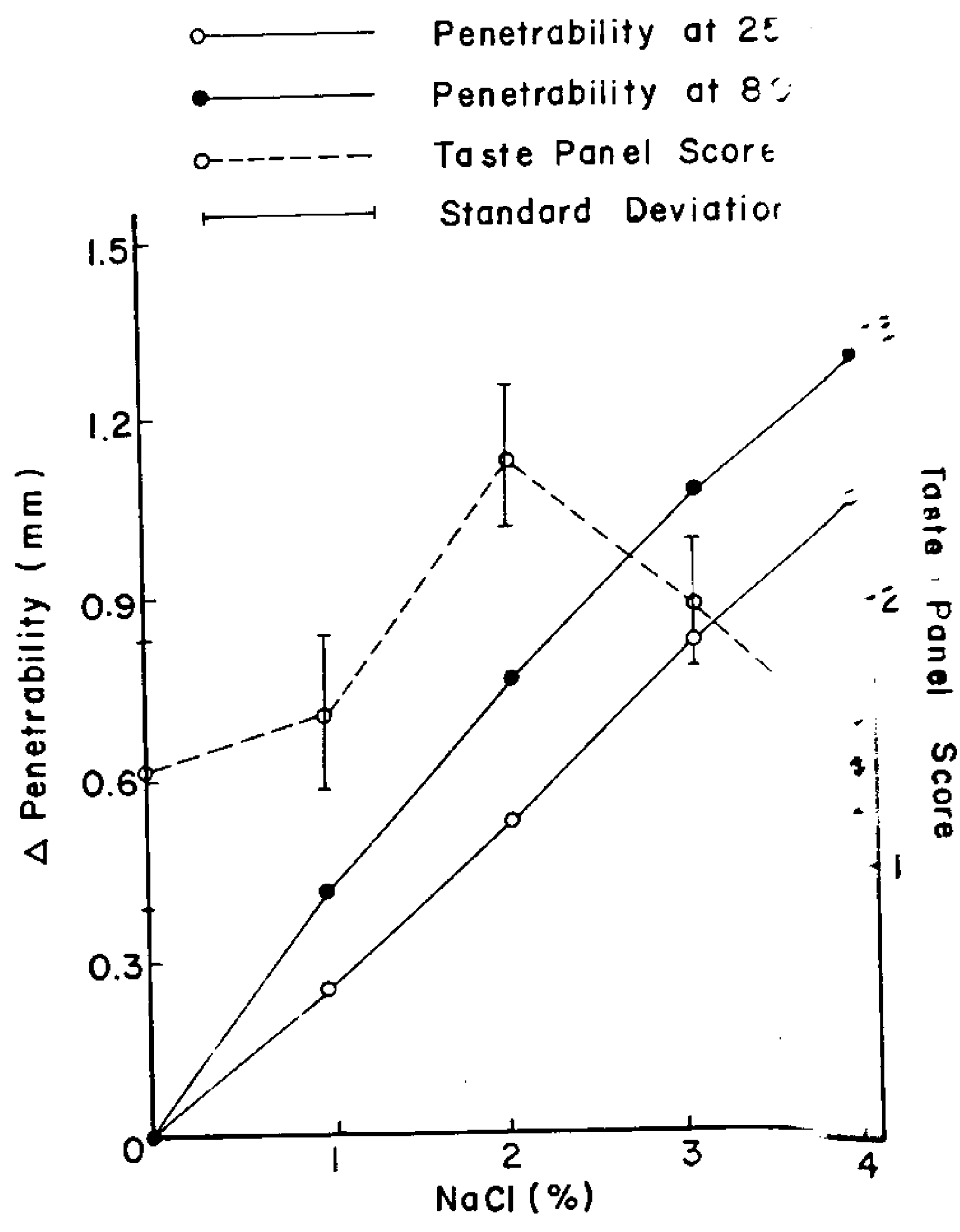

Penetrability at 25
Penetrability at 80
Taste Panel Score
Standard Deviation
1.5
1.2
0.9
0.6
0.3
0
Δ Penetrability (mm)
Taste Panel Score
1
2
3
4
NaCl (%)

Figure 3

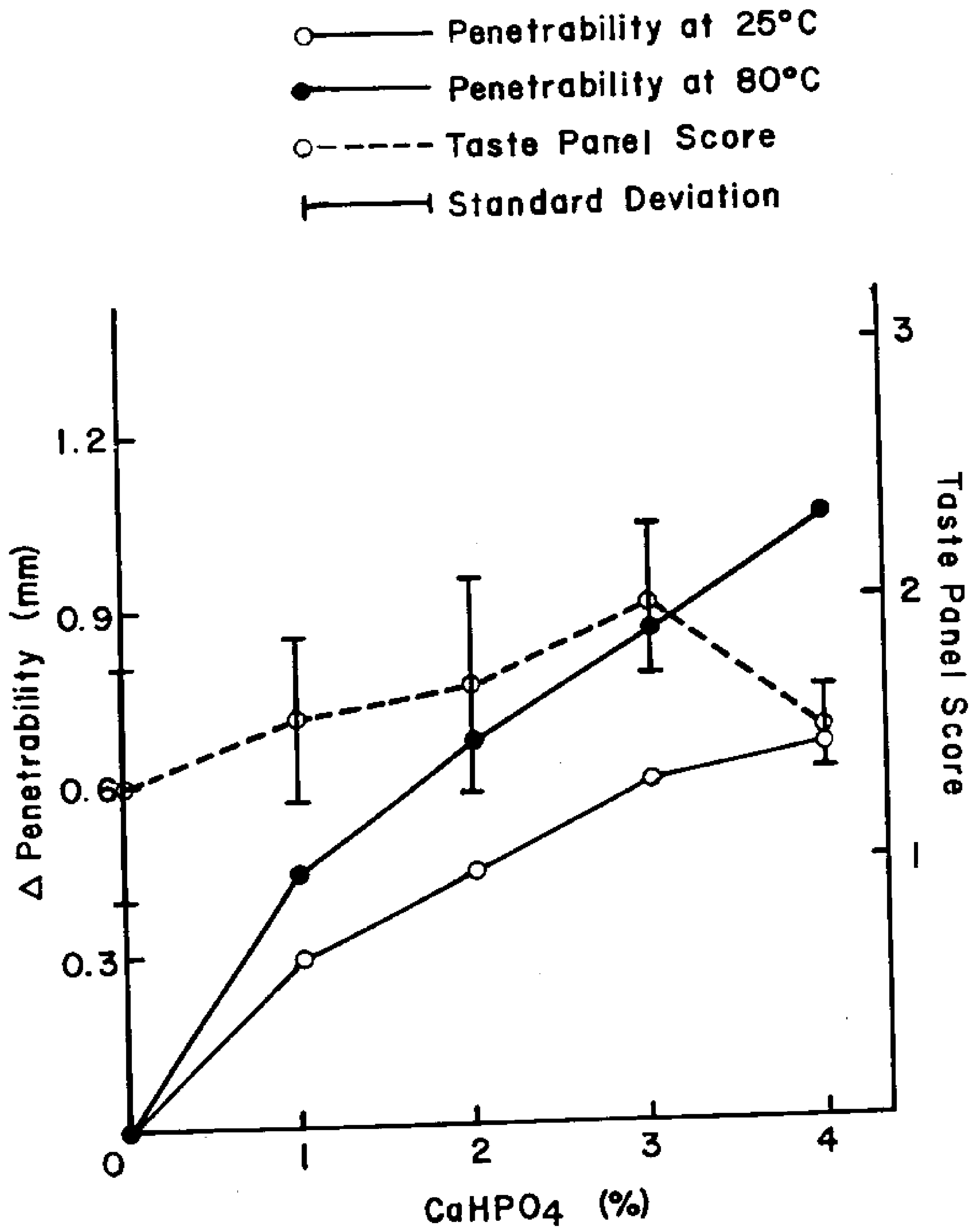

Penetrability at 25°C
Penetrability at 80°C
Taste Panel Score
Standard Deviation
Δ Penetrability (mm)
1.2
0.9
0.6
0.3
0
1
2
3
4
CaHPO4 (%)
Taste Panel Score
3
2
1

Figure 4

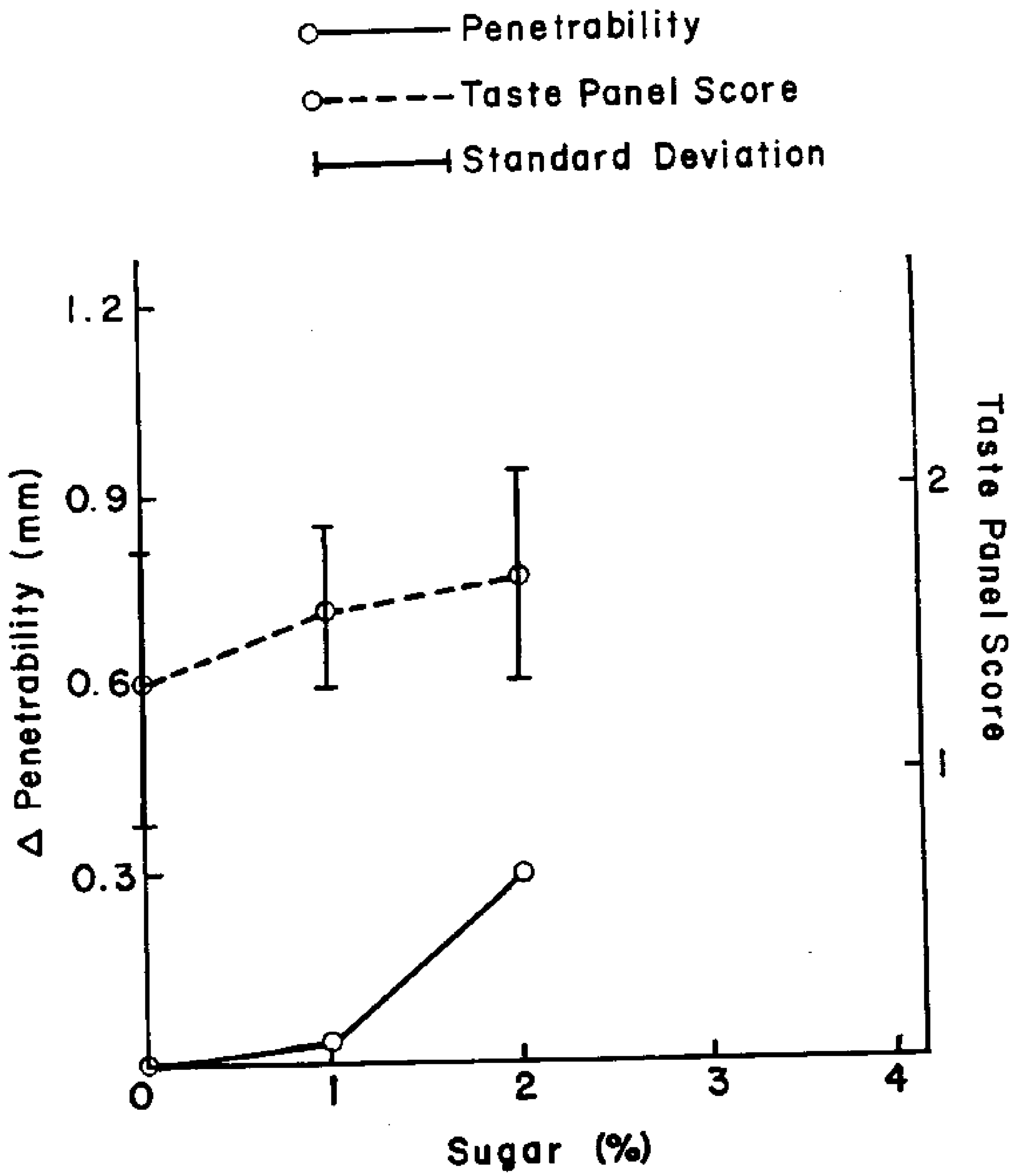

Penetrability
Taste Panel Score
Standard Deviation
1.2
0.9
0.6
0.3
Δ Penetrability (mm)
2
1
Taste Panel Score
0
1
2
3
4
Sugar (%)

Figure 5

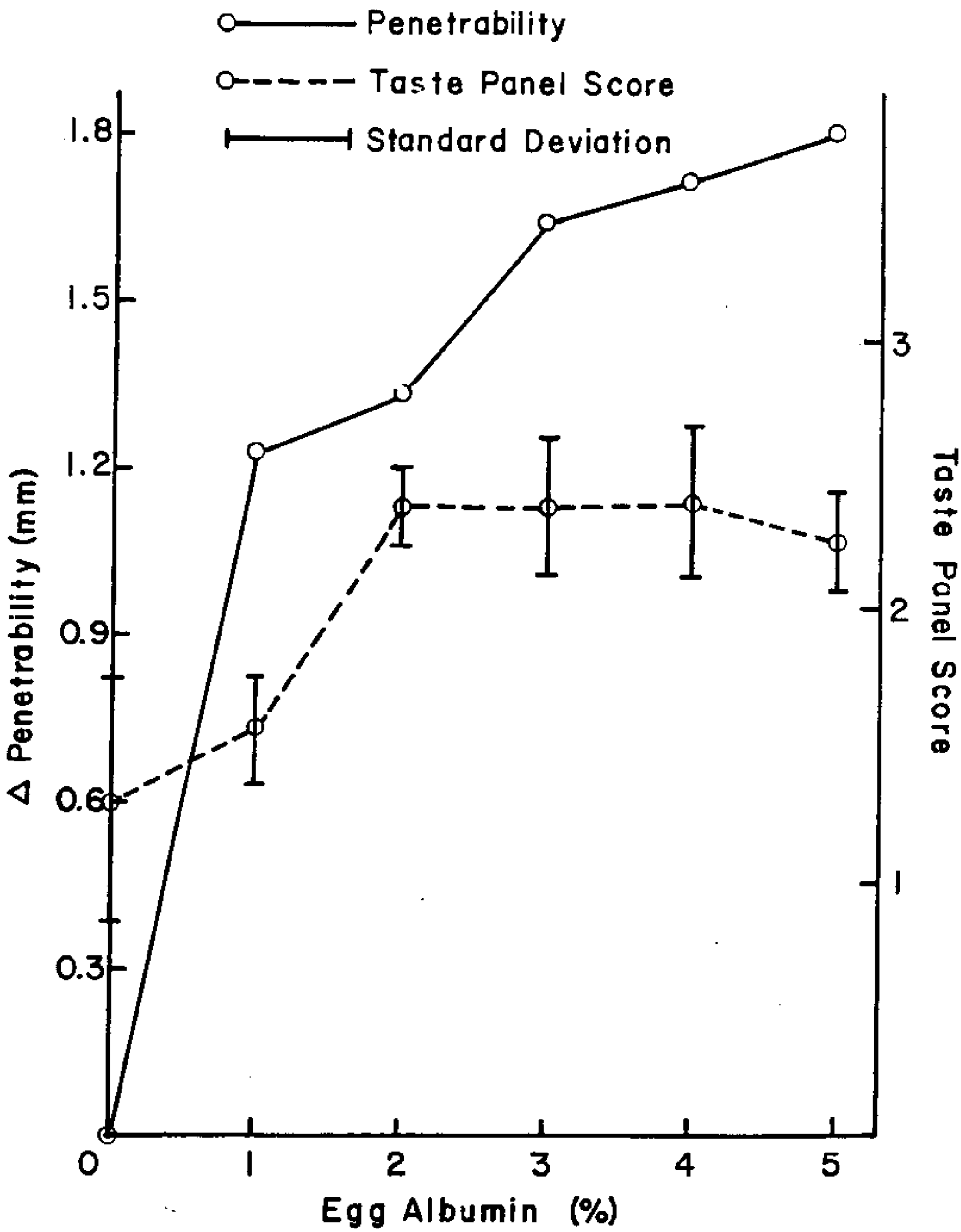
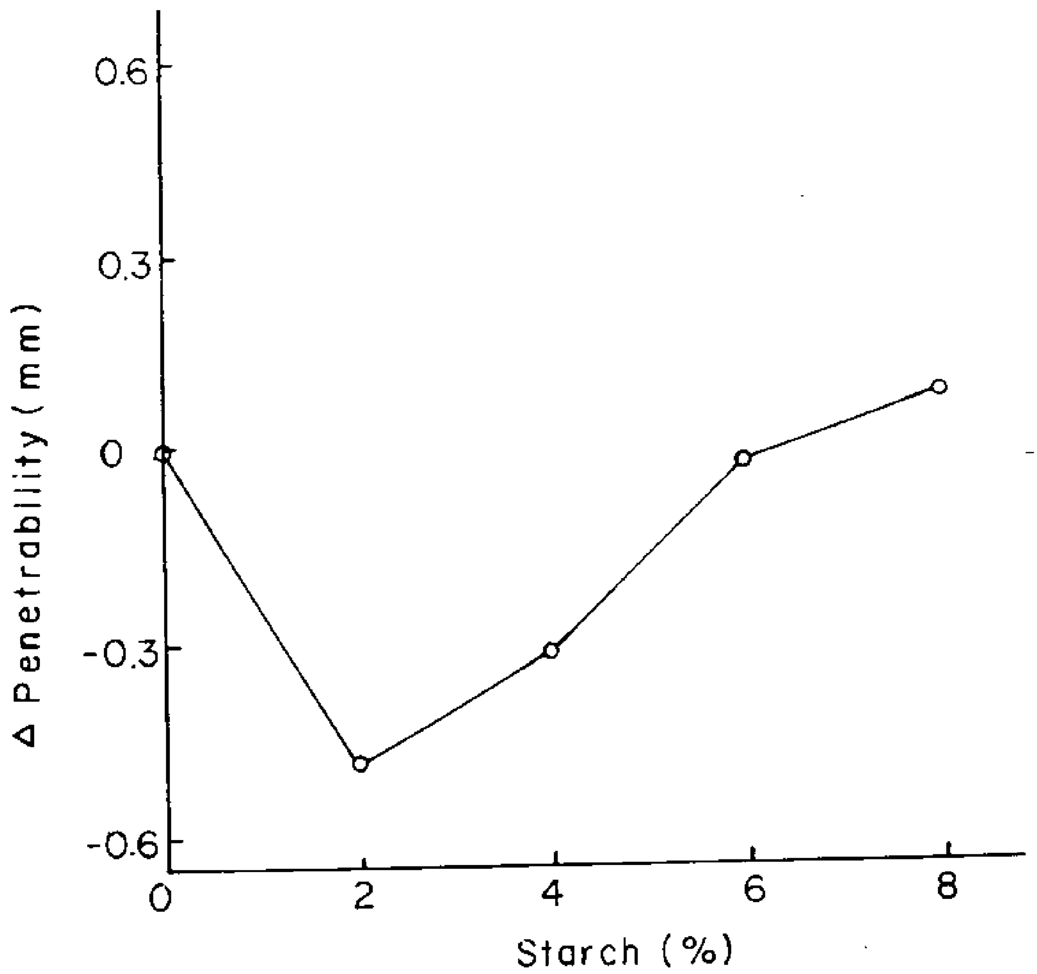

Penetrability
Taste Panel Score
Standard Deviation
1.8
1.5
1.2
0.9
0.6
0.3
Δ Penetrability (mm)
3
2
1
Taste Panel Score
0
1
2
3
4
5
Egg Albumin (%)

Figure 6



the 6% level. Starch may have a beneficial effect on bleached (water-washed) croaker by reducing the "rubbery" texture.

Combined Effect of Different Additives on Texture and Taste

Figure 7 shows the effect of different levels of $CaHPO_4$ on patties containing optimum effective levels of NaCl and NaCl plus egg albumin. Initial firmness of the patties differed with initial formulations as follows: 2% NaCl plus 2% egg albumin > 2% NaCl > control (no additive). Increasing concentration of $CaHPO_4$ caused increasing firmness in the control and sample with 2% NaCl. However, the effect was less pronounced in the sample treated with 2% NaCl, possibly because of an initial firmer texture. With 2% NaCl and 2% egg albumin in the patties, the addition of 1% $CaHPO_4$ caused an increase in firmness. Further addition did not cause an increase in firmness, and may have been slightly detrimental, possibly causing some softening of the patty.

Figure 8 shows the effect of different levels of egg albumin on patties containing optimum effective levels of NaCl and NaCl plus $CaHPO_4$. Initial firmness of the patties differed with initial formulations as follows: 2% NaCl plus 3% Ca HPO_4 > 2% NaCl > control (no additive). Increasing egg albumin concentrations caused increasing firmness in all of the samples. Egg albumin with 2% NaCl was more effective in increasing the firmness of patties than when no other additive was present, possibly because NaCl caused solubilization of myofibrillar protein. The addition of $CaHPO_4$ to the egg albumin-NaCl treated sample had little effect

Figure 7

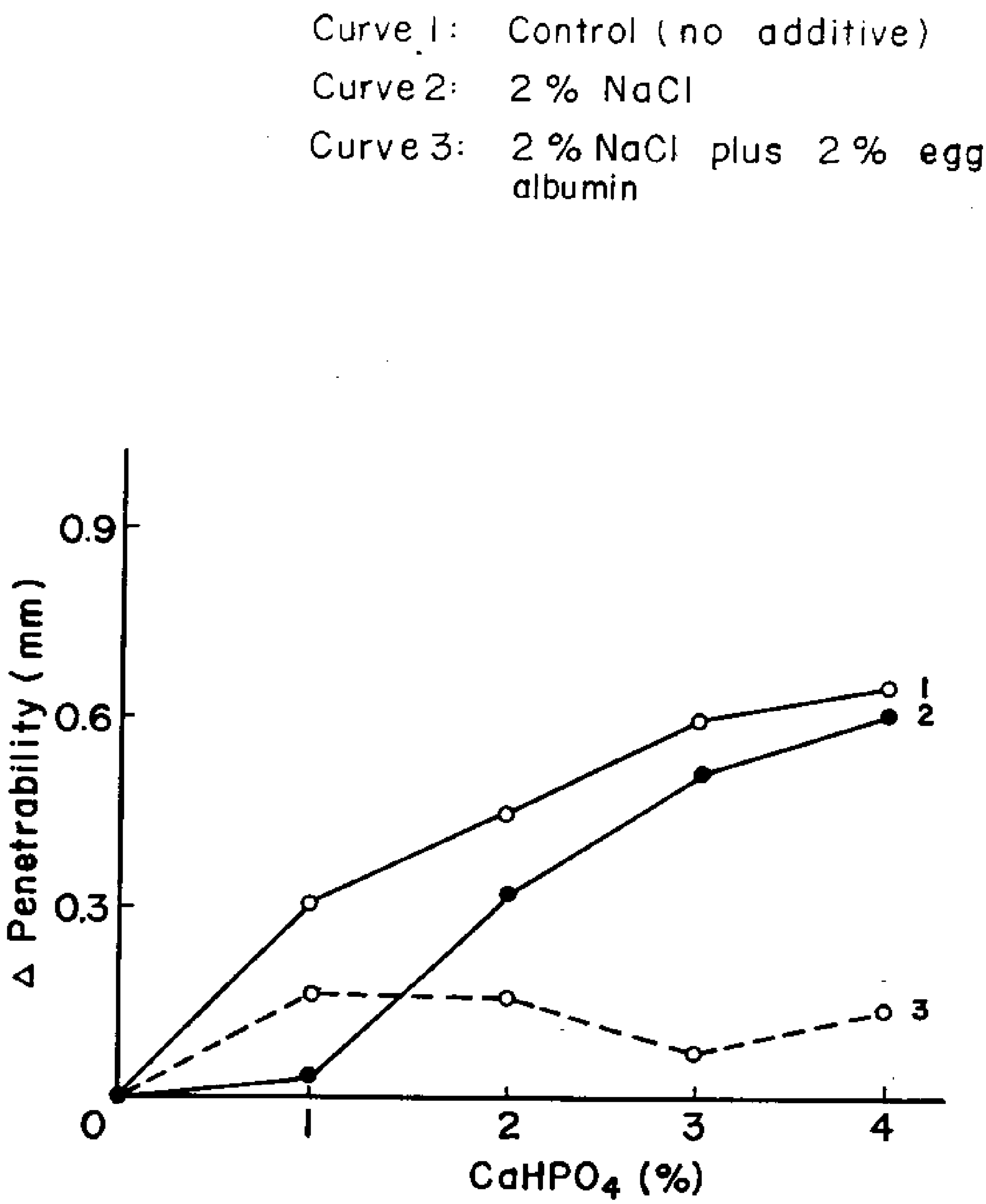
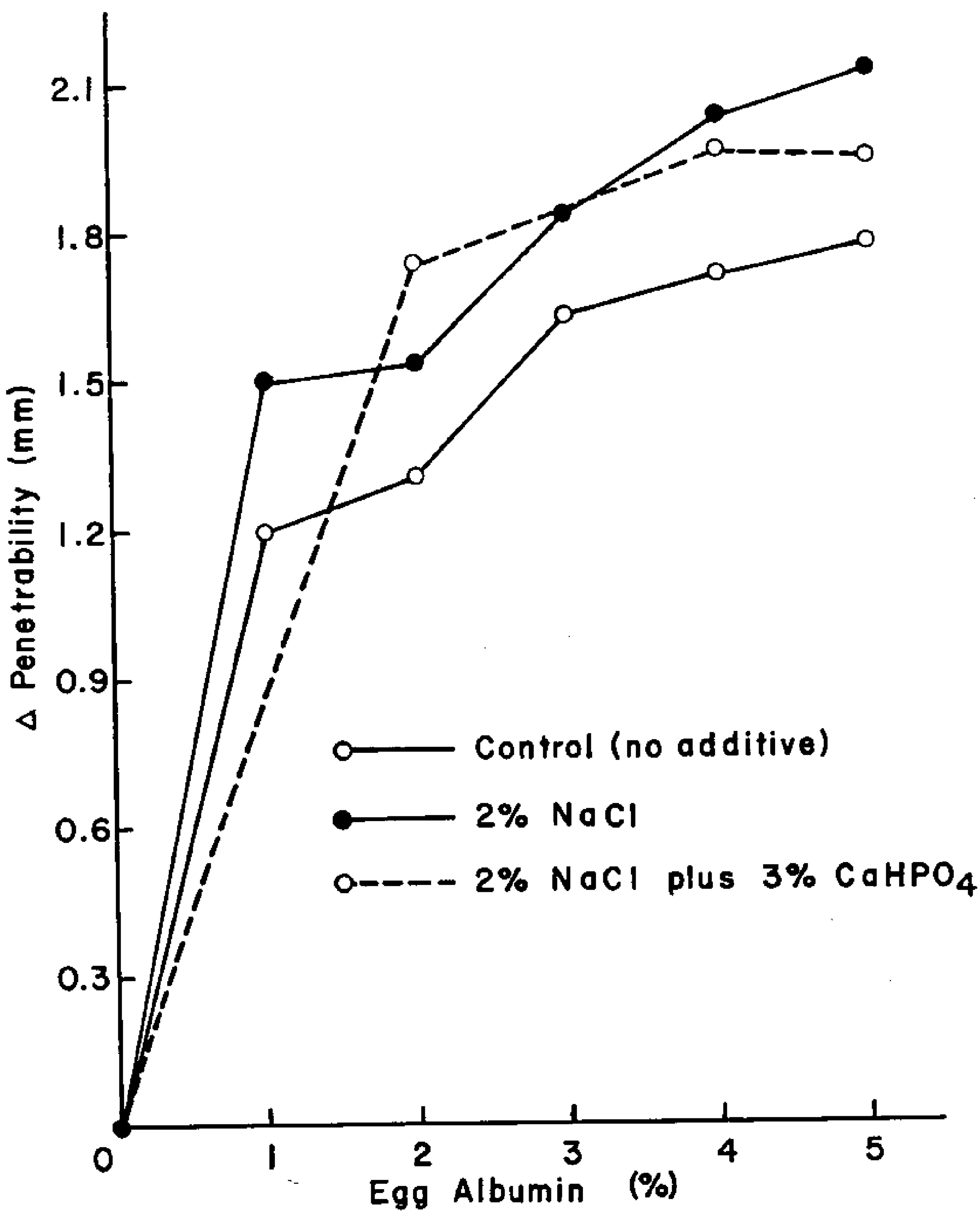

Curve 1: Control (no additive)
Curve 2: 2 % NaCl
Curve 3: 2 % NaCl plus 2 % egg albumin
0.9
0.6
0.3
Δ Penetrability (mm)
0
1
2
3
4
CaHPO4 (%)

Figure 8



2.1
1.8
1.5
1.2
0.9
0.6
0.3
Δ Penetrability (mm)
0
1
2
3
4
5
Egg Albumin (%)
Control (no additive)
2% NaCl
2% NaCl plus 3% CaHPO4

Only a certain level of firmness in croaker patties can be achieved with the use of salts, whether a single salt or a combination was used. The addition of egg albumin achieved an additional degree of firmness above that caused by the addition of salts.

Improvement of Taste

Preliminary taste panel results indicated that in order to obtain an acceptable taste the minced croaker had to be bleached and combined with other ingredients. Different combinations of oil and starch (Table 6) were used to prepare the sausage-like product. The product with 7% starch plus 10% oil was preferred by the taste panel (Table 6).

Analysis of the Product

Amano (1965) reported that the moisture content, pH value, starch content, and bacterial count should be examined in the quality control of fish sausage.

Chemical analyses. Table 7 lists the proximate composition of fish sausage formulation IV. Amano (1965) reported the average fish sausage contained 67-68% moisture, 14-15% protein, 5-6% fat, and 8-9% starch. The product in this study had a lower protein (13.6%) and higher moisture content (70.1%), probably due to incomplete removal of excess water (dewatering) during the bleaching process.

Microbiological examination. The initial microbiological quality of sausage-like products was analyzed and shown in Table 8.

Table 6 - Effect of different combinations of oil and starch on taste preference sausage-like products

	Formula (g)			
Item	I	II	III	IV
Ingredient				
Starch	5	5	7	7
Oil	7	10	7	10
Minced fish	100	100	100	100
NaCl	2	2	2	2
$CaHPO_4$	3	3	3	3
Sugar	2	2	2	2
Egg albumin	2	2	2	2
Seasoning	0.3	0.3	0.3	0.3
Liquid smoke	1	1	1	1
Rank by judge	1	2	3	4

Table 7 - Proximate analysis of sausage-like product IV

Analysis	%
Protein	13.6
Fat	7.5
Moisture	70.1
Ash	3.8
Starch	5.0
pH	7.1

Table 8 - Initial microbial quality of sausage-like products

	Agar plate count per gram of product	
Lot	Aerobic	Anaerobic
A	1.5×10^4	3.0×10^3
B	1.6×10^4	1.0×10^3
C	1.2×10^4	1.6×10^3
Average	1.4×10^4	1.9×10^3

The aerobic counts per gram varied from 1.2 - 1.6 x 10^4. The anaerobic counts per gram ranged from 1.0 - 3.0 x 10^3.

<u>Organoleptic</u> <u>evaluation</u>. Four of the five members of the taste panel considered sausage formulation IV (Table 6) acceptable for texture and taste; one taste panel member gave an indifferent score. The sausage was judged as being too moist by 3 of the 5 members of the panel. Complete dewatering during the bleaching process would undoubtedly improve the product.

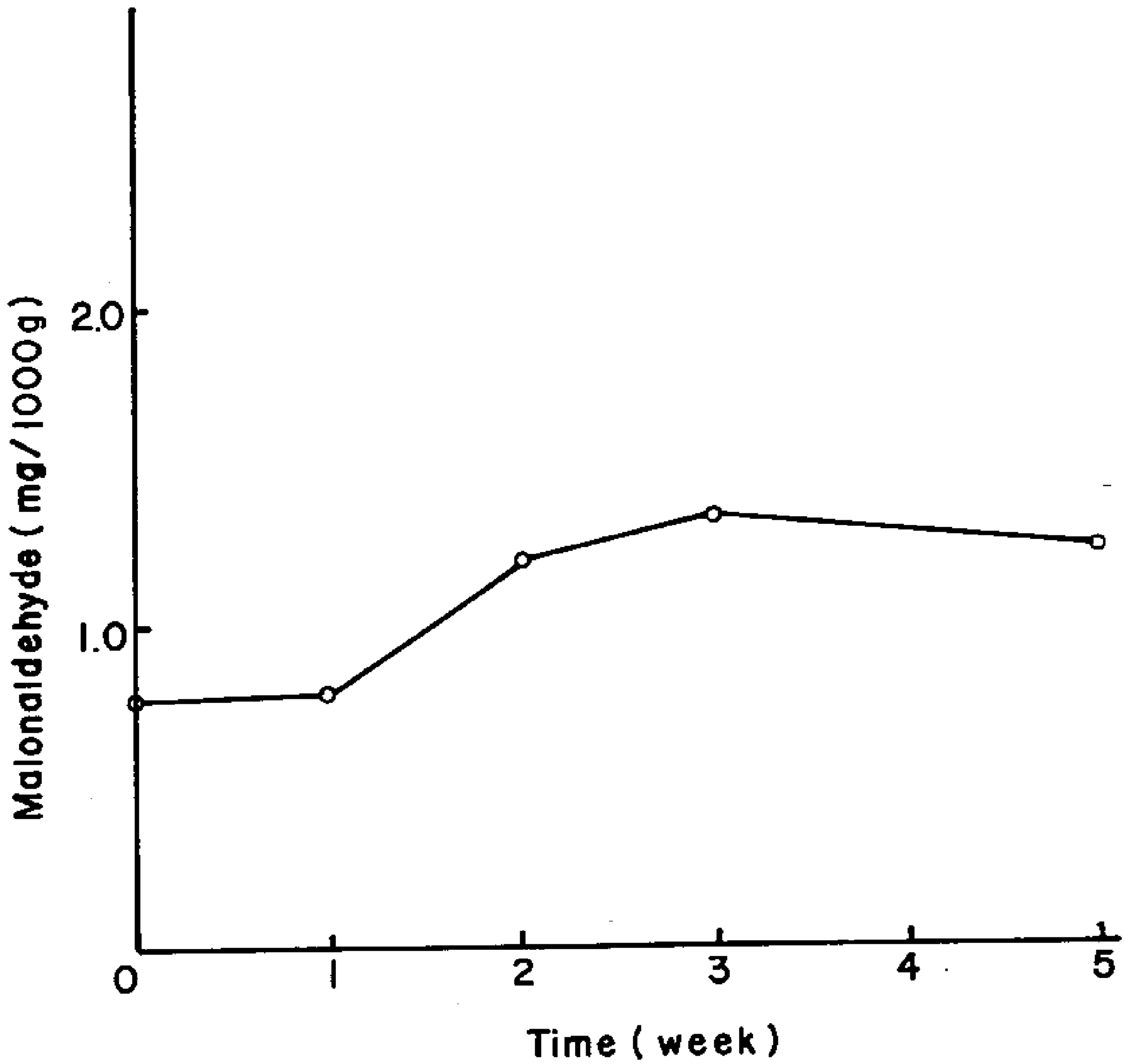
<u>Liquid Oxidation</u>

Sinnhuber and Yu (1958) reported that rancidity can be expressed in milligrams of malonaldehyde per 1000 g of sample (TBA number). They reported that canned and frozen fish of good quality gave calculated TBA numbers of less than 3 while products of poorer quality gave TBA numbers from 4 to 27.

The development of rancidity in sausage formulation IV during refrigerated storage is shown in Figure 9. In the first week, there was no measurable change in TBA number. During the second week, the TBA number increased slightly. After the second week, there appeared to be little further oxidation of the product. The product after 5 weeks storage at 3-5°C still had an acceptable odor and TBA number.

Minced croaker had an initial low oil content. Part of the oil, fishy taste and odor in croaker were removed during the bleaching process. In preparation of the sausage-like product, vegetable oil was used. Vegetable oil usually contains some

Figure 9



natural antioxidants (Lovern, 1966). Liquid smoke used in the formulation for taste effects also has antioxidant activity. The combined effect of bleaching, vegetable oil, and liquid smoke undoubtedly contributed to the storage stability of the product.

SUMMARY

Minced croaker muscle had low protein to water ratios which contributed a soft and watery (mushy) texture. Myofibrillar protein content and hydration of minced croaker, which are tentatively related to the binding quality, were low for fish but higher than that of meat muscle. Emulsifying capacity, one of the criteria for estimating the value of a meat as a potential sausage ingredient, was rather low in minced croaker when compared with other meats. Minced croaker appeared to have potential as an ingredient for sausage-like products (fish patties, fish sausages, etc.).

Addition of sodium chloride firmed the texture of minced croaker. Sodium chloride content was limited on the basis of taste to 2% or less. In order to avoid excess saltiness and possibly future conflicts over the use of phosphates, $CaHPO_4$ was added to increase the firmness in minced croaker. A flat taste was imparted if $CaHPO_4$ was used in quantities exceeding 3%. Increasing concentrations of $CaHPO_4$ had little effect in samples treated with 2% NaCl plus 2% egg albumin. Sucrose slightly increased firmness. Egg albumin and egg albumin plus 2% NaCl was very effective in improving the firmness of minced croaker. Addition of starch had a negative effect on firmness if the starch content was less than 6%. Only a certain level

of firmness in croaker patties could be achieved with the use of salts, whether a single salt or a combination was used. The addition of egg albumin achieved an additional degree of firmness caused by the addition of salts.

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STABILITY OF MINCED FISH

AN IMPORTANT FACTOR IN STANDARDS FORMULATION

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Minced fish today are becoming an important factor in increasing the efficiency of utilization of food fish in our Canadian fishery landings and in getting underutilized species into food use as a primary protein source of high nutritional value. Manufacturing processes are relatively simple for production of the primary product which is mainly frozen minced fish blocks, but the secondary production of formulated retail products still requires a considerable amount of development and imagination. A big advance in fishery products was the development of the intermediary semi-stable product, the "minced fish block," which can be stored, transported, etc., allowing flexibility of time and place for the final processing into a variety of retail consumer products either at the original processing plant or at the plant of a marketing organization.

Let's remember we are making a convenience fishery product in direct competition with meat, chicken and textured vegetable protein products and that the consumer is going to expect quality. This was recently stressed by R. J. Gruber in speaking to the Fisheries Council of Canada's Annual Convention, where he said, "The key will be quality." Let's avoid the questionable period where "anything goes." And where finally we have to face up to the fact that there is a minimum acceptable quality level.

In discussing standards for minced fish blocks, therefore, I feel that quality is all important. By this I mean not only the use of good initial quality fish processed on sanitary equipment in a sanitary plant, but also maintenance of this good initial quality through the storage and secondary manufacturing process right to the final product. In standards formulation, therefore, besides color, and other physical defects, etc., we must consider the potential stability of the minced fish product during manufacturing and distribution, a factor at least as important as the initial appearance. Unless we do this we cannot assure an acceptable quality in the final retail product. We must also consider products from fatty and darker colored meat as well as the white fleshed lean species. How do we control the stability? Perhaps, our greatest challenge is how to use the less stable meat from certain species.

What Are the Stability Factors Involved?

The most obvious is rancidity. The mincing process mixes fatty layers into the flesh and also results in exposure of the particles to air incorporated in the mixing process. Thus, the fat level in the product are important and use of antioxidants in some products is indicated.

Secondly, in species with darker meat, the presence of hemoglobin and myoglobin pigments capable of catalyzing various oxidative reactions present another source of difficulty. Even in the white fleshed species, in complete removal of blood leads to the same problems. Thus, it has been suggested that fish for mincing should be properly bled. In other cases, efforts are being made to remove the backbone followed by thorough washing, to remove the kidney and other tissue often containing blood as well as the main blood vessels running along the backbone, which are frequent sources of blood discoloration. Development of machinery for this purpose to handle the various sizes of fish is needed for handling many underutilized species.

Thirdly, in the present situation, the large amount of gadoid species now used means that by far the biggest problem with stability in frozen storage of minced fish is the reaction leading to formation of DMA. Various authors have found that trimethylamine oxide is converted, probably enzymically, into dimethylamine (DMA) and formaldehyde. This occurs in Japanese Alaska pollock (Tokunaga, 1964, Amano et. al. 1965). Castell (1971) found this reaction in frozen fillets of hake, cusk, pollock and cod in decreasing order of activity. It has also been found in Pacific hakes (Babbitt et. al., 1972) and just recently in our laboratory in whiting (Merlucius bilinearis) (silver hake). Just the formation of DMA doesn't mean much, but in our laboratory we have found that the formaldehyde which is also formed in equimolar amounts results in a binding of the protein, a polymerization, resulting in coagulation and decrease of WHC and texture deterioration (Castell et al., 1973).

If the temperature of frozen storage is -25 to -30°F this reaction is very slow and there is no problem. But in practice, we all know that warming occurs during transportation and then these reactions occur very rapidly in these species. For years we have also known that hake muscle (Urophycis sp) is a poor fish for freezing for this same reason. Tests show just a few days at temperatures between 15 and 25°F is sufficient to completely insolubilize the protein. Many of you are aware that Japanese pollock blocks give trouble in this regard unless they are handled well and not stored too long. Perhaps, you will agree that cod and haddock are sufficiently more stable to justify a higher price. We find that the enzyme causing this deterioration is almost completely absent in the flesh of cod and haddock, and in the minced flesh from their v-cuts, or fillets. But when we prepared minced fish from washed cod frames, we found poor stability.

At 23°F, the AM protein fraction had decreased to zero in 3 days whereas in a minced fillet sample it had just started to decrease after 10 days. At 0°F, not an uncommon storage temperature in the industry, the minced sample from the frames had lost 1/3 of its soluble protein within 4 days, although there was no change at -40°F even after several months. So you see that the problem is serious. We went further and found that if we removed the backbone along with the kidney tissue adhering, followed by washing, prior to deboning, that the problem was largely removed.

It was found that the enzyme could also be removed by thorough washing of the minced flesh, followed by dewatering, but it appeared that preventing the enzyme from getting into the muscle in the first place was the better solution. It seems that in cod and probably other gadoids, that a potent source of the enzyme is in the tissues around the backbone and that when these are removed, better stability results. Of course, with hake, the enzyme occurs also in the red muscle and thus is not as easily removed. Obviously then, we have to consider hake and related species as much more unstable than cod and haddock. Tests showed that the problem was not present with flounder or sole.

My thesis is, therefore, that the potential stability of minced product is one of the main considerations in formulating product standards. Our aim should be to provide the secondary manufacturer with the pertinent quality information so that he can match the quality of his input to a suitable type and quality of final product. I suggest rather than concentrate on species identity that it is knowledge of the inherent stability of the product that would be of primary interest.

Also of interest here is the texture of the minced product. From the belt and drum type of machine we usually obtain a coarse raw material retaining a considerable amount of the original texture, while other machines yield a paste with very little texture with different product end-uses.

Thus, we have several possible grades depending on the form of the material fed into the deboning machines and the type of equipment we select.

1. Minced flesh from fillet trimmings (V-cuts) not including skin (i.e., cod).

2. Minced flesh from selected portions of frames (headed, gutted and filleted fish) i.e., with backbone removed, and possibly skin and blacknape.

3. Minced flesh from headed and gutted fish (not filleted) with backbone removed.

4. Minced flesh from headed and gutted fish (not filleted) with backbone not removed.

5. Minced flesh from invertebrates with viscera removed.

6. Minced flesh from very small fish or invertebrates - whole.

7. Minced flesh for preparation of stable, salted and otherwise processed products.

When we consider grouping of species for mixed minced fish, the constraints of species stability, as well as color desirability and taste or appearance, will vary with the final consumer product being made. This of course, is in addition to manufacturing defects, amount of bone, pieces of skin, parasites, etc.

1. Single species - These include the desirable, higher priced species of fish, shellfish and crustacea which would normally be marketed as single species (or used for flavoring white fleshed fish products).

2. Mixed species - When we come to mixed species, obviously those with shorter storage lives such as the hakes, should not be mixed with cod, and similarly, the fatty species and those with dark flesh will have to be considered separately for most products. The following classes are suggested:

   a. Mixed species - white minced fish (cod, haddock, pickerel, cusk, catfish).

   b. Mixed species - hake (*Urophycis* sp.) and *Merluccius* sp. also pollock and Alaska pollock, with or without admixtures of smaller quantities of other white fleshed fish species (white and light colored).

c. Mixed species - fatty fish - pelagic, including herring, mackerel, capelin, carp, gaspereaus, etc. usually with considerable dark flesh.

To some extent the quality will vary with the group, and will also depend on the processing technique of the primary product, as referred above.

For mixed fish, we end up with four groups, the first two, white in color, but with the hake and pollock groups having a poorer shelf life in frozen storage. The third group, redfish, flounders, and whitefish may be white but again having a shorter storage life because of the presence of some fat. The fourth group includes the fatty species usually with dark muscle and which will probably end up in quite a different type of consumer product, likely in precooked products. This group needs a great deal more development work. Flesh from the first three groups can be used in existing products, i.e., fish sticks, portions, fish burgers, fish cakes, just as fillet blocks are now used.

Besides these four groups, we also have the single species products which include highly flavored fish or shellfish such as crab, lobster, oysters, salmon, etc. We must also allow for the use of protein extenders such as soy protein isolates, concentrates, etc., but this will mainly be a consideration with secondary products. Additives such as polyphosphates to control water binding capacity, and antioxidants will hopefully be used to improve stability characteristics.

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IDENTIFICATION AND QUANTITATION OF SPECIES IN MINCED FISH BLOCKS BY RADIOIMMUNE ASSAY

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We believe it is possible to identify quantitatively various species in a minced block of fish by applying a radio-immune assay method. In this technique the antibody to a fish protein, e.g., cod, may be chemically bonded to a solid support like a paper disk. When this paper disk with the attached antibody is brought in contact with an extract of a mixture of different species, the cod protein in the extract will complex with the antibody on the disk. Now if the disk is incubated with cod protein labeled with I^{125}, the radioactive cod protein will complex with the remaining uncomplexed cod antibody sites on the disk. Radioactivity on the disk could then be correlated with the concentration of cod protein in the extract, then other variations could be applied. For example, instead of incubating with radioactive cod protein it could be incubated with radioactive cod antibody. In this case, the radioactive cod antibody would complex with the cod protein which is complexed with the cod antibody bound to the paper disk, (Fig. 1).

An example of the sensitivity of this test is shown in Fig. 2. Here a correlation of radioactivity with cod protein is shown. It can be seen that cod protein can be detected as low as .001 mg/ml.

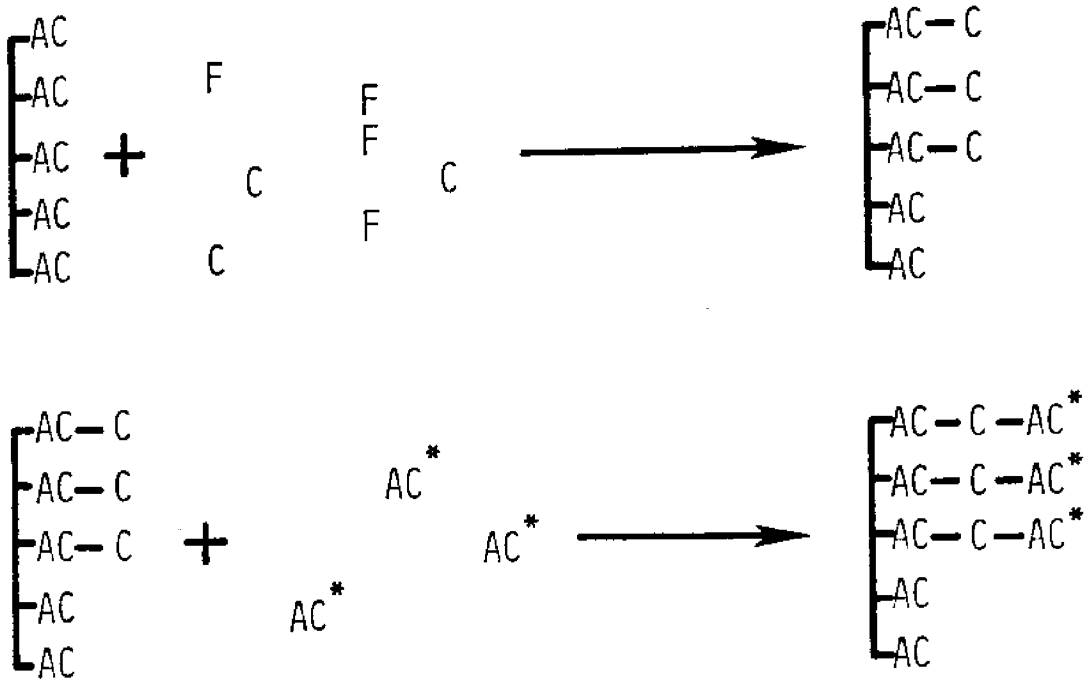


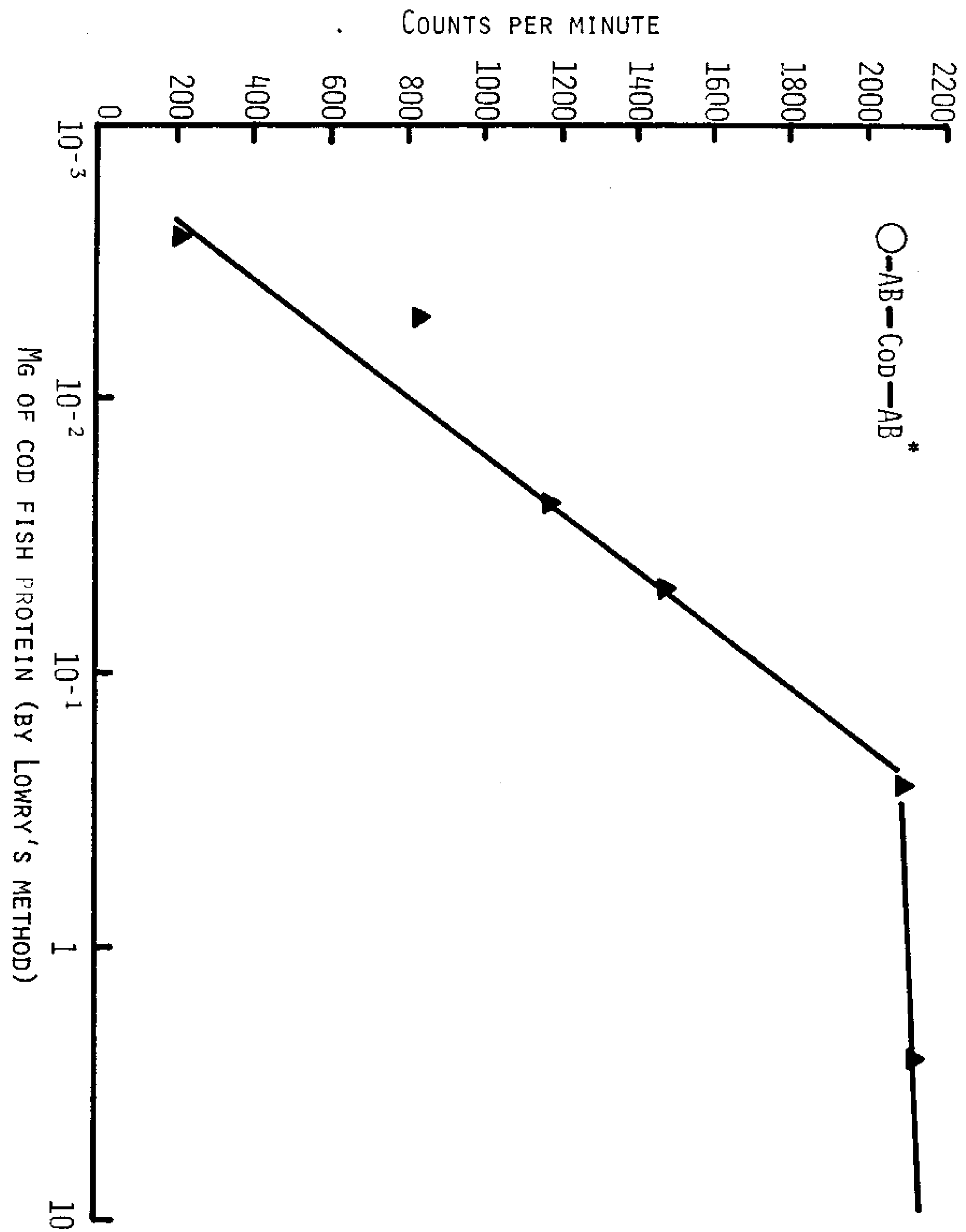
FIG. 1. ILLUSTRATION OF "SANDWICH" RADIOIMMUNE ASSAY

AC = COD ANTIBODY

C = COD PROTEIN

F = FLOUNDER PROTEIN

AC* = COD ANTIBODY LABELED WITH I^{125}



COUNTS PER MINUTE
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
○-AB—COD—AB*
10^{-3}
10^{-2}
10^{-1}
1
10
MG OF COD FISH PROTEIN (BY LOWRY'S METHOD)

From Table 1 it can be seen that cod protein can be detected quantitatively in the presence of haddock.

Table 1. Detection of Cod Protein in the Presence of Haddock using "Sandwich" Test.

% Cod	% Haddock	Counts per Minute
Negative Control	-----	706
100	0	2171
50	50	965

One complicating factor is that the antibodies of certain species may cross react, e.g., cod antibody may react with haddock protein to some extent. This problem could be overcome by absorbing the haddock reacting components in cod antibody with haddock protein immobilized on a solid support before using it.

Our preliminary studies look promising and our laboratory is now developing antibodies to various fish species in order to design a simple, practical test for identifying and quantitating the species that may compose a minced block.

APPLICATION OF BONE SEPARATION TECHNIQUES
TO PELAGIC AND UNDERUTILIZED SPECIES
AND THE PREPARATION OF DERIVED PRODUCTS

J. N. Keay and R. Hardy
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THE RESOURCE

The fish species which are to be considered in this paper fall into two main categories as far as British fisheries are concerned. A similar, although not identical, situation presumably exists in North America. These categories are:

1) Fatty fish, mainly pelagic species, i.e., herring, mackerel, sprat, pilchard and sand eel.

2) Low fat content fish both pelagic and demersal, e.g., blue whiting, Norway pout, Argentina silus, scabbard, grenadier, etc.

In addition to the relevance, this classification has for the marine resource scientist the different fat contents of the two categories is an important factor in the method of approach adopted by the food technologist towards their utilization.

It is important to note that neither of the categories includes the much prized gadoid species cod and haddock or even the less popular saithe, traditional species of the British middle and distant water fisheries. A brief consideration of possible changes in Coastal State Jurisdiction will reveal the significance of this.

The annual catch of demersal species by British fisheries in the middle and distant waters during the period 1971-73 averaged 680,000 tons. As a consequence of an extension of Coastal State Jurisdiction in the North East Atlantic area it could be that Britain was denied access to a high proportion of these large catches of highly prized species. On the other hand, in the near water areas off our coast where the whole of the British pelagic and shellfish catch and a portion of the demersal catch are taken the possible exclusion of non-EEC countries could greatly reduce pressure with beneficial effects for British fishing. However, as indicated by the data in Table 1, the result of these changes would be a markedly changed pattern of fish species available on the British market including greater quantities of pelagic fish and smaller quantities of demersal ones. This situation indicates a need to examine the possibilities for greater utilization and upgrading of the pelagic fatty fish catch and for substitution with presently underutilized species of white fish. A quick look at some world figures (Table 2) indicates that a concern for greater utilization of pelagic species is relevant on this scale also. The larger portion by far of the world catch of pelagic species is consigned to fish meal and this may in the future come to be regarded as prodigal.

What has just been described is the rationale underlying some of our technological work which will now be dealt with in relation to the two categories mentioned earlier.

TABLE 1

(From Sea Fisheries Statistical Tables, MAFF, London)

UK catch statistics in recent years

	1971 (tons x 1000)	1972	1973	Future*
DEMERSAL	750	650	650	305
PELAGIC	100	215	269	669

*Assuming Britain obtains 50% of catch in EEC waters that is at present taken by non-EEC countries

TABLE 2

(From FAO yearbook of Fisheries Statistics 1972 No 34)

World Fish Catch

	1971	1972	
cod, hake, haddock etc	10 681	11 472	(tons x 1000)
herring, sardine, anchovy	19 431	13 538	(tons x 1000)
mackerel, snoeks, cutlassfishes	3 247	3 131	(tons x 1000)

FATTY FISH

It will first of all be useful to identify and list the main problems associated with the utilization of these species.

1) Size of the fish.

2) Fat content.

3) 'Poisoning from histamine or analogues particularly in the scombroid species.

4) Bones.

1) The size of the fish especially the smallest ones, renders machine handling essential, at least in the Western world. With the equipment that has been developed so far, the throughput in terms of numbers of fish is high but in terms of weight it is low.

2) The highly unsaturated lipids usually closely associated with powerful heam catalysts give rise to severe problems of oxidative rancidity.

3) This problem of poisoning remains somewhat intractable but is almost certainly at the root of strong prejudices against the scombroids most notably mackerel. Chemical investigations in our laboratory indicate that even in grossly spoiled mackerel, the histamine content is too low to be associated with any toxic effects. On the other hand, some of the highest histamine levels we have recorded have been in spoiled herring although this clupeid is not normally connected in the public's mind with poisoning.

4) This prosaic but perhaps most important problem of bones results in much nutritious fish being excluded from the range of foods acceptable to many consumers.

The traditional solution to almost all of these problems is to can the fish; fatty fish is, of course, the raw material <u>par excellence</u> of the fish cannery. Perhaps for the future the sterile flexible pack will claim a portion of the fatty fish catch as raw material. But canned, or otherwise thermally processed fish, is unlikely to provide an acceptable single outlet for a greatly increased pelagic catch.

With the availability of bone separators/flesh-stripping machines, an alternative method of utilization has become available. With a minimum of handling (heading and eviscerating, possibly splitting) the fish can be processed to provide high yields of edible, relatively bone-free flesh. Moreover, since the particle size (i.e., the "flake" size) in fatty fish is generally small compared with that in the demersal species, there is a much less pronounced textural contrast between the comminuted and the whole flesh product. A further important advantage of this method of processing is that it is capable of producing a relatively uniform primary raw material from a number of different species of fish and the size of the fish to be processed becomes relatively less important. Thus, if bone separation has advantages to offer to the white fish processor, these are perhaps even greater for the fatty fish processor. Not surprisingly, however, there is at least one potential disadvantage. Comminuted fatty fish flesh consisting as it does of a matrix of finely divided fish protein impregnated with highly unsaturated lipid and quantities of heam protein which might be expected to be extremely susceptible to oxidative rancidity. As will be shown later, this is not as acute a problem as might be supposed and thus, lipid oxidation need not be an impediment to this form of utilization.

Production Methods, Problems and Acceptability

It would be convenient to pass whole fish through the bone separator. However, for a number of reasons, some aesthetic, some more practical, this is undesirable. The fish should, therefore, be machine headed and gutted in one operation or split. In Table 3 are shown the yields of mince obtained by the two procedures. Where splitting can be used, as in the case of herring, this clearly gives a considerable yield advantage compared with headed & gutting only .

The bone separator used was the Baader 694, which is that equipment most commonly available in the UK.

The physical character of the mince presents fewer problems than arise with white fish. The flesh of the original fish has an intrinsic brown or brownish-white color anyway and thus, most people find the appearance of the mince acceptable provided they can relate this to the species being tasted. A color which would be objectionable in a cod stick is wholly acceptable when it occurs in a herring stick and therefore, no attempt is usually made to remove or disguise coloration due to blood or other components. Acceptance also in smoked stick and portion products permitted red-brown dyes are added to kippered sticks since this is also done with the traditional product.

TABLE 3

Recovery of minced flesh from herring

Nobbing	Weight (g)	Yield (%)	Splitting	Weight (g)	Yield (%)
Whole fish	4860 (Original Weight)	(100)	Whole fish	4800 (Original Weight)	(100)
H & G fish	3566	73	Split fish	4145	86
Heads and gut	1257	26	Gut	625	13
Mince	2300	47	Mince	3144	65

A more detailed description of the preparation of kippered sticks will serve to show how the fatty fish minces are treated. There are in fact two approaches to this particular preparation.

1) Herring are split and converted to kippers by a modified form of the traditional brining, dyeing and smoke-curing technique. The herring are in fact transferred to the smoke kiln in the wet state from the brine and under these conditions, smoke deposition is very rapid and water loss low (4-5%) or approximately one-third of that aimed for in traditional kippering. The kippers are passed through the bone separator and the recovered mince formed into blocks and frozen. The blocks are then cut into stick size portions which are enrobed in batter and breadcrumbs, flash fried (30 sec at 180°C) refrozen and packaged.

2) In the second procedure the split herring are first passed through the bone separator and to the recovered mince there is added with mechanical mixing a sodium chloride solution containing an appropriate amount of coloring. (It is noteworthy that fatty fish seem to be much less susceptible to adverse textural change during

mixing, than are white fish.) The mix is then extruded into strips on a paper backing through a nozzle of rectangular cross-section (2 cm x 1 cm). The strips are tray-smoked at ambient temperature in high-density smoke after which they are frozen and cut into stick lengths, enrobed as before, flash fried, refrozen and packed.

The product obtained by both methods is a fish portion which has all the desirable eating properties of the kipper but which is predominantly bone-free. Thus, a delicious and highly nutritious traditional foodstuff is brought within the range of acceptability of a much larger group of consumers, most notably children.

The kipper product just described is only one of a range of portioned products which have been prepared from fatty fish. Others have been prepared from mackerel, from combinations of mackerel and saithe, from sprats and even from sand eels. The suitability of fatty fish for treatment in a variety of ways through canning (i.e., through variations in the size and shape of the pack and the addition of different sauces) is well known. This versatility appears to be capable of extension to the frozen, portioned products described above where a wide variety of changes can be had in the nature of the product by varying species, condiments, added sauces and enrobings. As an example, one can cite the very simple case of herring sticks in oatmeal enrobing. This formulation is analogous to a traditional Scottish dish but, of course, once again without the bones. This can be contrasted with a much more sophisticated recipe, "herring in Calaisienne sauce," which can also be produced in the stick form. The possibilities are limited only by the ingenuity of the development chef.

A few words about the consumer acceptability of these products. The fish stick is one of the great successes in the history of food marketing. Half of all the frozen fish now sold in the UK and in the United States is marketed in this form; clearly, acceptability is high. But what of fatty fish sticks? In laboratory testing using hedonic scoring we find that acceptability is also high. Moreover, this good response is also being achieved in limited trials in the institutional field using plate wastage as an index. We hope to follow these encouraging results with more comprehensive market testing.

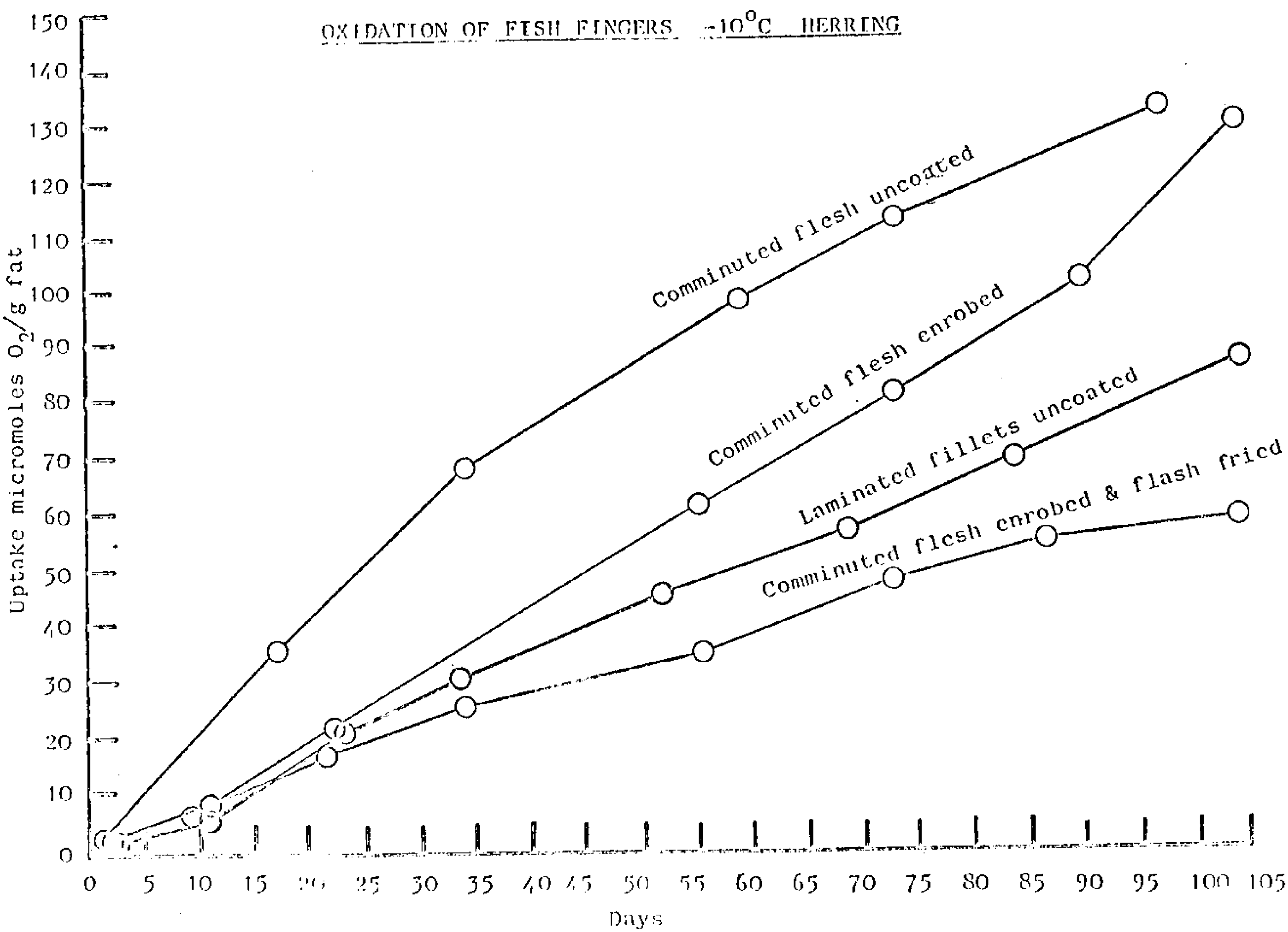
It would indeed be surprising if there were no problems associated with the products. The predictable problem of fat rancidity has already been briefly mentioned and a little more now needs to be said about it. Graph 1 shows the results of some oxygen absorption experiments with herring fish sticks. Comminution clearly results in greater susceptability to oxidation, but this can be at least partially compensated for by enrobing. By the simple expedient of flash frying, which is desirable in these products for other reasons, an even higher degree of protection can be achieved. However, under the conditions of this particular text (-10°C) the oxygen absorptions involved would give rise to rancidity in even the flash fried product after one month. In practice this could be avoided by the use of a packaging material with low oxygen and water permeability together with storage at -20° to -30°C where the expected shelf life would be from 3 to 6 months.

Another problem is that of cooking odor and contamination of the frying oil and utensils with fish oil and the subsequent strong objections from kitchen staffs in the institutional catering area. This is significant and serious and could have an adverse effect on the chances of success of a full commercial venture. We think that distribution in a sealed foil pack, including if necessary, added cooking oil, ready for insertion in an oven may provide an acceptable solution to this problem.

LOW FAT CONTENT FISH

Around the coast of Britain and indeed elsewhere in the world, there are a number of species of fish, some of which represent an enormous resource not at present being utilized, at least for human food. The blue whiting (*Micromesistius poutassou*), species which has been occupying much of our attention is estimated by the biologists to represent a sustainable fisheries resource of approximately one million tons per annum which is more than equal to the current total UK catch. Thus, we have good reasons for being interested. The causes of our failure so far to exploit this and similar species are several. First, the consumer, particularly in British society, possibly to a lesser extent in Europe and America, has very conservative tastes concerning acceptable species. There is a strong prejudice against even some well known species; mackerel is a good example. An entirely novel new species is likely to encounter very strong consumer resistance. Secondly, there is the more practical problem that a successful fishery for some of these unexploited species

GRAPH 1


OXIDATION OF FISH FINGERS -10°C HERRING
Uptake micromoles O2/g fat
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Days
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
Comminuted flesh uncoated
Comminuted flesh enrobed
Laminated fillets uncoated
Comminuted flesh enrobed & flash fried

had to await the improvement in fishing gear which has occurred in recent years and in particular, the capability of fishing at considerable depths. Finally, and this is the point that has most relevance to the present subject, these species are often small, and of repulsive appearance, lean, bony, and do not lend themselves to conventional processing techniques. The advent of the bone separator opens up new possibilities for their use.

Our experiments so far indicate that with the majority of these species highly acceptable fish sticks, fish cake and fish burger products can be derived. Moreover, the homogeneous nature of the mince fish permits admixtures with various flavors, whose use is difficult with whole fish flesh. Noteworthy among these are the smoke flavor additives. Liquid smokes have always offered the possibility of taking a step forward in curing which is now a flavoring process rather than a preservative one. There are clear advantages to be gained both in ease and economy of production. Until recently, however, no available liquid smoke conferred a flavor which was truly representative of traditional smoked fish. The difficulty of applying the flavors, topically, at standard dose levels added to the difficulties. Much progress has been made by the flavorists in recent years in the development of high quality smoke flavors and our own experiments on the combination of these with minced fish have been very encouraging.

However, one can see a problem for Britain and for other countries too, in that the resource available for conversion to minced fish products is, as has been stated above, very large indeed. It is possible that enormous quantities of minced fish could be placed on the market. The question therefore arises, are the products we have discussed suitable for exploitation on such a large scale?

I think we must conclude that they are not and that what is required is further innovation in this area. Thus, one can see that the extensive process and formulation work on comminuted fish that has been carried out in the United States in recent years is highly relevant to the current fisheries outlook.

THE APPLICATION OF EXTRUSION TECHNIQUES TO THE UTILIZATION OF COMMINUTED FISH FLESH

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Aberdeen, Scotland

One of the characteristics of the fish processing industry is a tendency to employ relatively small-scale, batch procedures in its production methods. Fully mechanized, continuous flow operations are rarely encountered. This is due to two main factors, one stemming from the nature of the raw material, the other commercial and organizational. First, the wide range of species landed coupled with fluctuations in supply render it impractical to use continuous flow. With one exception, the major species of cod and haddock, what might for want of a better word be called semi-continuous flow, is found in the larger factories. The variation in fish size within a species is a further complicating factor which is not encountered in other areas of the food industry, i.e., meat and poultry, where carcass sizes are relatively uniform. The second reason why continuous flow is not used probably stems from consumer attitudes about fish. Until quite recently, fish were not a prized food resource and this has had its effect on the industry in that it tends to be dispersed in small units, is under-capitalized, often poorly managed and inefficiently staffed. All too frequently, it does not see itself as part of the wider food industry of whose sophisticated techniques it has little knowledge and little inclination to use.

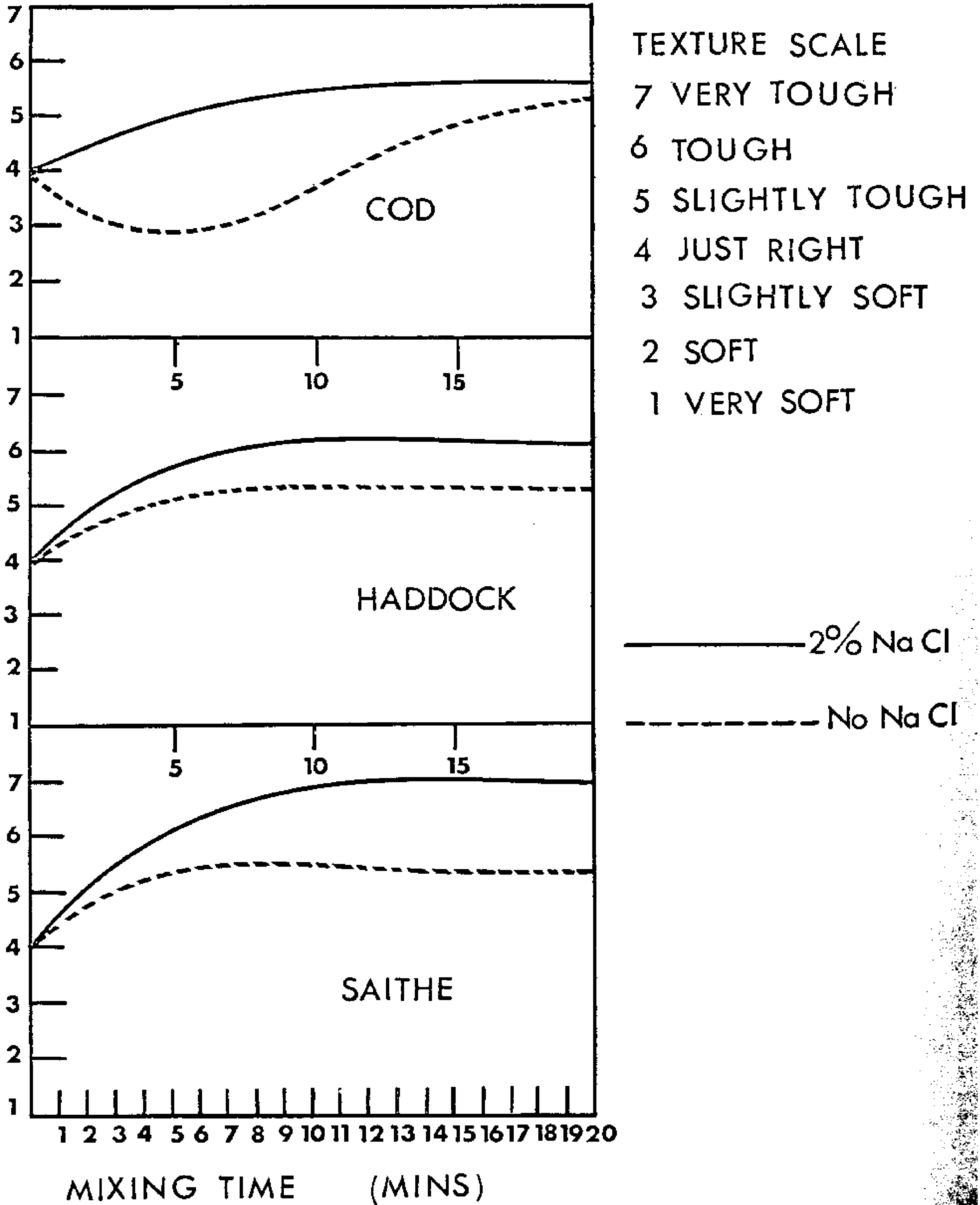
In recent times, however, the situation has begun to change. Thus, as competition for high grade protein in world markets intensifies, fish is becoming increasingly valued as a food commodity. Fortunately, with the advent of bone separators or flesh-strippers, the means of reducing a wide range of fish species, in high yield, to a small number of uniform basic raw materials, i.e., minced fish is now open to us. Moreover, the potentially enormous amount of such raw material, which was mentioned in our previous paper, indicates that production operations might have to become much more centralized and could take place on a scale as large as any in the food industry. The entire pattern of fisheries economics could be altered by such operations.

Let us look a little more closely at what is envisaged. Minced fish can be a homogenous raw material with standard or at least controllable properties, the most important of which is perhaps plasticity. I will go on to say a little more about this in a moment. One can, therefore, visualize very large quantities of a quite narrow range of fish minces (low, medium and high fat content) coming into the factory and entering a continuous process in which they are first of all subjected to washing, color adjustment and such other quality control steps as may be required. The material would then proceed along various flow lines to receive the metered addition of preservatives, texturizers, condiments, flavors, etc., as necessary for their subsequent conversion to finished products. Conversion to the final products might also involve a whole variety of mechanized steps among which the very simplest would be say the stamping out of fish cakes, fish sticks, fish burgers, etc., in very much the same way as things are done in a modern bakery. One of the techniques which we feel will play an important part in such operations is the process of extrusion. Up to the present time this process has not been used extensively in the food industry but has been attracting more attention in recent years. Considerable ingenuity has been shown by the technologists and much progress has been made. The hardware now available is quite highly developed and there is a range of it on the market.

It would have been rather foolish and pointless of us to intrude into such a specialized field of food engineering and, let me say at once, we have not attempted to do this. On the other hand, we know a great deal about food and fish in particular, and it is to the marriage of existing extrusion technology with this new and potentially very valuable raw material that we have directed our efforts.

When we first started experimenting with minced fish our efforts were hampered by the fact that every time we tried to mix the material with anything, salt. flavorings, texturizers, etc., we ran into texture problems. One can remember producing some of the finest cod fish tennis balls ever seen, but at the same time doubting if the market for the product would be very large. But then as we experimented a little further we discovered that certain factors affect these changes. Graph 1 for example, shows the effect of mixing time

GRAPH 1


COD
HADDOCK
SAITHE
TEXTURE SCALE
7 VERY TOUGH
6 TOUGH
5 SLIGHTLY TOUGH
4 JUST RIGHT
3 SLIGHTLY SOFT
2 SOFT
1 VERY SOFT
2% Na Cl
No Na Cl
MIXING TIME (MINS)

on texture. The various species behave differently on mixing and the addition of electrolytes such as sodium chloride has a very pronounced effect. Hydrogen ion concentration is also important and at around pH 4.5, at least in cod after the addition of citric acid no gelling occurs even after very aggressive mixing. The sum total of all this experience is the fact that it is possible to control the texture of minced fish with some precision throughout a wide range from soft and mushy to rubber-like. We have been able to exploit this condition rather successfully, and so a phenomenon that was at first a nuisance is now seen to be controllable giving an additional dimension to the range of products that can be made from minced fish.

Having achieved this degree of control we then proceeded to extrude in a variety of ways. One of these was shown to you in the previous paper when alternative techniques for making kippered sticks was described. But we have also produced fillet shapes and fish shapes, ring shapes and prawn shapes. Almost any shape can be produced on demand.

For curiosity perhaps our prawn shapes are the most amusing. In this case the texture of the fish flesh can be adjusted to give just the right degree of "bite" that is characteristic of prawn or scampi and with the addition of shellfish flavor and a little carotenoid (or otherwise permitted) pigment, the illusion is complete. Prepared from white minced fish they are really pretty good either enrobed and deep-fat fried or in a prawn cocktail.

Perhaps our most serious interest has been in obtaining an acceptable "fillet" from minced fish. One cause of lowered acceptability of such products is the absence of the flake texture which is so pronounced in the best cod fish sticks. We thought that it was worth trying to simulate this. Our chosen means of doing so was through that interesting group of seaweed derived materials, the alginates. Alginic acid is quite a strong acid and although only slightly soluble in water it enters into base exchange reactions. The sodium, potassium, ammonium and magnesium salts are soluble in water but the salts with calcium are not. By judicious addition of calcium ions to an alginate solution, precipitation of gelatinous hydrolyzed calcium algenate takes palce and the viscosity of the resultant jelly is stable and highly controllable. The properties do not alter, for example, on heating as would happen with gelatin and the jell is also freeze/thaw stable. Another interesting property of alginate layers is that they are non-adhesive. That is to say, two layers of alginate jell pressed together do not adhere or fuse but can be readily separated after prolonged contact and after both freezing and cooking. It was this latter property which prompted our interest in the use of alginates for producing layering in minced fish portions. An appropriate amount of alginate solution containing an insoluble calcium salt (gypsum) and a little glucono delta lactone (GDL) was mixed with the minced fish. The GDL hydrolyzes to give gluconic acid which releases calcium ions from the gypsum. These calcium ions in turn cause alginate precipitation. The mixture was poured into shallow trays which had been previously sprayed with dilute calcium chloride solution. The surface of the layer in the tray was then sprayed with calcium chloride solution. The $CaCl_2$ treatment is carried out in order to hasten the gelling time of the outer surface so that the layers can be handled before the main internal gelling process is complete. Within one hour the layers could be handled and were washed under running water to remove excess $CaCl_2$. Stacks of four of these layers were then prepared, frozen, cut into finger-size portions, enrobed in batter and breadcrumbs and then refrozen. For acceptability assessment, they were deep fat fried. The results, as far as textural properties are concerned were very impressive. The fish sticks all contained precisely and distinctly four non-adhering layers of fish which went a long way to simulating the less monotonous "flake" effect of whole fish. It is clear, however, that the product with its consistent four layers is undesirably uniform and in order to relieve this effect, we may have to back track, chopping up the layers and re-forming them in some random fashion. More seriously, however, the product still lacks some succulence and this problem is currently engaging our attention. The procedure, however, shows considerable promise, and if this is successful in the laboratory there seems to be no reason why these operations could not be set up on a commercial scale.

Finally, there is a procedure which is attracting our attention and which, although it strictly does not come into the category of extrusion, similar features and represents an alternative method of reforming minced fish. In this case the mince is hydraulically compressed into "logs" of various cross-sectional shapes, i.e., fillet shapes. With carefully adjusted conditions the particles remain coalesced to just that degree which holds the mass together while retaining optimal textural properties. The "logs" are cut into identical p tions of appropriate thickness. The technique is apparently successful in the meat industry but our judgment of its usefulness for fish must await the results of further experimental tests.

We hope that in this short talk we have been able to give you some idea of our experimental approach to the utilization of comminuted fish and to the thinking behind it.

SUMMARY OF SESSION V - RESEARCH AND DEVELOPMENT UPDATE

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Acting Chief
National Marine Fisheries Service
Seattle Laboratory

Solution of the problem of the development of rancidity in minced flesh was approached through washing of such labile species as black rockfish (Sebastes melanops) and carp, a relatively fatty freshwater species. Washing had a marked stabilizing affect as did the addition of ingredients such as salt, tripolyphosphate and sugar.

The soft texture of minced croaker was improved through the addition of calcium, hydrogen, phosphate and salt. Egg albumin, too, improved texture. Starch was reported to damage texture.

Particle size also has an important affect on texture. Sticks made from coarse minced particles had higher acceptability than did sticks made from flesh passed through the small holes of a strainer. A mixture of equal parts of fine minced and coarse minced fish was essentially as acceptable as all coarse minced flesh, and significantly more acceptable than fine particle flesh alone.

Moisture content had an affect on texture. A moisture content of about 82 percent was found to be optimum during storage of rockfish blocks for one year.

An investigation of the slight preference of untrained panels for whole flesh over minced flesh from the same fish, included an examination of different fractions (whole fillet, minced fillet, deboned frame, and deboned, headed and gutted fish) and showed that the act of mincing increased TBA values and TMA concentration. In hake especially, there was a continued increase in DMA during storage. These tests were made on straight, unmodified flesh and, therefore, do not let us know if malonaldehyde, TMA, and DMA formation is stabilized by modification (salt, phosphate, sugar) and/or washing, or both.

It was pointed out that DMA forms readily in gadoids and that this compound, formed from TMA, is accompanied by the formation of formaldehyde. Formaldehyde is a strong protein denaturant that begins to reduce protein extractability almost immediately after mincing. The possibility of obviating this phenomenon in some species of gadoids seems likely by the simple device of removing the spinal column and associated tissue. In some hake, at least, this is the site of formation of DMA and formaldehyde. In other gadoids, such as Alaska pollock, this reaction occurs throughout the muscle. In either case, mechanical removal of the spinal column is a desirable practice from the point of view of removing kidney, lowering bone content, and improving color.

Texture was also discussed from the point of view of using modern food processing techniques for the production of engineered minced products. The union of extrusion and minced fish offers new areas for exploration. Knowledge of the affects of pH, ionic strength and mixing time can be used to control texture. Fish flesh colored with carotenoid pigment can, when properly processed, have the shape and bite of shrimp. A flake-like texture in minced fish has been produced through the addition of alginates, which are reacted with calcium ions to form short gels in extruded layers of minced fish.

Problems were discussed relative to the use of small pelagic species that up to now have been handled largely by manufacturing into meal or by canning. Their use for food can now be a reality through deboning procedures. Lipid oxidation in many of these species is not the problem that one might have assumed. Kippered herring sticks, both washed and unwashed modified carp and croaker treated with liquid smoke, have been shown to range in resistance to lipid oxidation from good to excellent.

Demersal species, such as grenadier, Norway pout, scabbard and others, offer many new opportunities for increasing fish supplies. But many new problems must be solved before all these species can be used.

Finally, in anticipation of regulatory problems and inspection requirements for mixed species products, a progress report on an immunological procedure for identifying and quantifying the individual species in a mixture of species was described.

Research development is needed in several areas including:

1. An understanding of the mechanism involved in stabilizing lipids in minced products by the procedures used in the preparation

of surimi and by heat treatment.

2. Clarification of the mechanism of formaldehyde formation in some species and the development of methods that inhibit the formation of this compound.

3. The use of texture-modifying fish muscle proteins to permit the use of deep-water species that tend to be high in moisture and soft in texture.

4. The use of low-priced pelagic species for food and as extenders of higher-priced, less abundant resources.

5. An understanding of the chemical nature of the muscle pigments in pelagic species, and the development of processes for their removal.

D I S C U S S I O N

Q: Many tests reported here were at 0^oF, industry uses conditions somewhat colder. What will happen under colder conditions and why was 0^oF chosen?

A: In our testing facilities we were able to hold 0^oF more constant than a lower temperature. Attempting to hold a -10^oF temperature gave too much fluctuation which would accelerate changes in fish muscle faster than if we held at a constant 0^oF. If -10^o could be constantly held then that would be preferred, it would extend shelflife considerably.

Q: Mention was made that washing the minced material led to textural differences; what were those differences? Did the product become rubbery?

A: In un-modified blocks the texture became dry and crumbly and with longer storage became more so. Washing by itself does not produce a rubbery effect.

Q. Were nutritional values run on the washed flesh?

A: No, not specific values, crude protein and nitrogen were run and the protein content did drop due to washing but on a dry basis the protein remained the same. When fish flesh is washed the moisture content increases which brings the protein down but on a dry basis it's equal.

Q: In presenting the fish cakes to the panel, were these battered, breaded and fried?

A: No, they were not, we were looking for strictly texture and we felt batter, breading and frying would add a new dimension to our test. We can batter and bread this material and fry it and get successful tast penel support but you can't really get an objective measurement for texture this way.

Q: In using the Universal Penetrometer, did you actually measure the readings on the cakes themselves or on a larger mass of raw material?

A: We measured them on the cakes themselves that were approximately 9cm by 1cm thick.

Q. Is there a difference in quality between running two passes or if you tighten the belt and make one pass, is there a texture, flavor difference or is it strictly a color difference?

A: We get both a color difference and a flavor difference. This leads to our concept of fractionating and getting different qualities of minced flesh. By quality I mean not using the maximum belt pressure, but maybe using light or moderate pressure to get essentially more light meat, especially if you are working with a specie that has a tendancy toward rancidity during frozen storage, or other flavor problems. Carp is a good example, we found with less pressure we had less problems with off flavors. So it is both flavor and color.

Q: Indication was that texture was better when the flesh went through the 7mm opening rather than the 1.4mm opening. Did you also rate flavor and overall acceptability?

A: Yes and our panel scores reflected no significant differences in flavor and texture. Overall acceptability was lower because texture is measured as part of overall acceptability and overall acceptability will reflect the lowest rating factor. If your texture is poor and flavor is good, our judges usually reflect a defect. Overall scores were in line with others in texture and flavor.

Q: When using salt and calcium hydrogen phosphate separately, do you find that one releases protein faster than the other or which one would you say released most of the protein in fish to make it bind?

A: Salt is probably a little faster. You get a little more texture and probably a little more solubility with sodium chloride than you do with calcium hydrogen phosphate. It probably releases the material a little bit faster, at least on the basis of concentration. But if you could compare it on the basis of molar concentration, I would suspect that they are probably very even as far as releasing protein at least up to a certain point.

Q: Which is the best binder to use at this time and be safe?

A: There is no best one, every specie or group of similar species is going to be different. It's about like asking which is the best treatment for beef and pork - each is different and has different requirements - so do our many fish species. With croaker I think a mixture of salts and egg albumin may be the best.

Q: Have you tried any other binder with croaker?

A: No. Not at this point.

Additional comments on binders: At Oregon State we have not found it necessary to use binders. We prefer instead to vary our blending speeds in a Hobart mixer when using rockfish and shad in our sausage work, if we were to speed up the shad first we could make a bologna type product, where as if we mixed the rockfish in first, then added seasoning and the shad last, and as soon as we had an even mix, we would get a product and texture that resembles pork sausage. I would say as important as the binder you use is how you proceed in blending and mixing the material.

At Texas A & M we have data that suggests that the binding properties of the fish protein in croaker is probably better than that of most beef and pork products. I do not think you really need a binder. The fish cakes we prepared were very firm with the addition of a little salt although we started out with a soft material.

Q: Did you use a binder on the carp blocks the same as you did on the rockfish blocks?

A: Yes we did, as a matter of fact, the same formulation. The reason for our use of a binder was that we were preparing blocks intended for use as breaded fish sticks and portions and one of the problems on some of the minced blocks has been the popping off of the breading during the pre-cook. By use of sodium tripolyphosphate we did seem to tie up the moisture better, the modified product was more succulent and the incidence of breading blowing off was reduced substantially.

Q: At Texas A & M have you done any work with textured vegetable protein?

A: No, not at present, we plan to in the future; however, when our new seafood coastal lab is operational in Corpus Christi.

Additional comments on mixing and binding: With reference to texture as modified by mixing, of which several workers have mentioned, there is a fundamental difference; however, between the final texture that you get and the results of mixing or over-mixing, if you will, and that which results from the addition of a binder. One already discussed regarding the relationship of moisture to the total product or actually to the protein and another, that by the use of a binder you get a more succulent product that holds the moisture, and has a more desirable texture. Generally with alteration of texture by blending you tend to get a more rubbery product or a meat-sausage like effect. When you have extremes of texture differences that you are trying to modify, that is a specie that has an unusually high moisture content, you can effect changes but not significant changes by mixing or physical treatment.

In early NMFS research we actually made our binder separately. We used for every 100 pounds of minced flesh, 2½ pounds of fish, 1 lb. of salt, 0.15 lbs. of sodium tripolyphosphate and 5 lbs. of water, homogenized them in a waring blender and ended up with a sticky binder which was then added to the minced flesh, we had to be very careful on our mixing time, if we over mixed in trying to achieve a uniform blend we ended up with a rubbery product. In later work we skipped making this binder mixture and instead made a solution containing salt and tripolyphosphate and sprayed this onto the minced flesh with a minimum amount of mixing.

We have added soy protein in other work with dover sole. Dover sole that is caught in very deep waters has an abnormally high moisture content and a texture that is best described as jelly like. We have tried adding various ingredients to obtain a more favorable texture and soy protein has been one of these. We have succeeded in tying up excess moisture but we have not improved the texture much. We were seeking more fibriosity but have not achieved it as yet.

Q: Do you find temperature being a critical factor in forming these binders and products?

A: Yes, we always keep our temperatures below 40 degrees. In reviewing some Japanese work on emulsion formulation and our own work we try and keep the fish muscle as cool as possible. The Japanese try to maintain 34 degrees. If the product gets warm your intended raw material will become bally - - temperature is extremely important. Another technique some have used is to mix quickly, freeze the mass, then shred it and finally form it to the shape desired, this prevents over-mixing and the tendency. toward a rubbery texture.

Additional comment of temperature and texture: when mixing is done up in the range of 60-70 degrees you apparently loose texture. The fish physical properties are somewhat elastic and will develop with mixing at lower ranges of temperature, in the upper ranges this elasticity begins to break the longer you mix and its functional properties are no longer there.

Q: At Texas A & M when you used taste panels, were these children or adults?

A: The product will ultimately be aimed at children, but for these studies we used adults. Initial marketing trials showed serious mushiness with croaker texture.

Q: Do you plan on working with children?

A: If it looks like the product is going to be industrially feasible, we probably will. At this point all we are trying to do is establish the basic materials which can be used in texture development without adverse effects on nutritional properties.

Q: Regarding the mushiness of croaker, have you done any work with the soluble proteins to over come this texture problem?

A: No, not as yet. We would like to; however, in the future.

Q: Comment was made about starch causing the texture to disintegrate. Can you elaborate?

A: Most of texture development is due to interaction between protein, starch seemed to interfere with the action of protein resulting in texture weakness. We did not look at the structure of starch that closely.

Q: What kind of starch was used?

A: Modified corn starch.

Q: Any comments on cann_ng of minced fish? What does canning do to textural and flavor characteristics?

A: At Texas A & M we did not preliminary work on canning minced croaker and produced a good cat or dog food. That work was just not based on texture alone but taste and flavor as well. Human food use was not looked at.

A: At Oregon State we looked at Columbia River smelt for possible new uses and smoked some for three hours at 120-140°F, canned it adding some vegetable oil, retorted and came up with a jelly-like sliceable product with no initial off flavors. We held the product for some three months and the product was still texturally well set up.

A: At NMFS we have seen some minced salmon trimmings successfully commercially canned - some were not too good, but others were excellent products.

It comes down to a matter of species - some work, others do not - all must be tested individually.

A: Generally, the lower fat fish will not can well. Croaker has an intermediate fat level and while texture was fine, the taste of the final product was unappealing. We even tried different additives like oil, spices, liquid smoke, etc., but with little success.

A: Basically, its a matter of formulation if properly put together.

Q: There occasionally arises a problem with the block nape skin and worms in cod, does anyone have any suggestions on how to get these out?

A: Except for cutting away the dark spots and any parasitized material, no other way presently exists. Tolerance levels are in effect for some parasites, the wormlike and the cysts I believe.

Q: Comment on the protein isolate work being done at NMFS Seattle laboratory.

A: The work is intended to produce a product that is comparable to a soy protein isolate from underutilized or industrial fish, like menhaden or anchovy. Basically the process takes minced fish, washes them several times to remove the sarcoplasmic protein fraction, complexes it with hexameta-phosphate and acidifies the mixture to precipitate the protein complex. The complex is nuetralized and drum dried by complexing the protein. We are able to wash this product with hot water and remove some of the lipid fraction, winding up with a myofibrillular protein isolate. The experiments are still prototype, more will be reported in the future.

Q: What kinds of yields on the protein isolate project?

A: About 10% dry weight from whole fish. We loose the entire sarcoplasmic protein fraction which is where our spoilage factors come from. If we start out with 3¢ a pound menhaden at a 10% yield we are at 30¢ plus 30¢/# for processing that gives us about a 60-70¢/# product. These are rough ball park figures at the moment.

Q: What is the moisture content at a 10% yield?

A: About 3-4%.

Q: Any information on nutritional values and P.E.R.'s?

A: No, we have been primarily concerned with functional properties and water binding in particular. We are trying to get a product which is used as soy protein isolate as in food products. The product rehydrates quite readily and binds much like a soy product.

Q: Regarding blue whiting, is any information available on its moisture, composition and nutrition?

A: Yes, but unfortunately, that information and figures were not brought along from Scotland.

Q: Regarding your work at Toorey on storage and holding, what can you tell us about that?

A: We can hold at -30 degrees for a year, we notice only slight changes. The smoked products hold up equally well, we have noted no major problems. Most fishery products that are frozen in the U.K. are held about 2-3 months before use.

Q: Could you tell us something about the temperatures reached during the smoking process? Specifically temperatures inside the flesh?

A: No, I have no precise information on that.

Q: Have you observed any relationship between thermal denaturation of the protein and the stability of lipids?

A: No, we have not studied or correlated these qualities, we have here a natural process which produces a suitable product which is apparently acceptable to the industry and has no storage problems, at least the most likely storage problem of rancidity is not significant here.

Q: How large are the blue whiting and how boney are they?

A: Their size is about 20-30 centimeters, they are not so much boney as lets say some very deep water fish like the smooth-head which has an enormously complicated skeletal structure. You can produce a fillet but it will be quite thin and some would be marketable in smoked form, but for the greater part of a potentially enormous catch, mincing is the answer for achieving best utilization.

Q: At what depth levels are these fish caught?

A: The blue whiting is caught in a mid-water trawl much like a pelagic phase, the other species, grenadier, scallop and rat-tail are caught at much greater depths, something like 4,000 feet which presents enormous problems of catching.

As a resource the biologists have pretty well substantiated the potential of Blue Whiting, but they have not been as definitive for the others.

Q: When you talk about resource do you refer to abundance or to the quality of the fish?

A: I refer to the annual state of the catch without damaging the stock.

Q: Would this product be seen in the market place as a favorable substitute for other kinds of sih in fish sticks and what of the economics of ex-vessel price, cost of carrying the product, cost of marketing, etc?

A: We are hoping it will become a favorable substitute. I think its economics will remain low, but it's too early to examine the economics in that much detail. It's been an industrially fished resource principally by the Norwegians and somewhat by Iceland. Biologically the potential is there, our experiments just started this past January and preliminary processing and biological information lead us to believe at this point that we have a favorable potential here.

Q: In Canada's experience do you see the stability factor being one of the key factors in the integration of mixed species into minced blocks?

A: Yes, let's consider we have three general levels of stability here exampled by (1) the cods and haddocks, (2) the intermediates, - soles, rose fish and (3) the hake-like fish.

With proper processing, packaging and holding, many of our present problems and concerns can be overcome. But until we can technically show that less stable product can be converted to more stability by mixing we must move slowly and carefully.

Q: If you remove the backbone and wash prior to deboning, will this eliminate DMAO from going to DNA and formaldehyde and would this be considered an enzymatically catalyzed reaction.

A: Yes, this appears to be an enzyme reaction, where we found the enzymes associated in some of the tissue along the backbone, but not in the flesh. When we remove the backbone the problem goes away.

Q: What is the effect of specific ions of the heavy metals on this enzymatic reaction? Is the reaction speeded up by the presence of certain ions or inhibited by the presence of certain others?

A: We frankly do not know too much about this yet. Several years ago the Japanese made a study in this area and the factors that inhibit the reaction but they weren't really successful in coming up with a solution. In fact, they're not even sure that they established that its totally an enzymatic reaction. It doesn't rule out the possibilities that we discussed here since all the elements for such conversion are present i.e. the pigments, protein-like enzymes and conversion products of DNA. One thing that is bothering me, however, is that a lot of people say that it's the water soluble protein that is causing the instability of minced fish flesh. I'm not at the moment convinced that it's the water-soluble proteins by themselves. Some species like cod exhibit low amounts of enzyme and others like the hakes, exhibit high concentrations when the washed fractions are examined, thus washing hake is much more effective in altering its stability.

Q: How much mixing of species is presently being done?

A: In Canada, only experimentally, we are trying to determine what our parameters are and where the problems will likely occur. We still have much to do. At Oregon State we have mixed shad and rockfish (not commercially) at the 50/50 level, added BHA and BHT and stored it at -5 degrees and this trial run had a shelflife of one year. Generally, the only work done in the U.S. has been at the University or governmental loboratory level.

Q: To assist stability, has Sodium Bisulphite been tried?

A: No, but it's being considered.

Q: Has any exploratory work been done with regard to deactivating the enzyme before mixing, using either radiation or microwaves?

A: No, not that anyone was aware of.

VI.

C O M M E R C I A L L Y

A V A I L A B L E

E Q U I P M E N T

UPDATE OF TECHNOLOGY AND INDUSTRIAL APPLICATION

B A A D E R

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New York, NY

Nordischer Maschinenbau, Rud. Baader, Luebeck, Germany (founded in 1919) specializes in the development and manufacture of fish processing equipment. We have been doing this for the past 55 years.

There are two ways to separate the flesh from the undesirable parts of the fish. One is by cutting the fish away from the bones, producing fillets, the other is by forcing the fish through perforations, producing minced fish.

This mincing operation sounds like a very simple way to produce boneless fish flesh. However, for the production of high quality white minced flesh there are a number of important factors that must be considered.

The development of the "BAADER 694" Bone Separator was the result of an effort to get the maximum yield of bone free meat for the profitable production of fish fillets.

The BAADER Bone Separators come in two sizes:

A) The "BAADER 694," which is the smaller, has a capacity of 1100 lbs. of raw material per hour. Its dimensions are:

Length:	4' 2"	Height:	3' 7"	Power consumption:
Width:	3' 0"	Weight:	appr. 520 lbs.	1-1/2 Kw

Drum diameter:	180 mm	Width of Belt:	205 mm

Price: DMark 24,080.00
(about $9,400.00)

B) <u>The "BAADER 695"</u> with a capacity of approximately 3,500 lbs. of raw material (input) per hour.

Dimensions:

Length:	4' 3"	Power consumption:	4.4 Kw
Width :	4'	Drum diameter :	330 mm
Height:	5' 7"	Width of belt :	260 mm
Weight:	@ 2,600 lbs.	Price:	DMark 41,375.00 (@ $20,000.00)

Basically, the mechanics of the two separators are identical. The raw material is pressed through perforations, small enough to retain the bones, but big enough to let the flesh press through. The bones are scraped off on one side, and the flesh on the other. The smaller the perforations, the less the chances for a bone to get through into the minced meat. However, smaller perforations also mean an unwanted reduction of the fish flesh to smaller particles, which in the end leads to a paste.

The machine employs a perforated drum for separation. The raw material goes through a feed hopper and onto a thick elastic conveyor belt. This belt partly encompasses the drum and is pressed tightly against the drum by an eccentrically mounted collar.

The material fed onto the belt is squeezed through the perforations into the interior of the drum. A screw discharges the minced flesh from the drum. The bones and other solids remain on the outside of the drum and are removed by a scraper blade.

Both belt and drum are driven by a gear motor at exactly the same speed, to avoid any grinding or tearing of the fish flesh and to retain the flaky and fibroid structure of the fish flesh as much as possible.

The raw material entering the narrowing gap between the belt and the drum is subjected to a steadily increasing static pressure, and the flesh escapes through the perforations into the drum. The bones are trapped by the belt pressed against the drum. Thicker bones get imbedded in the plastic belt which squeezes off all the flesh around the bone. This way it is possible to get practically all of the flesh removed from the bones.

The size of perforations in the drum is important for the quality of the minced flesh. Larger perforations, of course, improve the flaky structure of the minced flesh, but on the other hand tend to let more bones escape through, and to leave more flesh on the separated bones. For most applications in fish processing, a drum with holes of 5mm or 3 mm diameter has proven to give the best results. There are drums available with 1.2mm, 3mm, 5mm, 8mm and 10mm. To suit the requirements of different raw material, the final squeeze pressure can be adjusted with the eccentrically mounted belt roller. With a ratchet lever, the eccentric roller is set to bring sufficient pressure between the belt and the drum to get all the flesh squeezed off the bones.

The perforated drum is mounted for quick removal. On the side of the drive it is inserted in a flange with drive pins, and on the other side it is supported in the side frame by two rollers.

After release of the belt pressure and the scraper blade, the perforated drum can simply be pulled out of the machine for cleaning or exchange for a drum with different perforations.

The side frame can be easily removed after slackening two bolts at its base. With the side frame removed, the belt and the belt rollers become accessible and can be removed without the use of any tools. To strip the machine for cleaning takes normally about five to ten minutes.

This is an important feature of the machine which allows quick and thorough cleaning or sterilizing of all parts. All parts of the machine which are in contact with the fish are made of stainless steel and are polished.

There are no corners in the path of the raw material where flesh could accumulate and remain for bacterial growth.

Very important, too, is the safety of the machine. The German Department of Labor has very strict rules for protection of workers. A manufacturer would not be allowed to put a machine on the market which is not properly guarded.

Maintenance is limited to lubrication once a day, and an occasional readjustment of the scraper blade to compensate for wear.

Now to the finished product. In general, the bone separators available on the market may be classified into two categories:

a) Those which are producing an almost non-fibrous product, like a paste;

b) Those machines which are producing the flaky minced fish, where the fibrous structure of the fish flesh is retained.

The Baader Bone Separators are designed to produce flaky minced fish. Since the belt and the drum are running at the same speed, there will be no tearing or grinding of the fish flesh.

The Baader Bone Separators will take almost any types of fish or fish pieces.

Results with different raw material:

Pin Bone V-Cuts

To tain a bone free fillet, be it cut by machine or hand, it is necessary for the so-called pin bones to be cut out. On one hand, the cut should be made as carefully as possible, and without any excessive loss of fish meat; on the other hand it is essential to obtain maximum productivity.

The Baader Bone Separators permit a yield of 90 to 95 percent from skinless V-cuts. By continuous feeding, a capacity of 2,000 lbs. per hour can be achieved with the Baader 694.

Yield on V-cuts with skin (for instance from the pin bone cutter on the Baader 188) is 85 to 88 percent.

Collar Bones

The collar bones which, together with the head, are being removed from cod prior to filleting, contain good and valuable meat, which can be recovered when severing the collar bone from the head. The collar bones represent 8 to 9 percent of the gutted, head-on fish. After thoroughly rinsing the collar bones to remove the black belly skin, the collar bones will give a yield of 50 to 60 percent on the bone separators.

Whole Fish

It is not enough to merely head and gut the fish and to remove the innards. As long as the main bone remains in the fish, the end product will be discolored. To achieve an excellent end product, the main bone with the blood sac and blood duct have to be removed from the fish. The yield is then between 70 and 80 percent from such headed and cleaned fish.

Whole Frames (Whole Bones) From Filleting Process

From such bones, as they come from the "Baader 188" for instance, 55 to 60 percent meat can be pressed out. However, the end product is colored by the blood, black belly skin, and parts of the bladder. Some of the blood can be removed by washing the minced product. Once so rinsed, the keeping quality of the minced flesh is only about 20 days. When frozen and stored, the product turns darker and darker with time and looses taste.

To avoid such discoloration, bones carrying such impurities must be removed prior to processing. For that reason, a frame or Bone cutter was designed for the "Baader 189" Filleting Machines. I will describe this Frame Cutter later.

The bones without spine and ribs represent about 8 percent of gutted and headed fish. The yield on the bone separators is 50 to 60 percent, depending on the pressure. When using light pressure, a 50 percent yield of clean, white minced flesh can be achieved. When using higher pressure to achieve higher yield, small particles of the skin from the back fins pass though with the flesh.

Best results so far obtained were with the 3mm perforated drum.

"BAADER 82" Bone Cutter

This Bone Cutter has been developed to prepare the headed frames after filleting for the Bone Separator, in order to produce high quality white, minced meat. The machine performs a cut below and above the main bone, and also cuts out the belly cavity. This means separation of all undesirable parts, like the blood sac, air bladder, black belly skin and the main bone.

As an attachment to the "Baader 189" Filleting Machine, the Bone Cutter automatically performs the necessary cuts.
It can also be delivered as a separate unit.
The Bone Cutter can handle headless frames from 20" to 43".
The speed is 18 to 25 frames per minute.
Operators: one person.
Power requirement: 1.5 KW
Dimensions with foundation: abt. 80" x 32" x 67"
Weight 440 lbs.
Price: about DMark 35,000.00 (abt. $13,650.00)

Blue Whiting As Raw Material for Minced Meat

1) The "Baader 33" - with picklin device is used to head the fish, open the belly, clean out the innards, brush out the black skin and the blood sacs.

Then the fish is processed on the "Baader 695" with a 3mm perforated drum. Using the 3mm drum, a better and whiter end product is being produced since fewer skin pigments get into the end product, and a higher yield is obtained.

Yield: 43 to 45 percent minced fish from ungutted whiting 10" to 12".

2) <u>The "Baader 33" with Filleting Device</u> - same as for herring fillets. Then, as mentioned above under 1), processed on the Baader 695" with a 3mm drum. The quality will be even better, because the main bone with the blood and bone marrow is removed in the filleting process. In this instance, the yield is smaller, about 35 percent minced fish from ungutted blue whiting.

3) <u>The "Baader 34"</u> - equipped as for herring fillets. Processed on the "Baader 695" with 3mm drum. Yield: about 40 percent minced meat of finest quality from ungutted blue whiting 10" to 12."

Presently, in Norway, "Baader 33" with pickling devise, and "Baader 34" are being used for blue whiting. Likewise, on German trawler factory ships, blue whiting is processed on a Baader 33 with filleting device, with a capacity of about 15 to 20 tons raw fish per 24 hours. The fillet, rather than the whole fish is then being frozen onboard and processed on a "Baader 695" Bone Separator on land, simply because up to now there are no "Baader 695's" onboard ships.

Finally, I would also like to point out the excellent results obtained by using 1.2mm drums for lobster and rock crab. A nice, flakey product is obtained, and the grit remaining in the end product is below the allowable amounts of grit set by the authorities.

Lay-out and Operation

The larger of the Baader Bone Separators, the "Baader 695", is normally fed by a feed conveyor, discharging into the feed hopper of the 695. This is possible because the separator is furnished with a feeding roller at the inlet chute.

The smaller type, the "Baader 694", having no feeding roller, is normally fed by an operator to obtain maximum throughput and to avoid any overloading of the machine.

DISCUSSION

Q: How much shell grit do you get in your crab deboning operation and have you run a calcium on it?

A: This is still fairly new with us and we have no data on that as yet.

Q: Have you tried coarse grinding first before deboning?

A: No, we have seen no need to.

Q: Does Baader have a special machine for flat fish?

A: No, our heading and gutting equipment can, within reason, be used on many kinds of fish. The same can be said of the filleting equipment. It should be pointed out that a line series of machines for heading, filleting and deboning should be set up for the best practical and economic way of processing these types of products

Q: Is the only method for kidney removal by brushing?

A: Yes.

B E E H I V E

O. Ross Taylor
Vice President
Beehive Machinery, Inc.

Since the Oak Brook Seminar in September of 1972, I have traveled throughout the world installing deboning equipment in the red meat, poultry, and fish industry, and I am now convinced of two things. First of all, we are not short of edible protein throughout the world, but only short of machinery to properly use it and the technology to formulate acceptable products for the consumer.

Mechanical separation of fish flesh from bone, skin and scale will no doubt be as important a part of the fish industry as it now is in the poultry industry. The fish industry today is where the poultry industry was five years ago. The poultry industry was then at a loss as to what to do with the meat. Since that time, through a conscientious development program, the poultry industry is now marketing approximately one million pounds per day of mechanically deboned poultry and turkey meat -- both raw and cooked through Beehive systems alone.

I am sure the fishing industry has the same market potential, if not greater, However, it is very important that the fishing industry be quality minded and produce quality products from minced fish that will be well accepted by the consumer. If products of inferior quality and stability find their way to the consumer and are not well accepted, it will certainly be a detriment to the minced fish program.

The equipment you will see demonstrated has been in operation 13 months. This equipment has required absolutely no maintenance thus far. Beehive deboning systems are presently operating in 25 countries throughout the world and approximately 200 installations in the United States on poultry, red meat and fish.

The Beehive fish deboner has been operated on the following cuts and species with very favorable results:

Salmon Tails

Clean salmon tails will yield approximately 75 percent meat, but at this high yield a certain amount of greyish fat that is against the skin will be extracted. At lower yields of 65 percent, the product is entirely pink and shows no evidence of the dark fat. Some customers are running our equipment consistently on this product and do desire higher yields because they combine the mechanically deboned salmon meat with potato flakes and added moisture to produce a salmon croquette. The fat disappears during mixing and is not evident in the finished product.

Salmon Collars

Salmon collars yield as much finished product as do tails and will show some discoloration which is from the dark fat layer and is a minor amount which can easily be worked into the product during formulation and mixing, and adds flavor to the product.

Let it be clearly understood that at higher settings of pressure on BEEHIVE equipment, some of the dark material will be evident in the meat, but on lower settings, the meat will be extracted without any discoloration from fat or skin.

Halibut Trimmings

Halibut trimmings consist of small irregular pieces, as well as large pieces of collars and tails. Halibut trimmings produce an excellent white meat and our yields have been from 65 to 76 percent and the meat is readily acceptable to our customers.

Cod V-Cuts and Perch V-Cuts

In order to get the yield available on these particular items, we designed a special ring valve. These particular cuts are almost entirely meat and contain only a very few bones. Our yield on cod v-cuts has been 93 percent and on perch v-cuts 94 to 97 percent since we designed the new ring valve.

Halibut Frames

Halibut frames were put directly into the deboner without pregrinding despite the fact that some of the frames were as much as three feet long. Halibut frames at different settings yielded 66 to 72 percent and produced a very acceptable product.

Cod Frames

Deboned cod frames yielded approximately 75 percent meat. The deboned meat is used in forming fish sticks and similar products. (On all of the cuts previously mentioned, our customers are deboning on a production basis without pregrinding, and the machine is operating very well.)

Perch Frames

Beehive deboners are also deboning perch frames with 75 percent yield (the same results as on cod frames.)

Whole Salmon and Bottom Fish

Some customers are deboning whole salmon and bottom fish, some of them weighing as much as 25 pounds. It would not seem economical to debone whole salmon, but apparently our customers have such a demand for their salmon croquettes that they are unable to maintain production by using only the desirable cuts such as tails, collars and trimmings.

Shrimp

Cooked shrimp pieces from a peeling and screening operation were run through a Beehive machine with very favorable results. These pieces were individually quick frozen (IQF) and were from the size of an orange seed to the size of a medium shrimp, averaging the size of a small pea. When the product arrived, the temperature was 8^{o} below zero. We immediately deposited the product in the deboner and it ran very well. Our yield on these shrimp pieces was only 60 percent. However, I know that our yield could be 95 percent if we had a proper ring valve to retain adequate adjustment. There were several people at this demonstration and all were very enthused and excited about the test. The shrimp meat coming from the chamber was only 10° above zero, so you can see that this product could be handled with very little or no bacteria problem. Because of the soft nature of fish bones, our equipment presents no problem with temperature rise and bacteria count.

Lobster

At our plant in Salt Lake City, we have deboned 34,000 lbs. of lobster bodies which were shipped to us from Australia. We are having great success with the product and the company representatives have visited the plant and were very pleased with the deboned product from Beehive equipment.

Dog Fish

The dog fish skin is very thick and the texture of coarse grit sandpaper on the exterior surface. It was necessary to cut these particular fish into pieces in order to debone them. However, after doing this, they did yield a very white meat. It did not have much texture, however, because the dog fish meat seems to be much softer than the other species which have been mentioned before.

Beehive Machinery is headquartered in Salt Lake City, Utah. We have found from past experience that if we intend to build quality equipment, we must manufacture this equipment ourselves. Beehive deboning systems are built almost entirely of stainless steel. We have 200 employees at our facilities in Salt Lake producing Beehive deboning equipment, transfer pumps, CO_2 chiller chambers and grinding euqipment. Our shops operate on a three shift basis. At the present time, we are in the process of moving into new facilities approximately thirteen miles south of Salt Lake City. This facility will contain USDA inspected testing areas, certified laboratories, and a complete testing kitchen.

Customers that wish demonstrations are cordially invited to our facilities. There will be no charge on demonstrations of 500 lbs. or less. Customers wishing demonstrations on more than 500 lbs. product will be charged 10¢ per pound. Our demonstration program consists of mechanically separating edible tissue from residue, formulating products in our R & D area, preparing the product for customer approval in our testing kitchen, and laboratory analysis on fat, protein, moisture, bacteria, etc., in our certified facilities.

The equipment demonstrated is our model #1272 machine. It is equipped with a variable speed drive and is at the present time producing 2,400 lbs. per hour finished product from salmon tails, collars, halibut frames, halibut trimmings, red fish, cod frames, whole bottom fish of various species, etc. This equipment is capable of producing 3,000 lbs. per hour finished product at maximum speeds.

In USDA inspected facilities it is not required to disassemble the Beehive deboning equipment during breaks and lunch; however, a general hose-down is required. It is the attitude of the USDA that the Beehive deboning equipment operates under pressure, and therefore is self-cleaning. One employee can easily disassemble and properly clean the Beehive deboning system in 45 minutes.

Beehive deboning systems are USDA approved for poultry separation, both raw and cooked, and are expected to be approved for mechanical separation of muscle tissue from bone for the red meat industry (beef, pork & mutton) within 30 days.

Let me once again invite any potential customers to our facility in Salt Lake City for testing and demonstration of our equipment.

DISCUSSION

Q: Do you see much scale material in your deboned material?

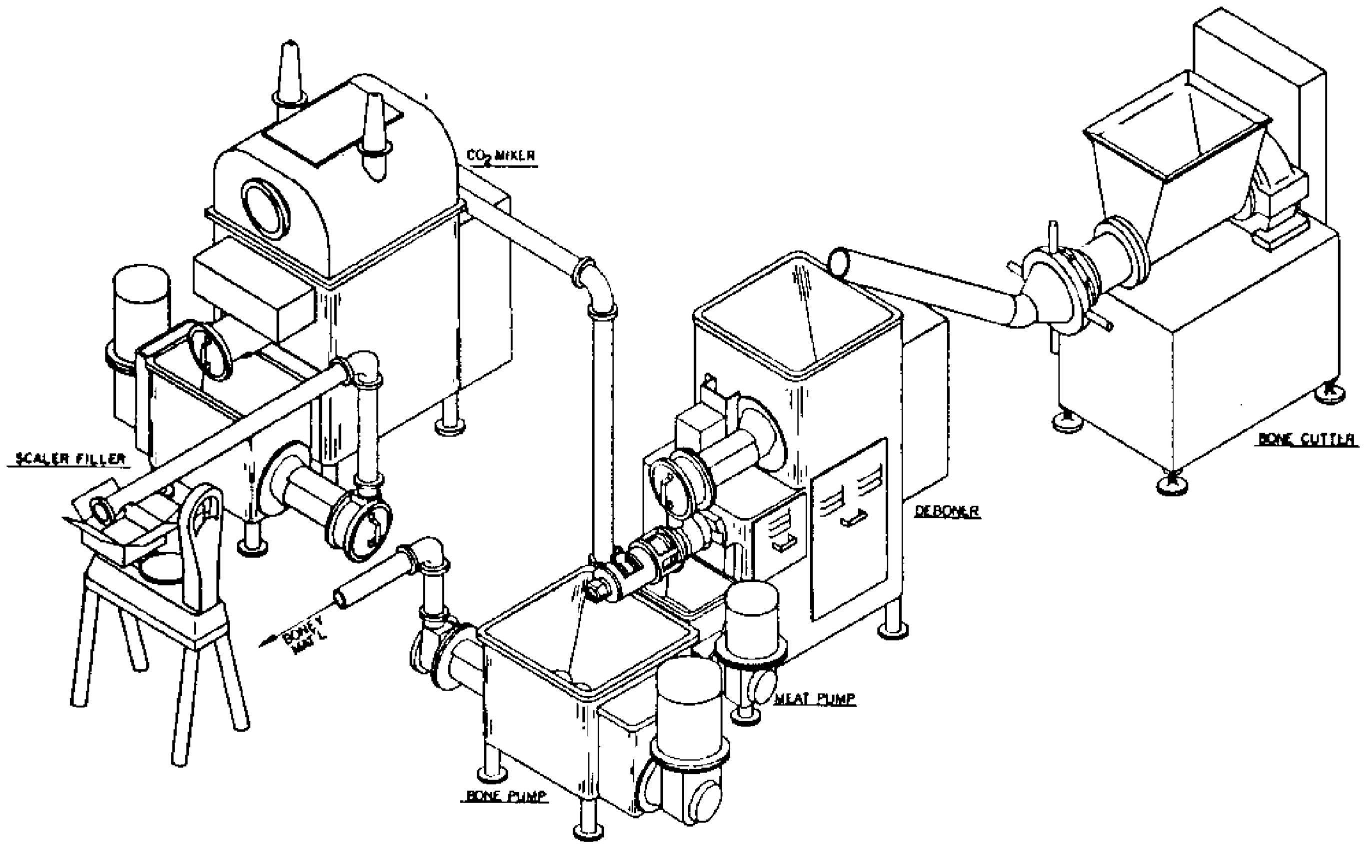
A: We have seen absolutely none.

Q: What advantage do you see in a slot opening versus a round hole?

A: We increase texture and particle size.

Q: Have you noted any bacteriological problems?

A: No, thing unusual, seafood bacteria problems begin all the way back at the hold of a fishing vessel. We have run counts on deboned fish flesh and find them acceptable. We would recommend as good practice that frames be washed with a 150-200 ppm chlorine solution to reduce surface bacteria.



ITEM	QTY	PART NO	HEAT TREAT	DESCRIPTION	MAT'L

MATERIAL LIST

THIS DRAWING IS ISSUED IN CONFIDENCE FOR ENGINEERING INFORMATION ONLY AND MAY NOT BE REPRODUCED OR USED TO MANUFACTURE ANYTHING SHOWN OR REFERRED TO HEREON WITHOUT DIRECT WRITTEN PERMISSION FROM BEEHIVE MACHINERY INC.

TOLERANCES: FRACTIONS / DECIMALS / ANGLES

MAT'L

REVISION / DATE / NO

BEEHIVE MACHINERY, INC.
9100 SOUTH 500 WEST
SANDY, UTAH 84070

DO NOT SCALE DRAWING | APPROVED BY | DRAWN G. MAUCH
DATE 9-4-74 | CHECKED

BEEHIVE DEBONING SYSTEM

DRAWING NO 2472 | REV C

B I B U N

George Vedie
Vice President
Food Masters, Inc.

Operating two models represented by the Bibun 16 and 18 seems to give the seafood processor the maximum throughput and a good economic return based on equipment capital expense.

Drum opening hole sizes range from 2mm, 3, 5 and 7mm, slight speed difference plus the pressure exerted between drum and belt result in 75 to 80 percent yields on whiting and hake and 70 to 80 percent yields on headed and gutted round small croaker. Using 10-12 inch whiting, the throughput on the Model 17 is 3,500 lbs./hour and on the Model 18 about 5,000 lbs./ hour.

Auxillary equipment found useful include screw or belt conveyors, headers and gutters, washers, mixers for additive use, strainers, plate freezers, cookers and extruders.

Most experience using the Bibun system has been obtained with fresh water carp, pike, ocean mullet, whiting, V-cuts, salt cod backbones, and smoked salmon trimmings.

The Model 16 costs $16,100 and the 18 about $23,000.

The equipment, by itself, takes up an area 4' x 4'. If auxillary equipment is added, this requirement, of course, will increase.

We can custom fit your requirements to our equipment, and we offer a full line of service to back it up.

DISCUSSION

Q: To reduce the incidence of bone, what is the best way to run the equipment?

A: We prefer to reduce belt speed rather than vary spring pressure, bone pass through is reduced. Let the equipment do the work efficiently for you.

Q: What yields have you experienced with frames.

A: An average of 60%, this is on raw materials that have been headed.

PAOLI SEPARATOR

Frank J. Miller
Assistant to the President
Stephen Paoli Manufacturing Co.
Rockford, IL

It has been almost two years since we last had the opportunity of meeting with this group, and we are pleased that the interest and acceptance of what we had to offer was great enough to warrant a second invitation. I understand that perhaps half of today's group attended the first seminar, and I hope that they will bear with the amount of repetition necessary to thoroughly indoctrinate the other half with the principles, construction and operation of the Paoli Separator. We know that we have advanced and improved in the course of learning and changing a few things in that period of time. For one thing, we're rather proud of our new 200,000 square foot facility that took the place of rather cramped quarters, within the last six months.

The Paoli separator is a unique and world-patented design concept that was first placed in production in 1964, marking a major breakthrough for the meat processing industry. We have shipped hundreds of separators that are presently operating in more than 30 countries around the world. They separate pure meat from bone, gristle, cartilage, sinew, fin, scales and shell in all types of red meats, poultry, fish and shellfish. In fact, there are a number of installations in which Paoli meat is produced at a rate in excess of a million pounds annually.

What you are interested in, of course, is what equipment is available today and what it can do for you -- so let's take a look. We produce the Paoli separator in three models -- The Super 19, the 20 and the 21. They all have the same basic features, construction and performance. They differ only is size and capacity.

The Super 19 is our smallest model. It is intended for the small processor with low volume, or perhaps for pilot installations prior to proceeding with larger equipment for full production. The 19 will produce up to 400 lbs. per hour of bone-free meat, depending upon the type of material being processed. It is very compact, being only 17" high, 17" wide and 42" long. It is powered by a 3 HP totally enclosed, fan-cooled motor and weighs about 300 lbs. It is priced at $8,699.00, including the motor which is integral with the drive.

Next we come to the intermediate size Model 20 which has been the most widely used of our separators. Its output is up to 1,000 lbs. of meat per hour. It is 28" high, 21" wide and 64" long. It weighs 542 lbs. and is priced at $14,784.00, without the 10 HP motor, which we can supply at extra cost.

Our largest separator is the Model 21 which is used by many large processors. Its capacity is approximately double that of the Model 20 or an output of about 2,000 lbs. per hour. It is the same height and width as the Model 20, but is 84" long. Its weight is 825 lbs. and its price is $26,884.00 without the

15 HP motor that is required.

Let us examine some of the Paoli Separator features that make it unique.

The feature that is most apparent is the extreme simplicity of design. There are only 10 parts (other than hardware) in the entire machine; and outside of the motor and gearbox, there is only one moving part -- the separator cylinder. We are continually working toward improved efficiency and simplification. If any of you are checking notes, you will see that there are three less parts required than were needed the last time we met.

It is obvious what this means in terms of maintenance - no parts to stock, no parts to fail, no parts to replace. The only part with any mortality is the separator cylinder which, like the blade in your razor, should eventually be replaced to maintain high efficiency; but its life is measured in years, as documented in many installations. There are no belts of any kind to adjust or replace. The drive is direct from motor to gear box to unit. There is little or no increase in temperature of material going through the separator; therefore, there is no need for water cooling connections or supplementary cooling equipment.

In most instances it is necessary for material being processed to be first passed through a grinder to reduce it to a size acceptable to the separator. It is possible, however, with some types of small flat fish, to feed directly into the separator. In some cases where grinding is required, suitable grinding equipment for this purpose may be available; if not, we can supply it. The type of grinding equipment required varies with the material and quantity being processed. We can recommend what might be needed for your application.

The reduced meat and bone mixture feeds directly from the grinder into the hopper of the separator. There it falls onto the surface of the rotating cylinder and is drawn around between the cylinder and the outer shell. In the course of rotation is reaches a restricting area and the pure meat is forced through microgrooves into the interior of the cylinder. These grooves will not accept bone, cartilage, fin, scale or any type of perceptible material; therefore, this residue remains on the outside of the cylinder, and the rotation feeds it out the open end. The meat moves in the opposite direction on the inside of the cylinder and is delivered through an outlet in the bottom of the shell.

The openings through which the meat passes are several times smaller than those which can be produced by any other design; therefore, they can block the passage of perceptible particles which would otherwise remain in the meat. This produces the most grit-free product possible. In fact, we will guarantee it to be 100 percent free of perceptible particles.

The continuous slot formation of the passages also allows the meat fibers to be retained intact to a degree not otherwise possible. This produces a meat with a remarkable degree of bindability that you can, in fact, form into a patty and fry on a grill like a hamburger. Paoli separated meat will retain its shape any way that it is formed and heated. Upon heating, because of the retention of the complete meat fiber, the very fine texture of the product changes to more of a hamburger, or rough texture.

Daily maintenance and cleaning is a very simple procedure, as you would expect from its simple construction. The Paoli separator can be taken down for cleaning in less than 10 minutes. Seven bolts allow the removal of the upper shell parts, 4 more bolts release the end bracket, and then the cylinder assembly is removed. All of the parts are stainless steel and all parts except the cylinder are simply washed in hot water. At the end of the day the cylinder is hosed down with hot water and then immersed in a dilute acid bath overnight; it is then hosed again and reassembled. Permanent adjustments are made at the factory and, therefore, reassembly is just a matter of dropping parts into place. Only an Allen wrench is required to assemble and disassemble.

Now let's examine further the application of the Paoli separator and also the products produced. The Paoli Separator can be used to process almost any material where you want to separate degrees of hard from soft -- certainly any flesh protein.

To give you an idea of the amount of meat which can be retrieved through use of the Paoli Separator I will mention representative yields of meat obtained from some of the materials which we process:

Headless, eviscerated fish	74-91%
Fish frames after filleting	40-60%
Lobster bodies	45-55%
Crabs (all types)	37-58%
Whole undersized shrimp & crayfish	40-70%
Poultry necks and backs	60-75%
Poultry carcasses	50-65%
Beef neck bones	25-38%
Beef brisket bones	25-32%
Pork neck bones	40-60%

These yields are based upon the use of this one machine with only one pass through required.

An example of application might be halibut collars. This very boney section of the halibut has been discarded with the head as unusable. However, we have processed halibut collars, obtaining a yield of 91 percent pure, delicious white meat.

There are many so-called "trash-fish" throughout the world whose flesh is very tasty but impractical to use because it is filled with bones. We are in the process of setting up an operation to process great quantities of African Bongo fish, a shad type of underutilized fish. In this case we obtain 74 percent meat yield from fish which is otherwise unusable.

To essentially discard countless tons of fish frames after filleting, without separating the 50 percent or more available meat, is almost a crime in days of increasing shortages and prices.

Bear in mind also that the discard from the separator retains its original value. It is a finely ground mixture of bone, cartilege, gristle, etc., and makes an excellent additive for prepared petfood and other animal feed -- to say nothing of fertilizer, bone meal and fish meal. Thus, the entire output of the Paoli Separator is both useful and profitable.

For some processors we have set up proposals wherein not only is the meat separated and utilized, but also the discard is processed into fish meal. We can prepare such proposals for those who are interested in this type of total system.

The Paoli Separator is equally adept at processing shellfish -- all types of lobster, crab, shrimp, crayfish, prawns, and the like.

For example conventional processing methods fail in extracting the meat from undersize shrimp; and to attempt this manually is totally impractical. In some of our installations the undersize shrimp are cooked and then passed through the Paoli Separator yielding a tasty shrimp meat paste. This meat is used in a great variety of ways such as spreads, pate's, additives for processed cheese, soups, in fish balls, made into patties and shrimp-shapes which are breaded and fried, and also added to extenders to give a true seafood base. In the U.S. coastal waters alone, this application could add 10-15 million pounds of shrimp meat annually.

One variation of processing has been to use the Paoli Separator aboard ship. In this case, meat can be retrieved and stored and the residue discarded at sea, thus increasing the amount of fish or shellfish which can be handled before having to return to port.

Not everyone may be aware of our success in the lobster industry. The Canadian government in the Maritime Provinces came to us for help in recovering meat from lobster bodies, which were normally discarded. With the Paoli Separator we are able to retrieve over 50 percent pure lobster meat from these bodies which had previously been discarded. In a Canadian government report, which we will gladly supply, this Paoli meat is considered superior to normal lobster paste. Several processors in the Maritimes are now producing this lobster meat at a rate and profit which allowed one of them to pay for the entire equipment within two weeks production.

One basic Paoli Separator (with the possible interchange of one part) can process any type of material -- cooked or raw, fish, pork or poultry.

I should point out that the basic principle of "hard from soft" separation can apply to a great many materials in addition to meat. We have successfully separated many fruits and vegetables in our laboratory. For example, we can remove the peel, stem, seeds and core from apples and deliver pure apple sauce. While these applications have not been exploited because of the heavy demands of the meat industry, they are none the less feasible and practical.

While it is not significant at this time in seafood processing, you may be interested in the fact that the Paoli Separator has been accepted by the USDA for installation and use in all types of Federally inspected plants.

Our laboratory and plant are located at Rockford, Illinois (near Chicago) where we are continually working on further development and improvement of our separators. We welcome your visit at anytime so that we may show you the operation and construction of the Paoli Separator and the exact product it will produce from your raw material.

I stand here offering you the opportunity of reducing waste and increasing profit -- increasing the meat yield from your fish by 20-30 percent. That's not a bad offer. All we need is the opportunity to prove what I have said to those processors who have not actually seen our equipment in operation -- give us that opportunity.

DISCUSSION

Q: What about the ability to adjust the Paoli out in the field and yields and will it separate skin?

A: The equipment should need no adjustment once it leaves our plant, we adjust and set it based on the nature of your requirements. If necessary, we will evaluate your raw material to be sure the settings are correct. It is pre-set for maximum yield and operation. Skin separation will depend on texture. The more textured and coarse it is the better the separation. Some skin is not compatible for separation, especially true if it is very soft.

Q: A tuna plant layout using a Paoli was shown, is such actually in operation.

A: No, not acutally, but we do have a proposal for one.

Q: What is through put versus cost?

A: Model #19, 400 lbs./hr. at $8,699

Model #20, 1,000 lbs./hr. at $14,784

Model #21, 2,000 lbs./hr. at $26,884

SESSION VI - SUMMATION

Roy E. Martin
Director, Science and Technology
National Fisheries Institute
Washington, D.C.

Our invited equipment manufacturers are to be congratulated on the excellent job they have done in preparing for this conference. With so wide a diversity in topic matter covered, it is difficult to adequately do justice to each specific input. Instead, let me sum up this session by outlining the parameters of what is available to you as researchers and potential users of this technology.

1. Basic Design: From drum slots to hole; openings in the drums from 2-7 mm; temperature rises from 0-5^{o}F; from pre-sizing to none at all and use from ship board to shore.

2. Yields: From 37 to 95%

3. Costs: From $9,500 to $56,000

4. Space Requirements: 4' x 4' to 25' x 25'

5. Throughputs: From 400 lbs. to 15,000 lbs.

6. Auxillary Equipment: Chillers, pumps, conveyors, bone cutter, filleting machines, washers, mixers, strainers, extruders, freezers, headers and gutters, cookers and grinders.

7. Species Investigated: Shrimp, cod, perch, salmon, flounder, croaker, whiting, carp, pike, mullet, lobster, crab and halibut

New heads have been designed, fewer parts used, added safety features installed and greatly improved cleanability built in. This entire list is quite an improvement over the state of the art since our last conference.

Given a specific fish or fish part there is almost nothing that cannot be done from a purely technological and mechanical standpoint.

We know a great deal more than we did at our last conference; our flexibility continues to increase.

Our success can be measured by the increased number of companies currently testing this technology and reducing it to commercial practice. This is progress, and this is why we are here.

VII.

P R O D U C T S

D E M O N S T R A T I O N

PRODUCTS DEMONSTRATION

Dr. Frederick J. King
Northeast Technology Center
National Marine Fisheries Service
Gloucester, MA

A display of products to show the range of characteristics found in commercially available and experimentally produced products.

This part of the program is a display of products derived from minced fish flesh. All of these products are from commercial sources. We do not assume complete coverage of all commercial products. Several products are in development or test marketing stages right now, and others are available commercially. To all organizations who are interested in demonstrating their samples, we offer an invitation to do so at the next suitable opportunity.

Fish sticks and fish portions are presently the most popular end products made from minced fish. Samples of fish sticks (1 oz.) and fish portions (3 oz.) were supplied by Coldwater Seafoods, Scarsdale, NY, for this demonstration.

Gefilte fish is an established product in ethnic markets. It is made from mixed species (carp, whitefish, and pike). Including it in this demonstration should stimulate discussion on mixing species for other products that are based on minced fish. The demonstrated sample bears the label of Manischewitz Food Products, but several other brands of gefilte fish are available in retail stores.

Minced fish blocks are used to make fish sticks and fish portions. These blocks can be used to make several other food items as well. A display of samples cut from commercial blocks is included in this demonstration. A discussion of a draft proposed U.S. Standard for Minced Fish Blocks will be included in another part of the seminar.

Mr. David King, King-Bartolotta Corporation, Erie, Michigan, is demonstrating several products made from minced fish which resemble well-known meat products. They include "hot dogs," "knockwurst," "ring baloney," and "full-size baloney." A fact sheet about these products and their machine to process fish into these products is supplied by King-Bartolotta Corporation.

Mr. Vytas "Mac" Maceikonis, the Nestle Company, White Plains, NY, is demonstrating the use of food flavor ingredients in three items based on minced fish. They are: 1) a canned lobster flavor spread, 2) canned codfish loaf with lobster sauce, and 3) frozen seafood stuffing. Fact sheets on these items are supplied by The Nestle Company.

Mr. Robert Stephenson, Vita Food Products, Inc., Bronx, NY, is demonstrating a smoked salmon spread and gefilte fish. Both items are sold by Vita Food Products.

Mr. Leonard Omstead, Jr., Omstead Foods Ltd., Wheatley, Ontario, is demonstrating "Fish Fries." This product is derived from freshwater fish. Its shape resembles a log, and it is deep fat fried. It is sold through Omstead Foods' brokers as described in a fact sheet.

Mr. Frank Miller, Stephen Paoli Manufacturing Company, Rockford, Illinois, is demonstrating "Paoli Lobster Meat." It is derived from lobster bodies at the North Shore Packing Company, Darnley, Prince Edward Island.

VIII.

ECONOMIC AND MARKETING CONSIDERATIONS

THE FUTURE DEMAND FOR SEAFOOD:
HOW WILL WE FILL IT?

Donald R. Whitaker
Office of Resource Utilization
National Marine Fisheries Service
Washington, D.C.

At the first Technical Seminar in Oak Brook, Illinois, a year and a half ago, Mr. Frank Holas, speaking as the head of a major seafood corporation, stated that his overriding concern was with "an adequate supply of quality raw material which will enable us to service the needs of our customers and afford us the necessary throughput to keep our major processing plants operating economically."

Now, a year and a half later, I am sure this is still Mr. Holas' major concern. And I am sure he is more convinced than ever that quality minced fish can do much to keep his plants operating economically.

At that meeting, Mr. Holas also said, "I think we should be looking at the long range picture and in doing so, realizing that our competition is not the other fish and seafood processors, but indeed, those companies that vie for the protein food dollar."

There never seems to be enough time to sit back and think through the long term prospects for this business. The long-run outlook is probably far from anyone's mind at the present time when the seafood business is concerned with the state of the economy, the decline in seafood demand, bulging warehouses, a new production season underway, and high interest rates.

Nevertheless, let's take a look at the future. Since 1972 new variables have made the short term forecaster's job a perilous one.

How, for example, would you project the resolution of monetary realignments and the almost daily changes in the values of many currencies, soaring prices, the energy situation, or the seafood market downturn that has occurred in recent months? And what of the economic trends? There were forecasts of some slowdown in the world's economies even before the energy crisis hit.

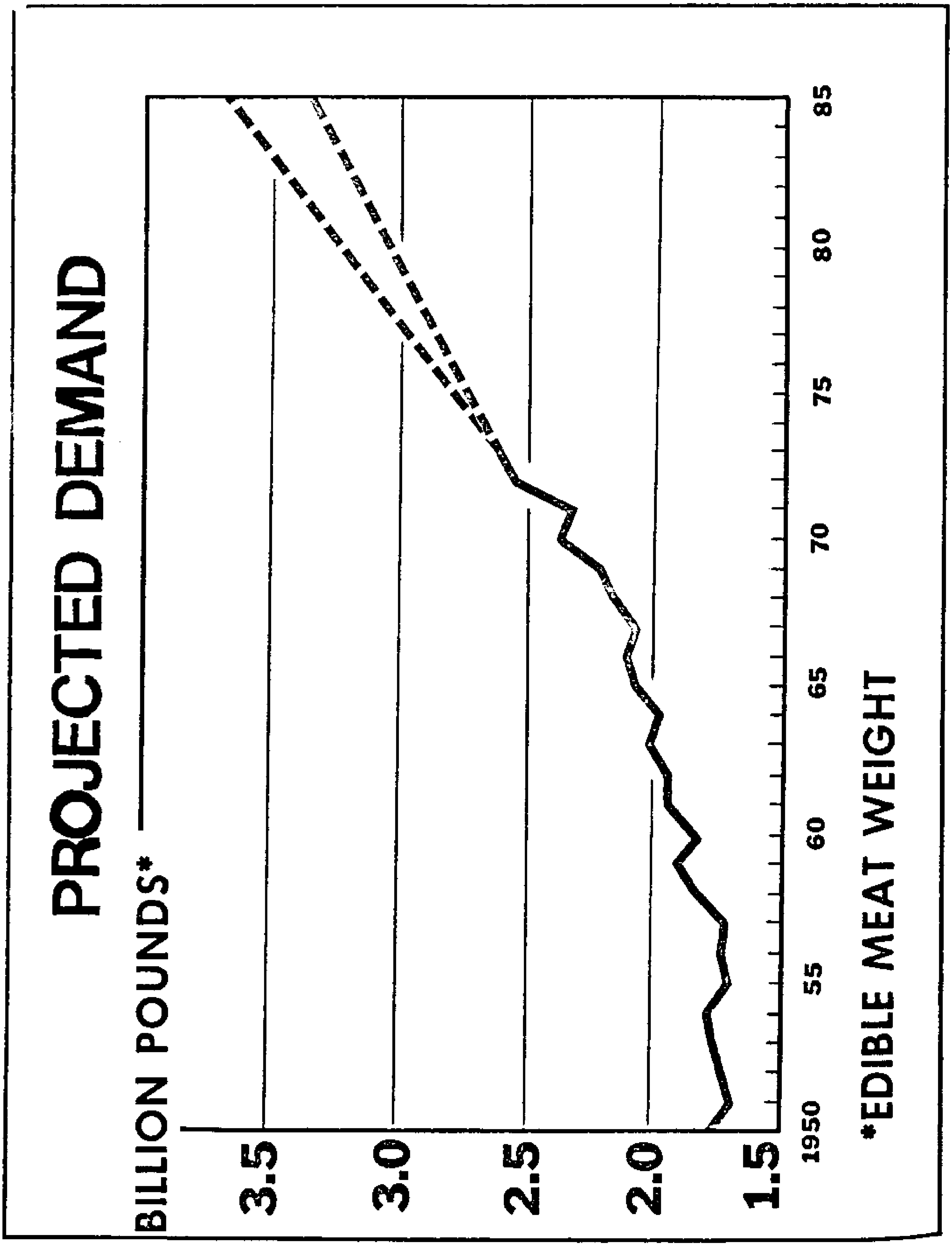
These uncertainties make it essential to examine the longer-term trends in the fisheries situation (Figure 1).

Over the longer haul, the prospects are for steady growth in the demand for seafood. I would like to point out two alternative levels.

The first is based upon the assumption that the average yearly increase in poundage since 1960 will continue. If this occurs, our needs by 1985 will total 3.4 billion pounds on an edible meat basis. This is an increase of 730 million pounds, or 28 percent over our current use.

The second alternative projects the percentage growth in demand that we have experienced since 1960. Total consumption has gone up at an average annual rate of 2.8 percent. Under this higher alternative, our needs by 1985 would total 3.7 billion pounds, up 1.0 billion pounds or 39 percent more than we presently consume.

Figure 1


PROJECTED DEMAND
BILLION POUNDS*
3.5
3.0
2.5
2.0
1.5
1950
55
60
65
70
75
80
85
*EDIBLE MEAT WEIGHT

What are the major factors that will contribute to this rising demand? (Figure 2). Increasing population plays a part -- although not as big as it used to -- because of a decline in our rate of population growth. Even if U.S. consumers did not eat more seafood than the present 12.6 pounds per capita, we could still expect a growth in seafood sales because of rising population. If the current population growth rates continue, we can expect a 10 percent increase in total consumption by 1985, just because of more people.

The other major factor I have labeled as income. It can be expected to add from 18 to 29 percent more consumption in addition to the 10 percent for population growth. Thus, its influence is about 2 to nearly 3 times greater than that of population growth. Although rising incomes are important in the demand for seafood, here I am really using income as a proxy for many other factors stimulating demand, such as the growing preference for convenience foods, working mothers, and so forth. All factors which we know are important, but which are statistically difficult to measure.

But it is the income, tastes and preferences, and other factors that affect our per capita consumption (Figure 3). Based on the previous projections of total demand, we get the following estimates on per capita consumption. By 1985, per capita consumption would be between 14.5 and 16.0 pounds, an increase of 16 to 26 percent over current consumption.

Now that we have looked at the total picture, let's turn to

Figure 2

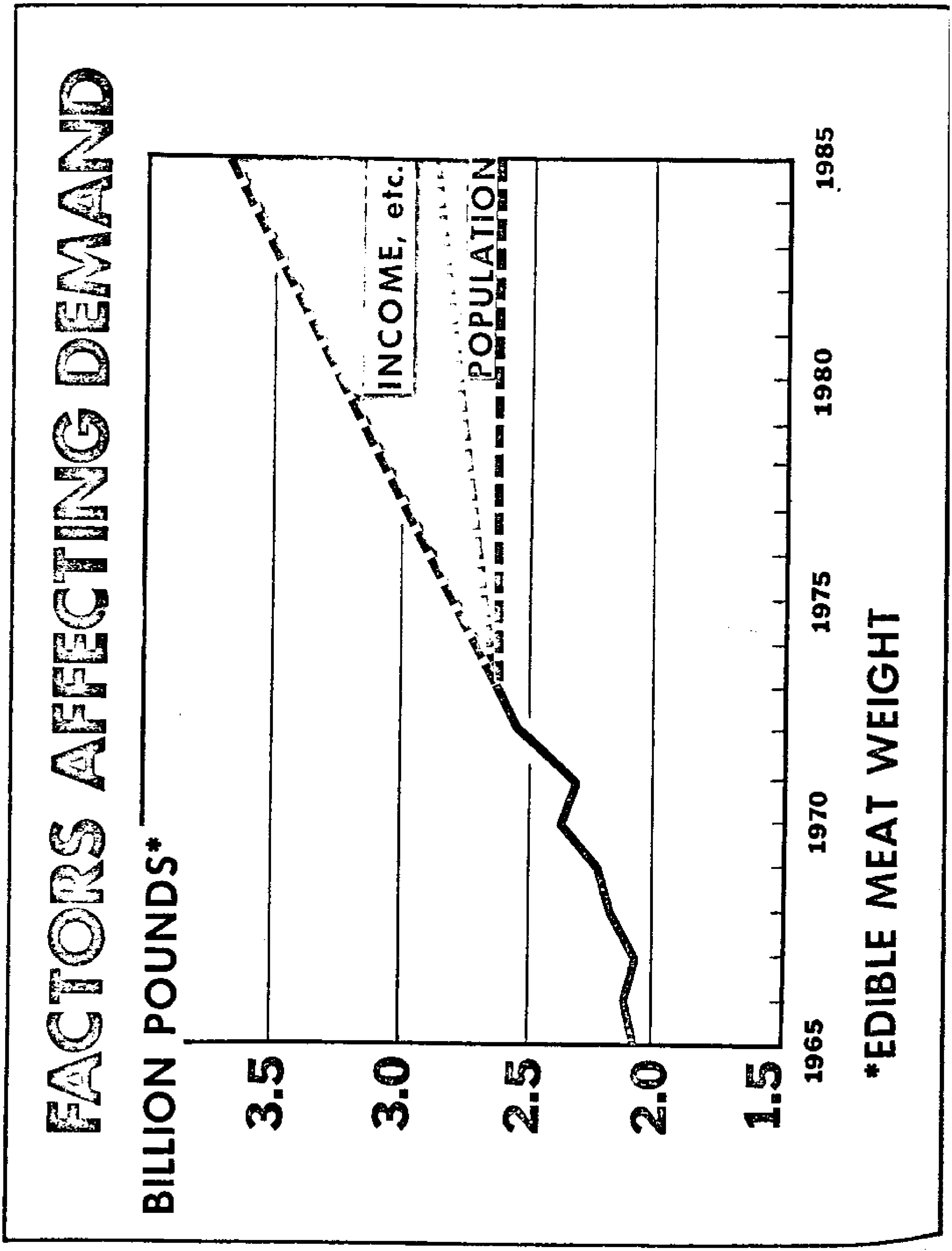
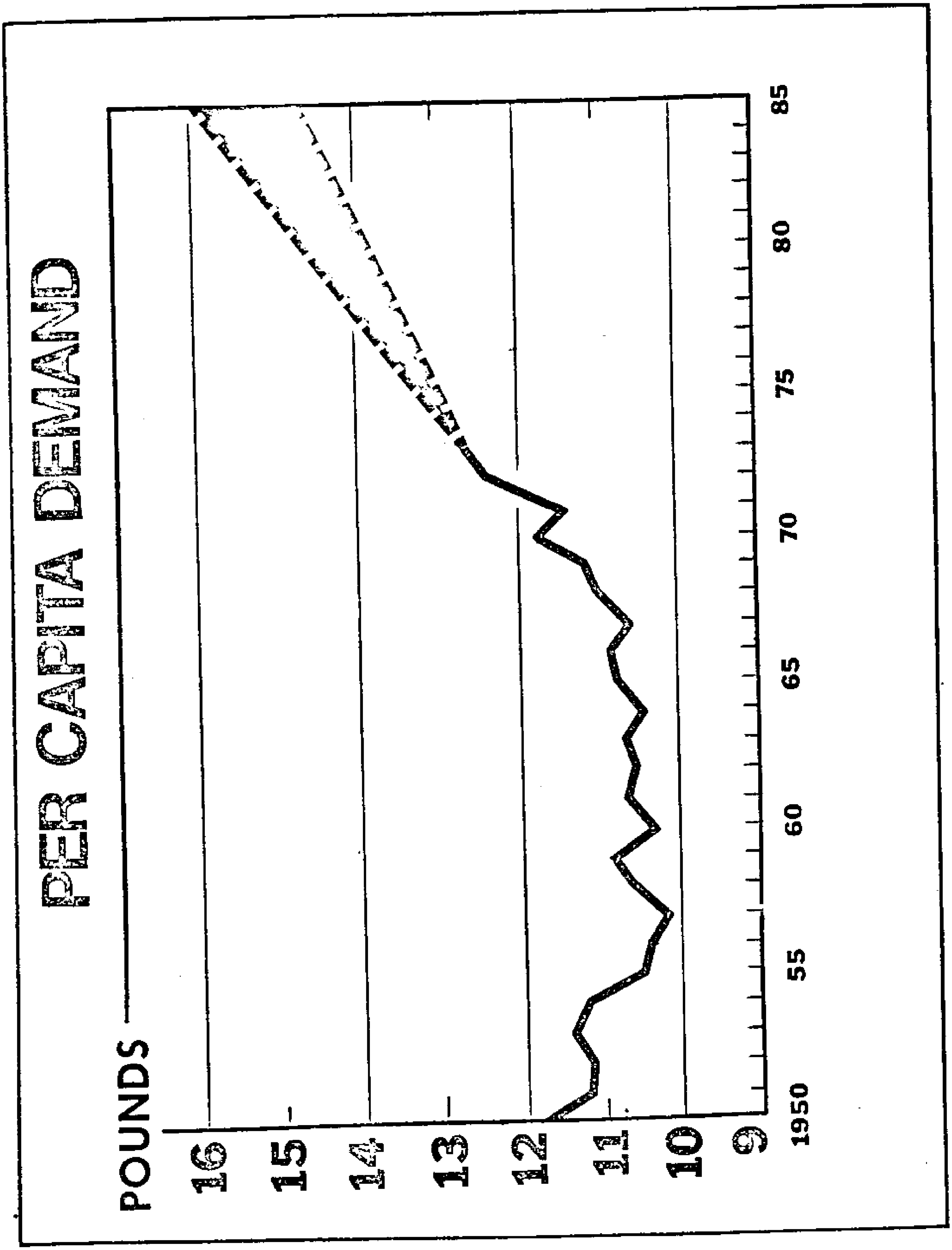

FACTORS AFFECTING DEMAND
BILLION POUNDS*
3.5
3.0
2.5
2.0
1.5
1965
1970
1975
1980
1985
INCOME, etc.
POPULATION
*EDIBLE MEAT WEIGHT

Figure 3


PER CAPITA DEMAND
POUNDS
16
15
14
13
12
11
10
9
1950
55
60
65
70
75
80
85

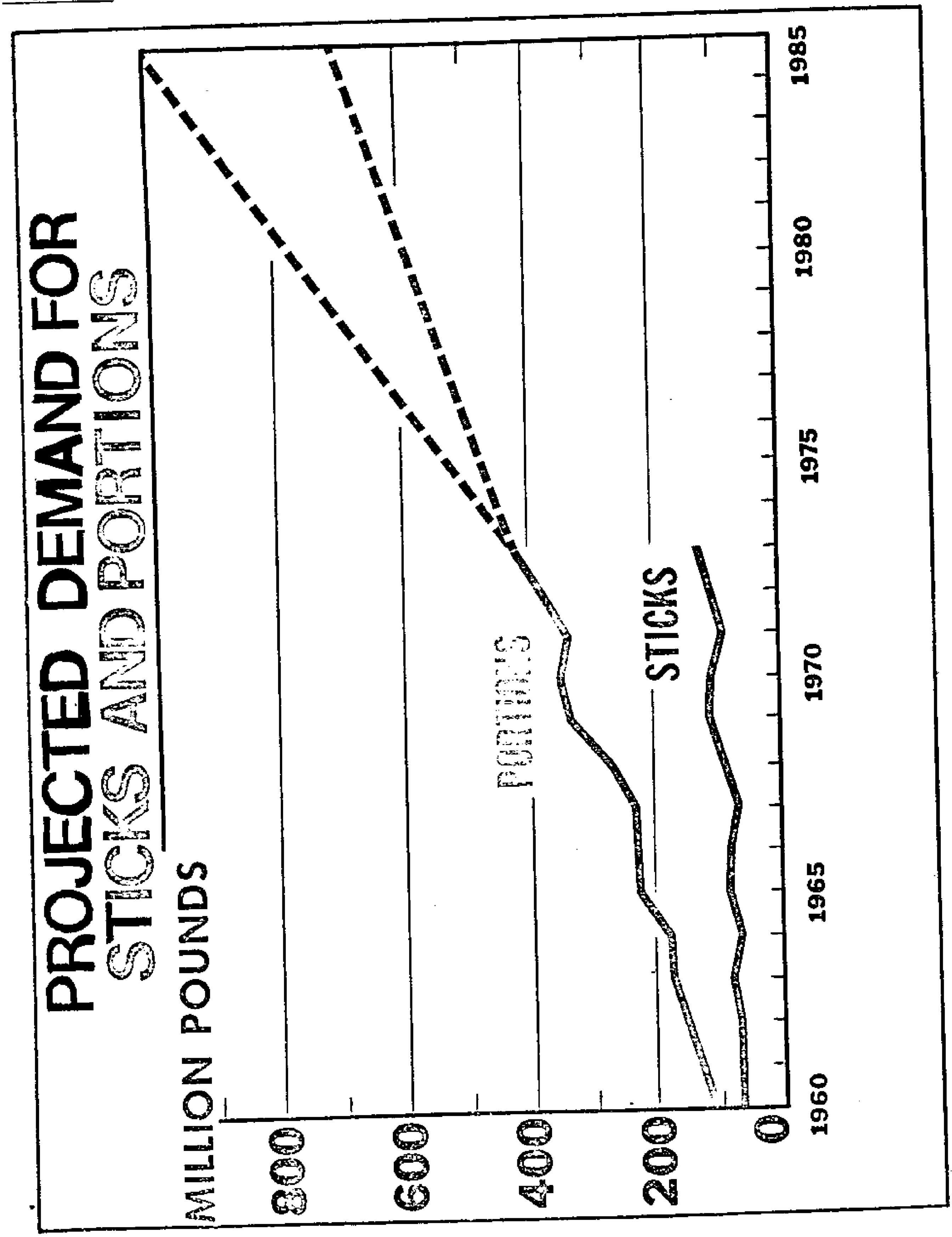
one specific item -- the demand for sticks and portions (Figure 4).

Since 1960, production of fish sticks has nearly doubled -- from 65 million pounds to 127 million pounds last year. The growth in fish portions has been even more rapid -- rising from 49 million pounds in 1960 to 296 million pounds last year -- a 6-fold increase. Since 1960, there has been only one decline in total production of sticks and portions. That occurred in 1971 when cod blocks started to become scarce and cod block prices went from 32 cents to 45 cents. After the slight drop in production in 1971, big gains were recorded in 1972 and 1973 -- total production has gone up nearly 100 million pounds in the last two years. Going back to 1960, there has never been a decline in portion production. The growth in fish sticks has been less spectacular. Production has dropped an average of one year out of three.

However, the overall trends in production are quite remarkable. Sticks have grown at an average rate of 5.3 percent per year; portions have grown by 14.7 percent per year; and total production of the two has risen at a rate of 10.6 percent per year.

The lower level projection for sticks and portions assumes that total production will continue to grow by 23.7 million pounds per year -- the average annual increase since 1960. At this rate, production would hit 700 million pounds by 1985 -- 67 percent more than last year. Now, if you take the average compound rate of 10.6 percent per year and project to 1985.

Figure 4


PROJECTED DEMAND FOR
STICKS AND PORTIONS
MILLION POUNDS
800
600
400
200
0
1960
1965
1970
1975
1980
1985
PORTIONS
STICKS

you get a fantastic increase in production -- triple what it was last year. To be on the conservative side, I dropped the rate of increase to 7.5 percent. Even at this rate, production more than doubles in the 12 years between now and 1985.

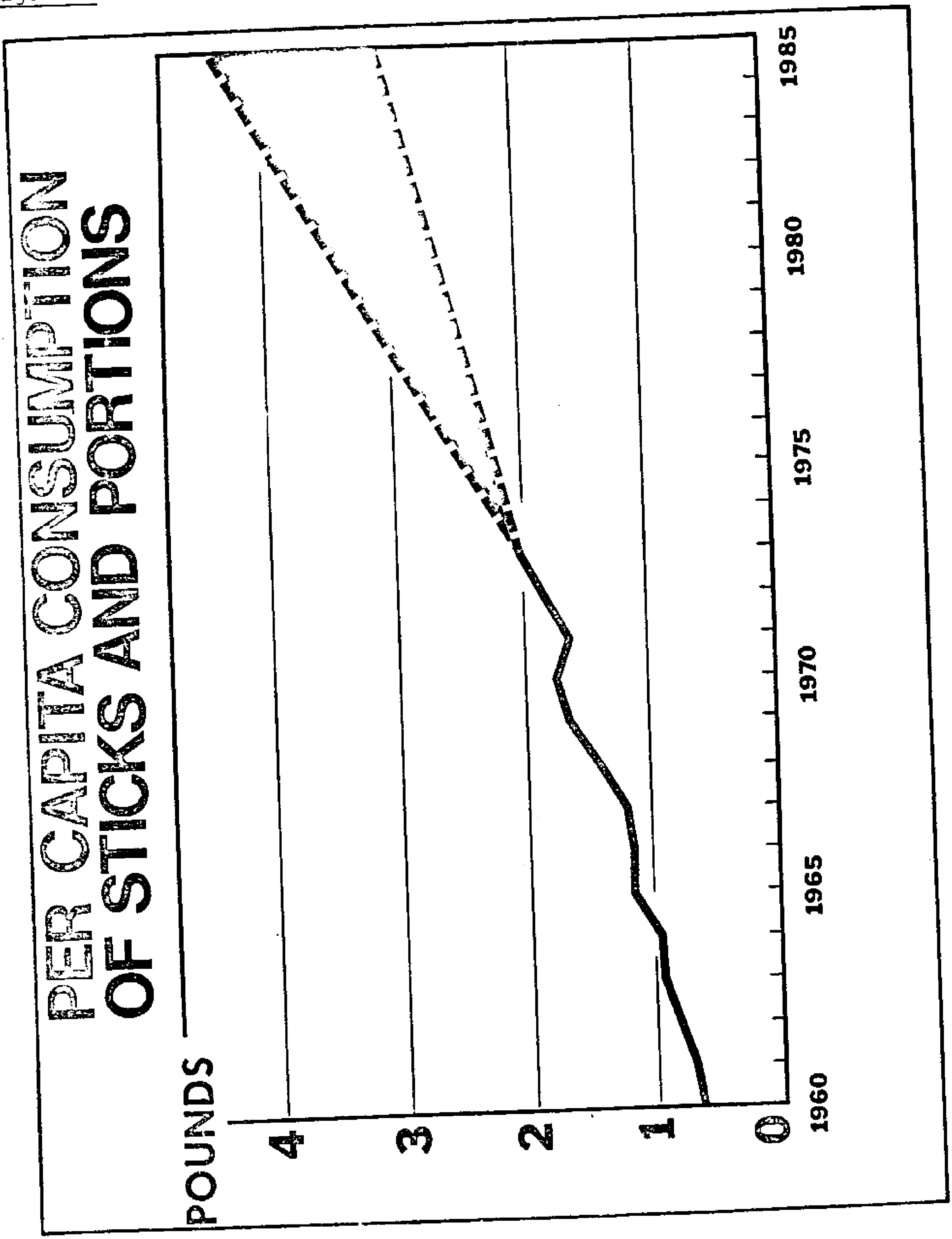
On a per capita basis, this is the picture for sticks and portions (Figure 3). Per capita production hit 2 pounds for the first time last year. Except for a slight decline in 1971, it has increased steadily since 1960. In fact, per capita production has tripled since 1960.

Under the most conservative estimate, per capita production would increase by 50 percent by 1985 -- 3 pounds compared with 2 pounds last year. Even when a slower growth rate is projected -- 7.5 percent compared with the actual rate of 10.6 percent since 1960 -- per capita production could double to 4 pounds by 1985.

Now that we have established a fairly bright picture for the future, the real question comes down as to how are we going to supply this demand. If events continue the way they have been going, we get the following picture. U.S. landings would show no increase. More likely they would trend slightly downward between now and 1985. Therefore, we would have to continue to rely on imports to meet our growing demand -- as we have for the last two decades. If this were to happen, by 1985 we would be relying on other countries for 80 to 85 percent of our seafood needs.

Aside from the question of whether our policy should be one of depending on others for our seafood, I think there is a real

Figure 5


PER CAPITA CONSUMPTION
OF STICKS AND PORTIONS
POUNDS
0
1
2
3
4
1960
1965
1970
1975
1980
1985

question as to whether other countries would be able to meet our needs.

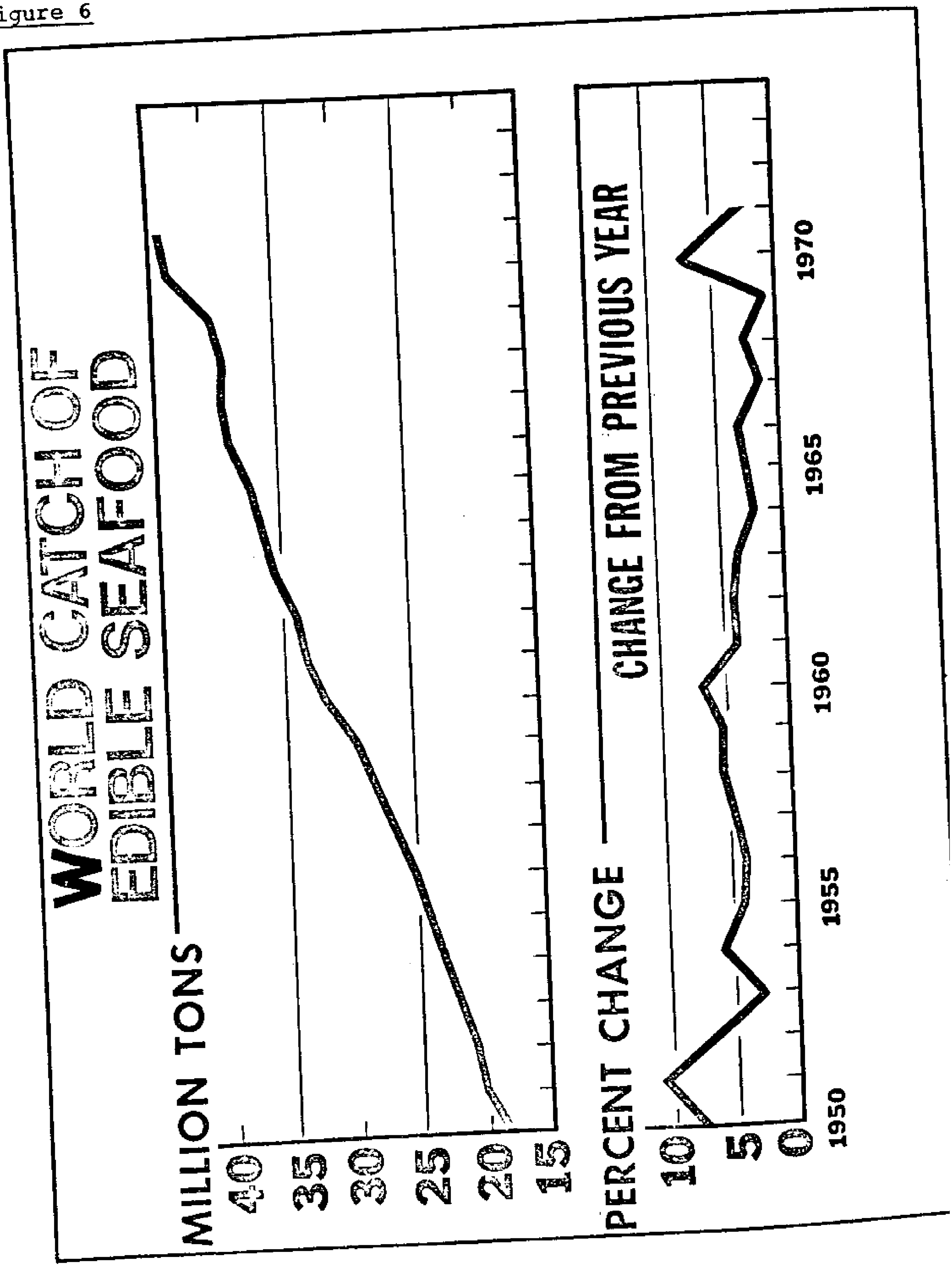
The rise in world seafood production is well known to all of us. However, the figures usually mentioned refer to the total catch and not the edible catch which is our concern. That part of the total catch used for reduction purposes has grown at a rate nearly 3 times faster than the part going into food use.

If you look closely, you will see that the steady growth in the world's edible catch has started to level off a bit (Figure 6). I might add that the latest data for 1972 just touches the top of the chart at 45 million tons.

The point I am trying to convey is better illustrated by the line at the bottom of the chart. This points out a gradual decline in the yearly growth rates. In the decade of the fifties, the average rate of increase in edible seafood catches was 5.8 percent. In the decade of the sixties, the rate of increase dropped nearly in half to 2.6 percent. For the latest year, 1972, it was only 1.8 percent, or less tha the rate of growth of the world's population. In fact, in the last 8 years, there has been only a marginal increase in per capita production when figured on a worldwide basis.

Now, keep in mind two additional facts. Number one, there is a limit as to how much we can take from the oceans. Many feel that given the current species taken and the current technology employed, world catches will top out at about 100 million

Figure 6



WORLD CATCH OF
EDIBLE SEAFOOD
MILLION TONS
40
35
30
25
20
15
PERCENT CHANGE
CHANGE FROM PREVIOUS YEAR
10
5
0
1950
1955
1960
1965
1970

tons, compared with present catches of 70 million tons.

Number two, as the nations of the world grow more affluent, demand rises. In other words, there is more competition with the Unites States for the available species.

Rising affluence usually first goes into the upgrading of one's diet. The first step is normally to switch from cereal proteins to animal proteins.

The slowing down in the rate of growth in edible catches can be traced to nearly all of the traditional species. A few will illustrate my point. (Figure 7).

We rely on imports for about 93 percent of our groundfish fillet supplies and about 99 percent of our block supplies. But when you take a look at the world catches of ocean perch and haddock, you see no rising trend which would leave you to believe that they cannot continue to help supply our growing demand.

The same is true for other popular species like salmon and halibut (Figure 8). These world figures are only through 1972. We know they both dropped further in 1973, and that they will again this year.

Yellowtail flounder is our most popular flatfish. World production of it is on a down trend (Figure 9). Greenland halibut may have offered possibility for substitution, but it appears to have peaked out and will stabilize at a much lower level.

What we see happening in one species after another is illustrated here (Figure 10). Catches are on the down trend, or at best are holding steady. However, demand is growing. And this

Figure 7

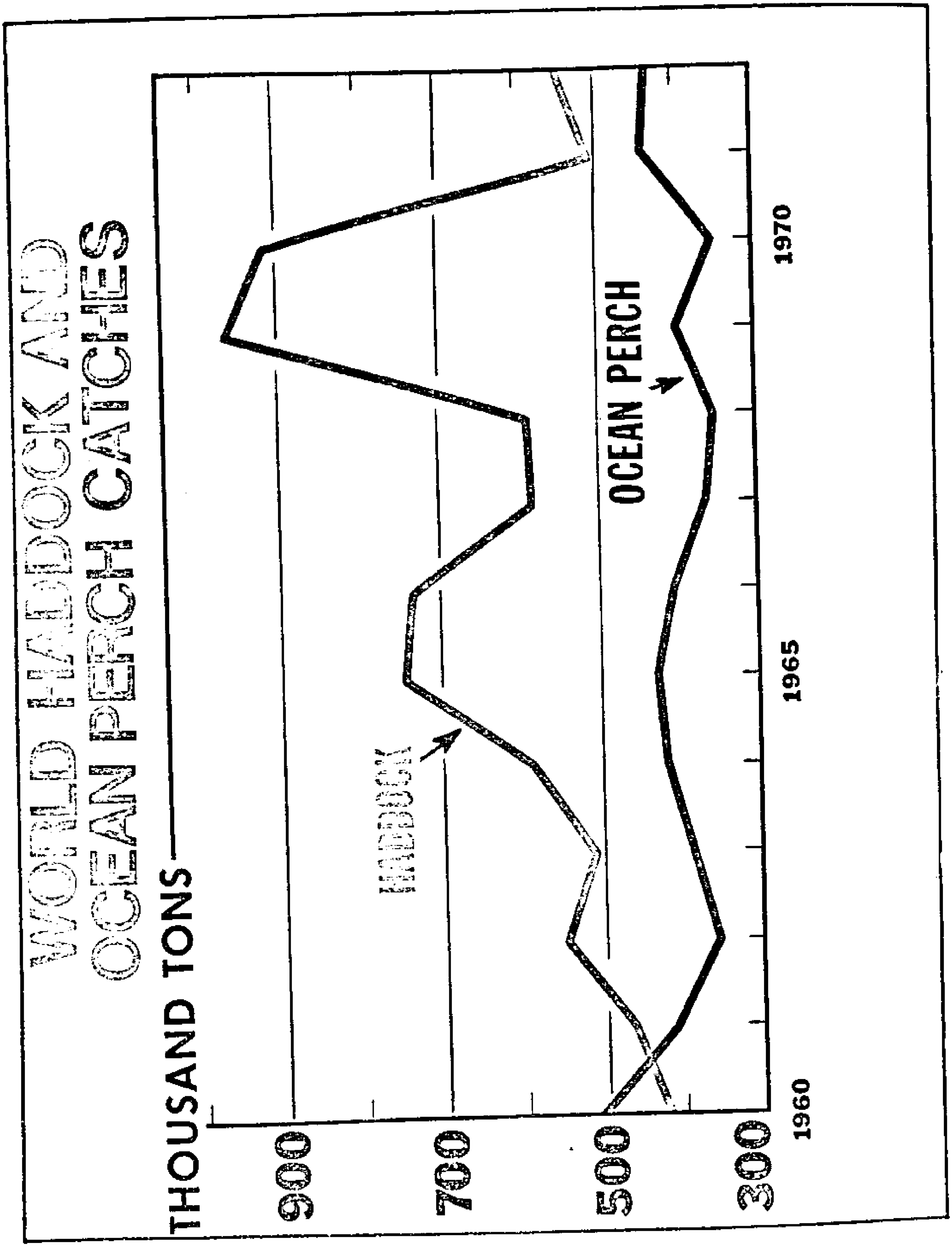

WORLD HADDOCK AND
OCEAN PERCH CATCHES
THOUSAND TONS
900
700
500
300
1960
1965
1970
HADDOCK
OCEAN PERCH

Figure 8

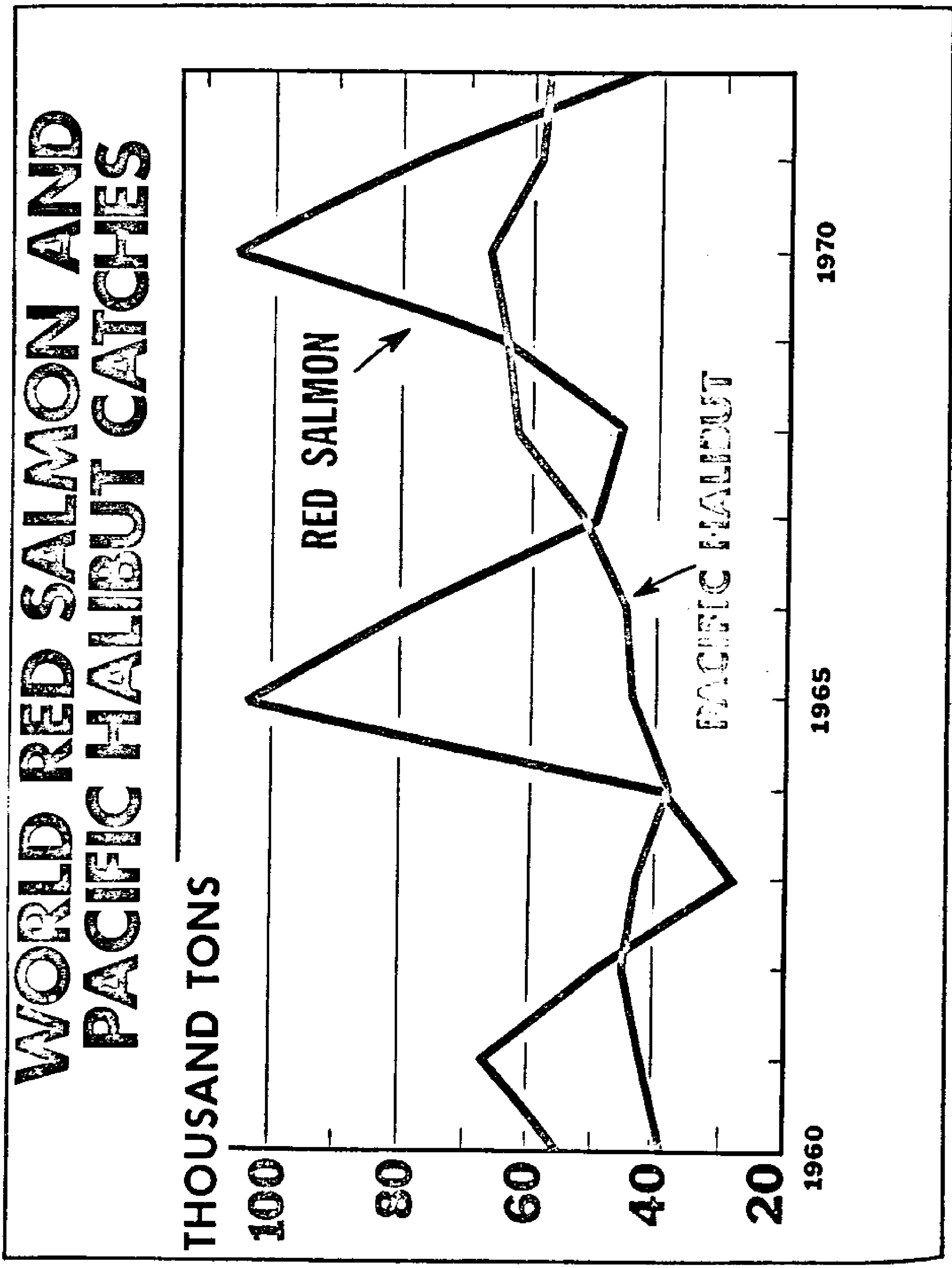
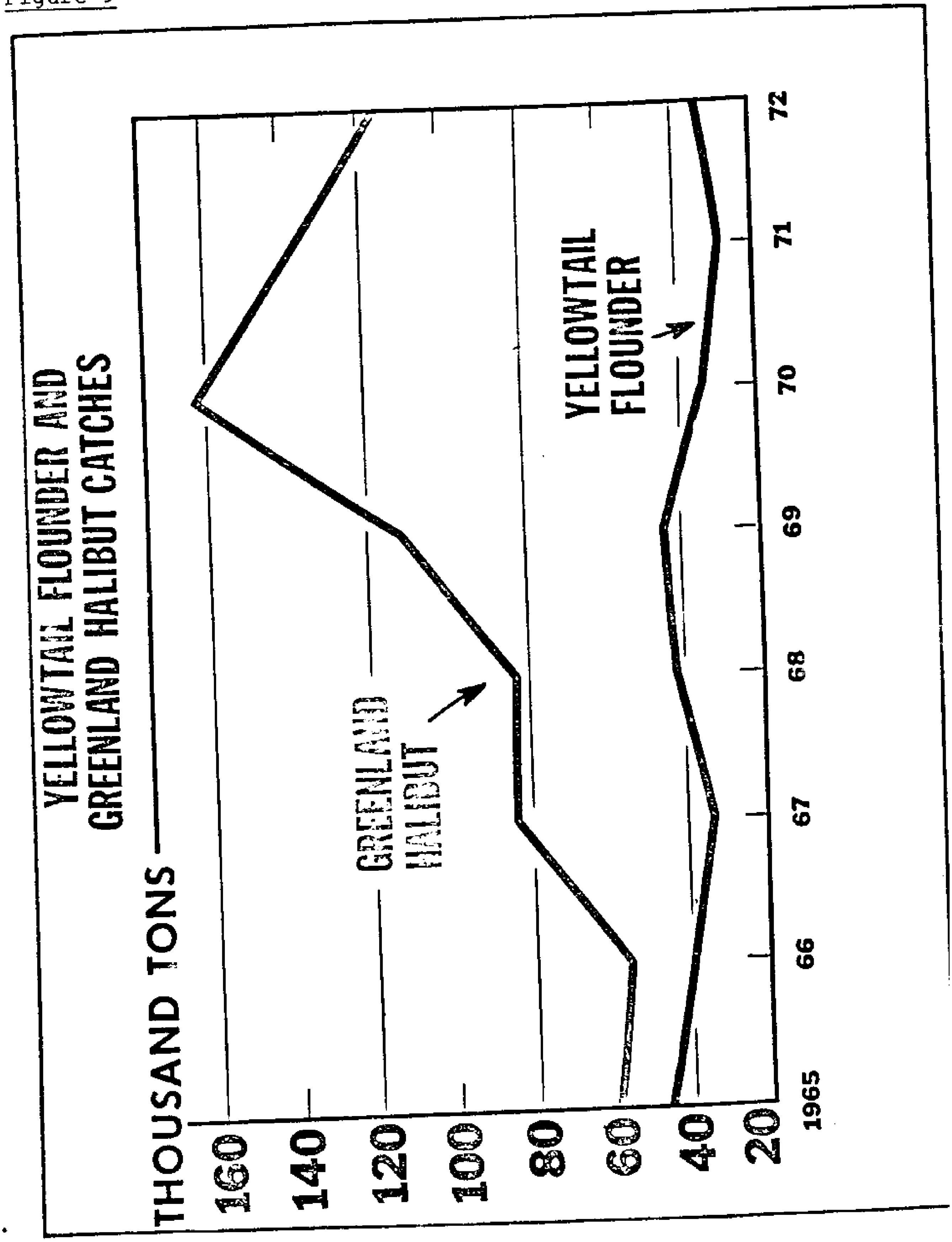
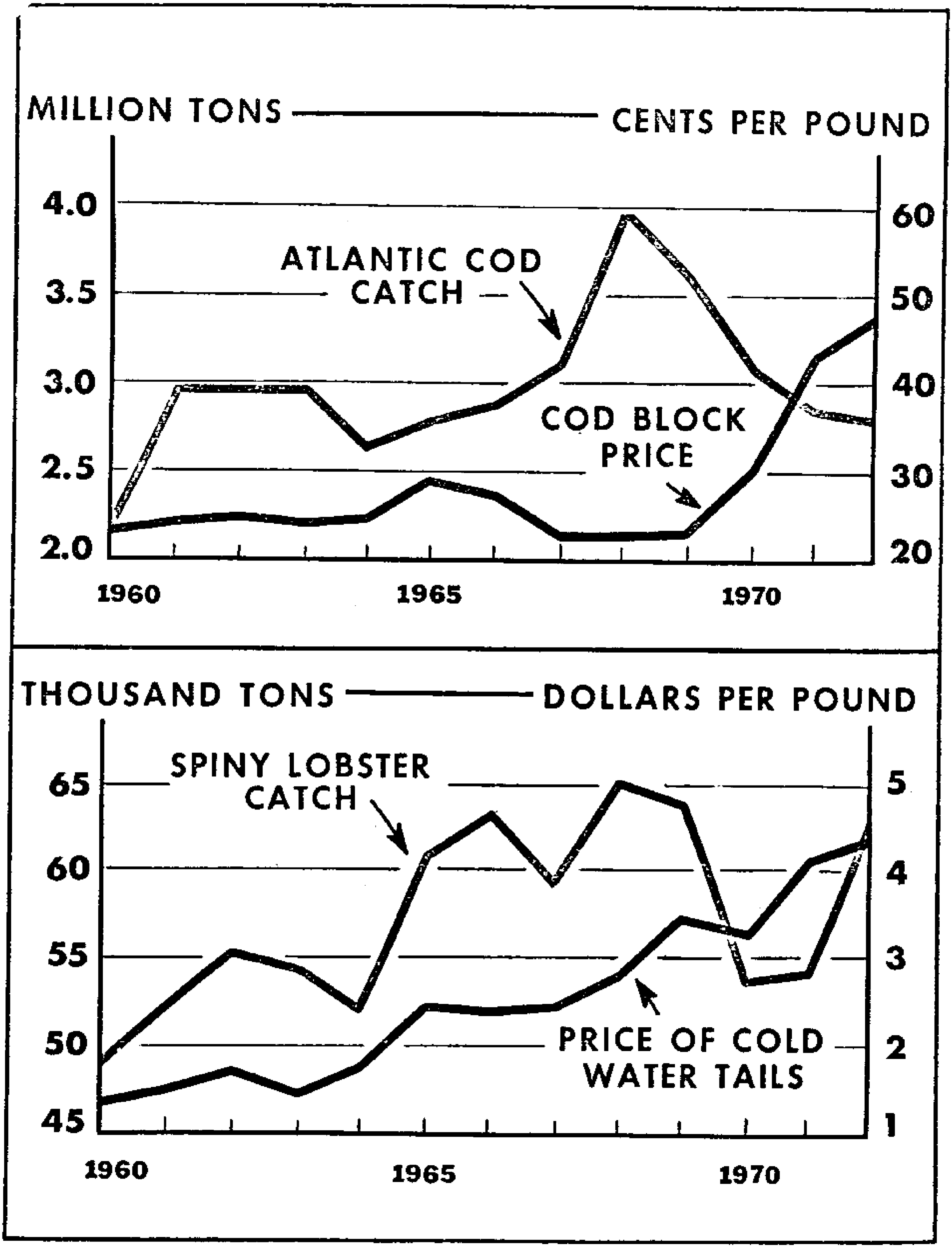

WORLD RED SALMON AND
PACIFIC HALIBUT CATCHES
THOUSAND TONS
100
80
60
40
20
1960
1965
1970
RED SALMON
PACIFIC HALIBUT

Figure 9



YELLOWTAIL FLOUNDER AND
GREENLAND HALIBUT CATCHES
THOUSAND TONS
160
140
120
100
80
60
40
20
1965
66
67
68
69
70
71
72
GREENLAND
HALIBUT
YELLOWTAIL
FLOUNDER

Figure 10


MILLION TONS
CENTS PER POUND
4.0
3.5
3.0
2.5
2.0
60
50
40
30
20
ATLANTIC COD
CATCH
COD BLOCK
PRICE
1960
1965
1970
THOUSAND TONS
DOLLARS PER POUND
65
60
55
50
45
5
4
3
2
1
SPINY LOBSTER
CATCH
PRICE OF COLD
WATER TAILS
1960
1965
1970

is pushing prices up at a skyrocketing rate.

Here again, the FAO figures only go through 1972. But we know there has been no improvement in the total cod catch and prices in recent months would be off the chart if we tried to plot them. Pretty much the same trend shows up on the spiny lobster picture. It's obvious the world catch has grown little, if at all, since 1972, or prices would not be touching the $6 level as they did a few months ago. If $5 to $6 isn't an incentive to produce, I don't know what is.

Because of this situation, I think high seafood prices are likely to endure.

This does not mean that we will not see some modest easing of prices, as we have recently. But I do not believe that the world's seafood markets will soon register the low price levels they showed only a few years ago.

In other words, inflation has had a heavy impact on the world fisheries situation. The cost is borne by all nations who either buy or sell seafood in world markets.

These are inflationary times we live in. Our own rate of price inflation has picked up in this decade of the seventies, in part a direct result of higher food prices. To most Americans, the current rates of price inflation are excessive and undesirable. Yet Americans are largely unaware that many nations today are paying for even greater rates of inflation than we are.

The Greek cynic Diogenes once pondered over the problem of high food prices. When asked about the proper time to eat, he he decided..."If a rich man, when you will: if a poor man, when you can."

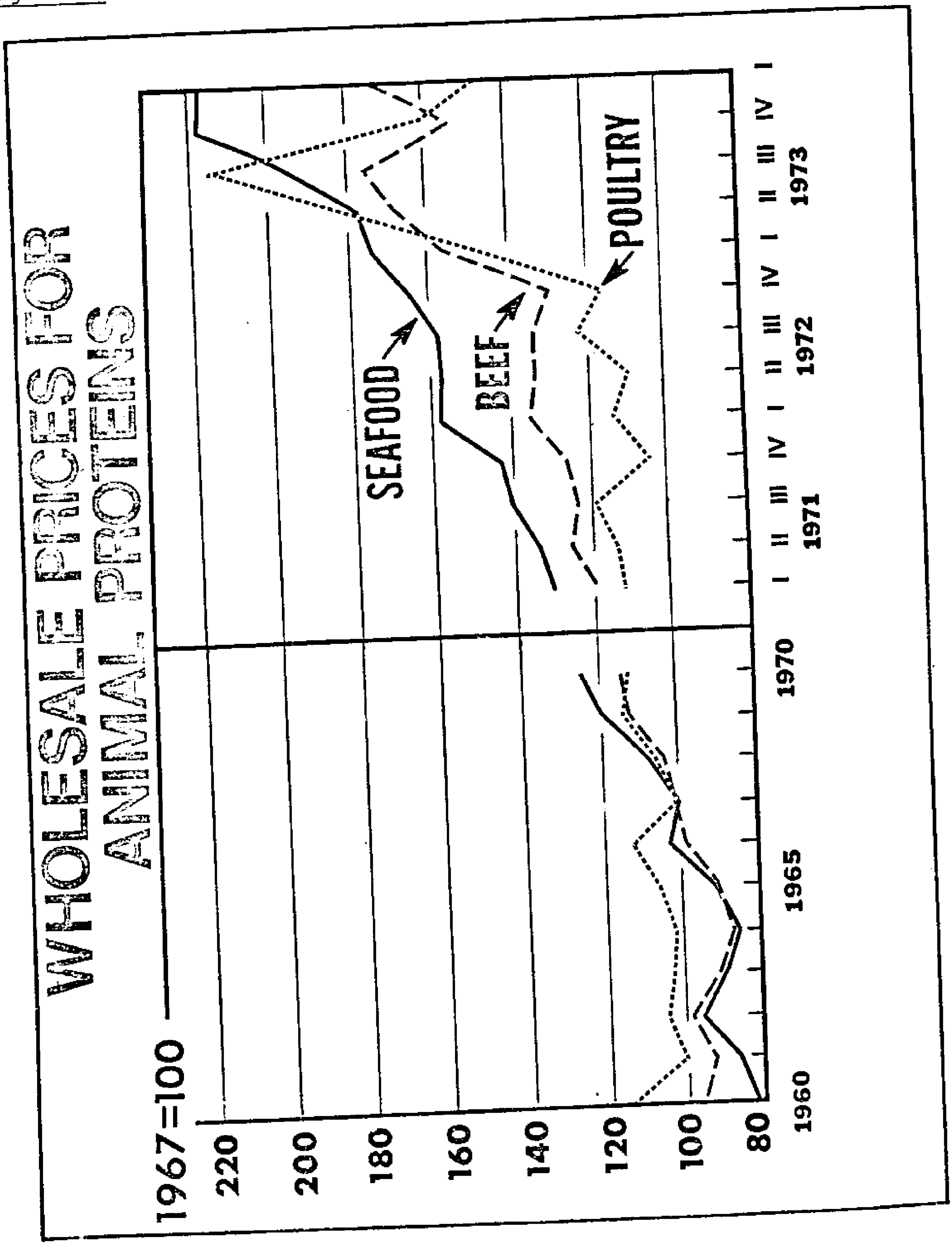
The culmination of all the events and trends I have referred to has led to two results that must be watched closely in the future.

The first has to do with the relationship of seafood prices to those of its competition -- beef and poultry (Figure 11). Looking back at the decade of the sixties, you see that the price movements for beef and seafood were closely related. In fact, you can go back as far as the thirties or fourties and find that the price movements have been quite similar. I'm not saying, and this doesn't show, that the prices of beef and seafood were the same. What is shows is that the annual changes -- whether up or down -- have been nearly the same. If over the course of a year the price of beef went up 10 percent, seafood tended to rise by about the same amount, vice-versa. In other words, the relative difference between them stayed about the same.

The way its drawn here, it doesn't show up dramatically, but there are two important dates to keep in mind. You will notice there was a slight drop in seafood prices in 1967. In addition, consumption dropped that year -- both probably the result of the Papal Decree of December, 1966 concerning the eating of fish on Friday.

However, the slump did not last long. Demand picked up, and by the summer of 1969, seafood prices started to move upward. You will recall that in the Spring of 1969, cod blocks

Figure 11



WHOLESALE PRICES FOR ANIMAL PROTEINS
1967=100
220
200
180
160
140
120
100
80
1960
1965
1970
I II III IV
1971
I II III IV
1972
I II III IV
1973
SEAFOOD
BEEF
POULTRY

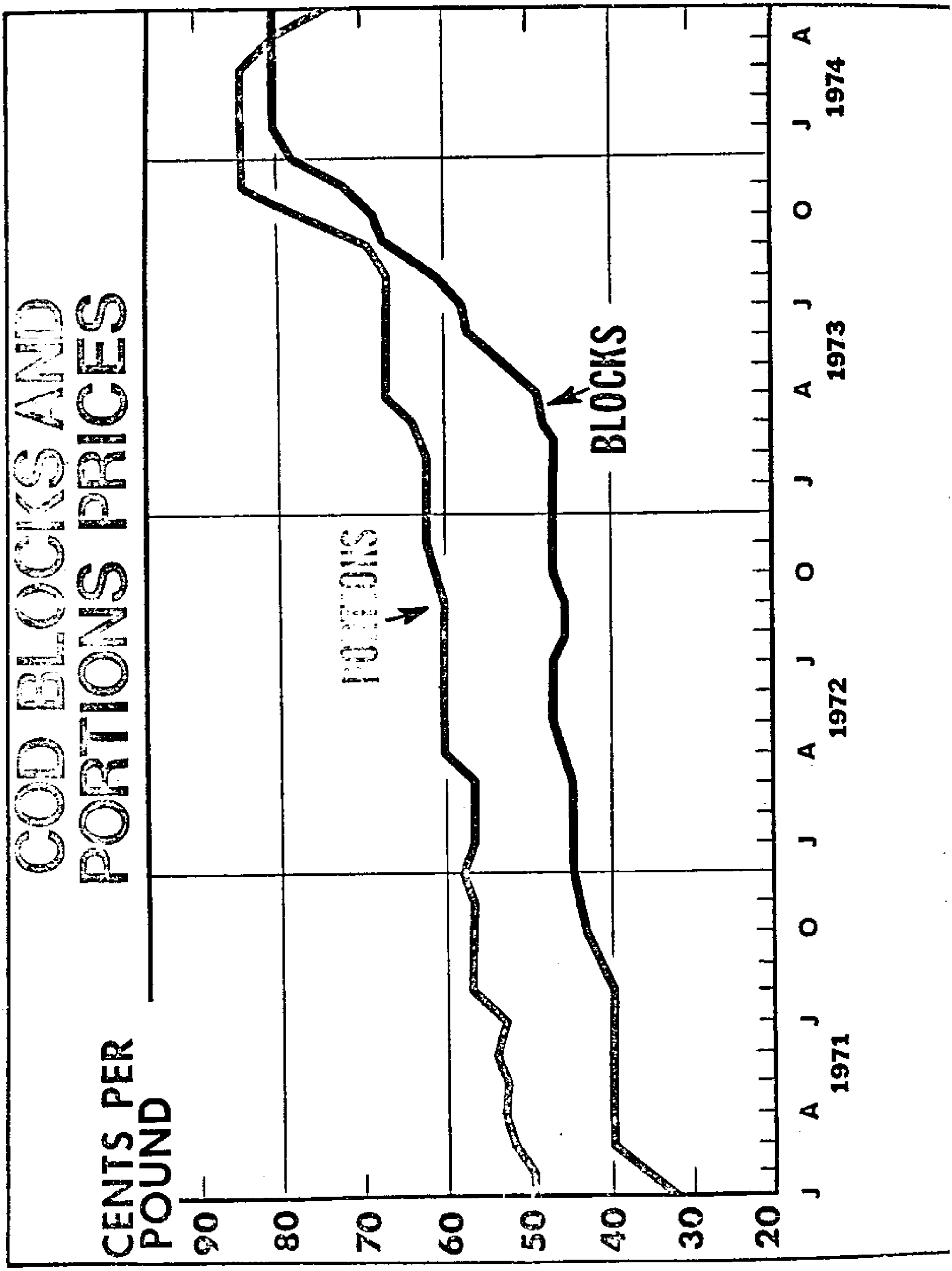
were 21 or 22 cents. Wholesale seafood prices rose 5.5 percent in 1970, 9.5 percent in 1971, 16.5 percent in 1972, 19.5 percent in 1973, and as of the first quarter of this year, they were 25 percent above the first quarter of last year.

The right hand side of the chart shows these movements more clearly. Like everything else, beef and poultry have also moved upward, but there were two differences. First, seafood has gained steadily, except for a slight pause in 1972. Beef and poultry have had a few declines along the way and when their priced dropped, promotion was heavy and demand picked up, and probably at the expence of seafood. Look at the current situation now compared with 1967, which equals a hundred on the chart. Seafood prices have more than doubled; beef is up by 74 percent, and poultry has risen by 48 percent. In fact, over the last six years, the price of seafood has risen faster than any other major food group. The relative difference in prices of seafood and its competitors has changed. The question is how much longer can seafood continue to rise at a much faster rate than beef or poultry?

How, the second result of all the trends we have discussed is illustrated in this chart (Figure 12). It is that the price of raw material is going up faster than the price of the finished product, putting seafood processors in a cost-price squeeze. It is happening for nearly every product. I could just as easily have used breaded shrimp as this example instead of cod.

In this example, I've lagged the price of blocks by three

Figure 12


COD BLOCKS AND PORTIONS PRICES
CENTS PER POUND
90
80
70
60
50
40
30
20
J A J O J A J O J A J O J A J O J A
1971
1972
1973
1974
BLOCKS

months. That is, wherever you see the price for portions, underneath it is the price of blocks three months before. Now maybe the 90 days is not the exact factor to use, but if you look at 1973 and 1975 you will find the results would have been the same whether it was 2 months, 3 months, or 4 months. Processing margins for seafood have narrowed considerably almost to the point of nonexistence. Another question is, how much longer can this continue.

It seems to me that the seafood processor finds himself in a precarious position.

1. He needs a higher price to re-establish his normal working margins. But he can't get that price because the demand is not there, and he is already out of step with his beef and poultry competition.

2. With demand putting a ceiling on prices, the textbook answer is too increase supplies and this will lower prices.

3. But here, the processor finds supplies of the traditional species drying up. Either catches have leveled off or they are on the decline at the same time competition from other countries is bidding up the price.

How can the processor breakout of this situation? It seems to me his only alternative is to turn to the moderate-priced, non-traditional species. He certainly can't wait for aquaculture -- that's 10 to 20 years off. Fishery development, such as was started here in New England a year ago, is still 3 to 5 years off. For the immediate future, it has to be minced fish.

With the concept of minced fish, industry can start to tap the 30 to 40 million tons of underutilized fish. It offers opportunities for a whole new processing industry in the United States. We will soon see this in sales of Gulf croaker surimi to Japan. Our scientists believe that as much as a billion pounds of croaker are available each year.

The concept of minced fish is comparable to the development of the fish stick in the fifties and the freezing of fillets in the thirties in that markets were expanded considerably with these developments.

Never before has the industry had the opportunities minced flesh offers in the way of shapes, flavors, textures, product combinations, and new names. Not only can minced fish expand our seafood supplies, but in combination with textured vegetable protein, supplies can be stretched even further.

The only real stumbling block I see in the bright future for minced fish is that of quality. If we rush too fast and overlook standards, quality control, appearance and deterioration in storage, this could upset the whole idea behind this emerging technology.

SOME MARKETING CONSIDERATIONS

WITH RESPECT TO MINCED FISH PRODUCTS

Joshua John
Fisheries & Marine Service
Department of the Environment
Ottawa, Ontario, Canada

I am delighted to participate in this Seminar and particularly on this panel dealing with "The Economic and Marketing Considerations Surrounding Minced Fish." My assignment is to speak specifically about the marketing problems and opportunities. As you all know, this subject has increasingly occupied the minds of many marketing men in recent months. I must confess that I cannot speak on the topic with any degree of empirical expertise. This is because I am not really a "marketer" but only a student - and perhaps a keen one - of the marketplace and of the fish marketing process. I hope this qualifies me to make at least some rudimentary observations on the subject of our discussion today.

There is one thing we can say about the contemporary fish marketing scene without fear of contradiction, and that is - it is always changing. And, minced flesh and minced fish products are part of this change.

The topic of minced fish conjures up in our minds the wave of the future. From the point of view of the producer, it represents a concept of the maximum and economical utilization of a harvested resource. From the marketing man's point of view, it represents a product-offering of good value at a relatively low price. From the consumers' viewpoint, it represents a "good buy" with perhaps a good deal of what the economist would like to call "consumer's surplus" in it. In short, it is hailed as the untapped bonanza of the fisheries.

During my remarks, I shall first deal with some of the marketing problems surrounding minced fish products; then, I shall proceed to outline some of the exciting opportunities that lie ahead; and finally, I shall touch on some of the ways and means of transforming our great expectations concerning minced fish into a reality.

What then are the marketing problems with respect to minced fish products? I refer here to the marketing problems of the producers of minced flesh as well as the marketing problems of converters who use minced fish as a raw material to make end products. Broadly speaking, we can identify four distinct problems: first, there is the general problem of marketing management that accompanies the introduction of a new product. A new product represents a cycle of change in an otherwise well established and traditional marketing pattern. Each cycle brings with it problems of adjustment. Sometimes, this adjustment process becomes protracted and cumbersome; sometimes it is easy and short-lived. To be beneficial, this cycle of change must be controlled in accordance with market needs. In introducing a new product, the marketing man has to virtually go back to the drawing broad and ask the same old questions he has asked before while introducing other older products. Basically he has to meet five tests. I would like to call them market survival tests. The very first is the test of profitability. Secondly, the growth potential test: that is, whether or not there is a need for the product in the marketplace and the extent to which there is room for the growth and development of the market to provide as wide a market base as possible for the product. In other words, how big is the present and potential market? Thirdly, the competitive test; whether or not the product has enough strength and superiority to compete with traditional and even future potential products. Fourth, the distribution test. The question here is whether or not the new product - in our case, minced fish products - will use existing distribution facilities; or will it require new facilities and channels of distribution. And finally, the investment test. The point here is whether or not the product requires a high or low level of new investment.

Associated with investment is the stability test. That is, those who are planning to invest in this new area must have some reasonable assurance that the rules of the game will not be changed with any degree of frequency. In order to market minced fish products successfully, the marketing man has to meet these basic marketing survival tests.

A second marketing problem with respect to minced fish products stems from the general tendency of the average consumer to perceive price as an indicator of product quality, even in these days of stretching the food dollar. The general consumer feeling is that "you get what you pay for." Such an entrenched attitude can pose a real danger to the marketing of minced fish products. Within the context of high food prices, the sudden introduction of relatively low-priced items, as for example minced fish end products can create a backlash effect on demand. In order to avoid this danger, a good deal of consumer education and promotion is required to disseminate the real values of the product and to build up sufficient consumer confidence. Not much is known about the consumer likes and dislikes about minced fish products, as yet. This aspect seems to be the "dark continent" on the marketing scenario at present. I hope that in the immediate months ahead we will be able to explore this area in some detail.

A third marketing problem is the prospect of a sudden and almost overnight entry of too many producers and converters into the production of minced flesh and its products, without adequatel preparing a durable and expanding market base. The presence of super-normal or above average profits in a particular product or products can attract too many producers with little or no competence in ensuring product quality and marketing. A sudden over expansion in production followed by a glut in the market has been the perennial problem of almost all primary industries. Fisheries have been by no means an exception to this general phenomenon. In the fishing industry, we have had far too many ups and downs in the past and these have always left devastating effects on the primary, secondary and marketing sectors. "Those who cannot remember the past are condemned to repeat it." Let us therefore, make every effort to exercise caution and to avoid an over expansion in production without paying corresponding attention to the consumer and the marketplace.

And finally, in the absence of well defined and strict ground rules with respect to quality, minced flesh is showing up in the market place in a wide range of quality spectrum, all the way from good to poor. For a new product trying to gain a footing in the market, this type of inconsistency and variability in quality is a real handicap. And to the converter, who goes in enthusiastically to buy and use minced flesh in the production of end-products, this may and has in fact, produced some initial disenchantment. To date, quality control has been one of the main problems surrounding minced fish, and the future marketing prospects for minced fish products will depend to a large extent upon the degree of success attained in eliminating these quality problems.

Let me now turn to the marketing opportunities with respect to minced fish products. To understand these opportunities, it is essential to take a look at the present and emerging marketing environment for fishery products. Our general marketing environment is characterized by several major factors. First, the growing pressure on existing food resources and an anticipated shortage of animal protein by the year 1980. In mitigating this anticipated protein gap, seafood can play a significant role.

Second, within the general context of rising food prices and inflationary trends in the economy, there is a growing pressure and search for cheaper priced food items. Third, in response to this and also because of the growing cost-price squeeze, producers are increasingly looking for alternate and cheaper raw materials in order to market reasonably priced consumer products. Fourth, the growing cross-elasticities within the various components of the food sector and particularly between meat and fish. The consumer is becoming more and more price sensitive and appears to be switching from one protein source to another primarily on the basis of price.

From a purely marketing standpoint, one of the greatest strengths of minced flesh is the substantially lower labor cost involved in its production. For example, the production of minced blocks requires only 1/3 the amount of labor that goes into a regular fillet block. At a time when labor costs are becoming a big factor in production costs, minced blocks offer a very attractive escape route. It provided a fairly cheap raw material for the production of fish sticks, in comparison with the traditional fillet blocks.

Another strength of minced fish products is the virtually unlimited size of the potential future market. The market for convenience foods has been rapidly increasing over the world as a whole. And, what is more exciting is the future possibility of even traditional markets such as Japan turning to convenience foods on a massive scale. As incomes rise and as the retail and merchandising revolution begins to make an impact on traditional markets, the demand for convenience foods will most likely grow to fantastic proportions. Basic population growth is an additional factor which will reinforce such a growth factor.

A third marketing opportunity for minced fish stems from the high degree of versatility that it seems to possess. That is to say, it lends itself readily to be blended with other ingredients such as vegetable protein, meat, cereals, cheese, potatoes, etc. It permits numerous food combinations to suit the tastes of discriminating consumers. Thus, it lends itself easily to new product development. In the context of today's and tomorrow's food prices, minced fish products represent high value at a relatively low price. This appears to be the fundamental strength of the product. Minced fish products appear to have demonstrated some measure of success in the retail market segments in the United States. Its success in the food service market is now awaited and will be watched with much interest by all.

How do we go about tapping the untapped bonanza? What must we do to seize the opportunities? A philosophical approach to this question could be summed up in the statement that "you cannot strengthen the weak by weakening the strong...you cannot help the poor by destroying the rich." In terms of marketing, what this means is that we cannot afford to weaken the market for traditional fish sticks and portions in order to strengthen a completely separate market for minced sticks or portions. Similarly, we cannot afford to destroy the market for traditional sticks and portions in order to build a new market for minced sticks and portions. The salvation of the new product lies in making it a part of the traditional line and thus, in marrying the old and the new. On a more practical level, it is necessary to undertake a good deal of support work in terms of consumer education, market development and promotional literature. We need to bring into force a very comprehensive and energetic consumer education program, while at the same time working on all the other elements of marketing, viz. products and product quality, distribution, price, research and marketing intelligence. Today, more than ever before, the marketing field is experiencing a greater impact of the behavioral sciences. Therefore, it is most essential to make a special effort to inform consumers about the nature and characteristics of the product. We need to know what the consumer's attitude is towards the product; we also need to know what consumer habits affect the product. To this end, we need to put marketing research to work early in the marketing planning exercise. We need consumer panels, consumer tests and consumer education. Actually, we should build the entire marketing program for minced fish products around the consumer. Perhaps, the following quotation from a speech by Mr. Edwin Ebel of General Foods before the 1958 Marketing Conference of the National Industrial Conference Board would give us some perspective with respect to minced fish products marketing. Mr. Ebel said:

"So long as men thought the earth was the center of

> the universe, a true understanding of it was impossible. Only after Copernicus came up with the theory that the sun was the center, and our little earth was just one of several planets that moved about it -- only then were astronomers able to make correct observations and reach sound conclusions..."
>
> "Now, if we think of our product (in this case, the minced fish product) as the center of a small business universe, we are as wrong as the ancient Greeks. Actually, the consumer is the center of the business universe and any product is simply one of a legion of planets that move around the consumer....As far as we, as marketers of consumer products are concerned, the thing the consumer is loyal to, is his or her own convictions as to what is best for his or her own best interests."

In line with this excellent expression of marketing philosophy, I sincerely hope that those of you who are engaged in, or those contemplating to engage in, the marketing of minced products, will endeavor to follow closely the consumer interests.

In closing, I would like to add that this whole area provides an excellent and fruitful opportunity for government-industry cooperation. Jointly, government and industry can identify where we are today, where we want to go and what we we must do to get there. In the long-run, the fundamental merits of minced fish products (assuming satisfactory quality control and inspection) from the standpoint of value and price should make it a successful marketing proposition.

SESSION VIII - SUMMATION

Donald R. Whitaker
Office of Resource Utilization
National Marine Fisheries Service
Washington, D.C.

We have a growing demand for seafood. We have fishery resources to meet this demand. We have an important new technology to utilize these resources. So, what's the problem? Why are we gathering at Oak Brook one year and Boston the next? We're here because it's a long way from the beginnings of laboratory research to the marketing of products.

If a company is to grow and prosper, it must engage in new product development. For the food industry, the chance of success with new products is 20 percent or less.

If minced fish is to be successful, it must overcome a host of marketing problems.

1. You cannot assume anything; you have to start at ground zero. It's like reinventing the fish stick, but 20 years later.

2. Practically nothing is knew about the consumer likes and dislikes for these products. The consumer is more price conscious than ever before. So, a lower price should be a plus factor. Offsetting this is the possible backlash that a lower price will mean lower quality in the mind of the consumer.

3. Another problem is the ease with which too many processors can put too much product on the market without testing

the market and the possibilities for expanding its base.

4. Variability in quality can be a big handicap. This doesn't mean it all has to be bad. Maybe only 10 or 15 percent can affect all production because no buyer wants to take a chance on the quality. Apparently, it took only a few bad experiences to turn off the Georgia school system.

But all these problems are worth tackling because of the opportunities which lie ahead.

1. Consumers recognize inflation quicker in their food bills than in any other area. They are actively seeking lower priced alternatives. In this respect, the time was probably never more right than now for the introduction of minced fish.

2. The timing was never more right for the processor caught in a cost-price squeeze.

3. The market seems almost unlimited, especially for convenience food. In this context, minced fish has the versatility which lends itself easily to new product development.

The real question is now are we going to get the consumer to try these products. We know they have the nutrition she wants, the convenience she wants, and are in a general price range which is attractive.

A couple of years ago, Mrs. Paul's bought all, or nearly all, of the advertising time on the Johnny Carson Show one night. But how often do we see this happen?

Consumers must be informed about the products, and likewise, the industry must know the consumers' attitudes. There is much for marketing research to do.

IX.

STANDARDIZATION

QUALITY ASSURANCE

AND

NOMENCLATURE

INTRODUCTORY REMARKS

SESSION IX

L. J. Ronsivalli
National Marine Fisheries Service
Gloucester, MA

Under conditions in which an ample food supply is available, the continuing market demand for any given food depends on a number of basic requirements that it must meet. To cite one such important requirement, the food must be of good quality when purchased by the consumer. It is the only sure way to generate and maintain consumer confidence and repeat sales.

In order to insure good quality, there must be reliable tests for quality and there must be a set of criteria such as quality standards that permit the evaluation of the results of those tests. These remarks apply even more so to new food products or new food forms. In the case of new food forms, where there are significant departures from standard processes, we need also to be concerned with labeling requirements as well as proper and legal identification of the products.

Minced fish is a new food form, to some countries at least, and the papers and panel discussion that follow address themselves to the importance of quality in minced fish.

INSPECTION OF MINCED FISH BLOCKS

Thomas Billy
Fishery Products Research and Inspection Division
National Marine Fisheries Service
Washington, D.C.

The specific subject I will cover today is the role or relationship of fishery products inspection to developing minced seafood technology. The approach I will take will briefly describe our voluntary fishery inspection program and the types of services we provide. Then I will relate our inspection activities to the topic of the seminar concerning fish flesh and its utilization. The need for product standardization and inspection, particularly minced fish blocks, will also be discussed. Efforts presently underway to provide the necessary tools or yardsticks to improve current problems will be described and finally, I will make some recommendations for followup action by industry, researchers, and government inspection representatives.

First, some background on the inspection program itself. The fishery products inspection and safety program is operated by the Office of Resource Utilization of the National Marine Fisheries Service. Our agency is a part of the National Oceanic and Atmospheric Administration in the Department of Commerce. The voluntary program provides inspection certification and technical assistance to producers and for all types of processed fishery products, including minced varieties. The program is based on the application of approved product specification and official standards for grades, identity or sanitation.

Fishery products that have been processed in a plant under our inspection program and meeting all our requirements may then be identified with our official inspection shield. This is the round mark with "Packed Under Federal Inspection" on it. This mark indicates to consumers and product users that the seafood was produced under good sanitary conditions, that it was wholesome and that it had reasonably good flavor and odor at the time of inspection. In addition, if the inspected product should meet special quality standards, the product may be labeled U.S. Grade A. The grade mark indicates that the product rates high in all quality factors. The next speaker, John Ryan, will go into this area in considerable detail when discussing the draft of a minced block standard.

Our quality concerns fall into three areas. First consumers, then idnsutry, and finally problems that we face within the inspection program. With regard to consumers, I will cite a few examples of actual cases that occurred lately. Two hundred thirty-seven pounds of blocks made from minced cod and pollock here rejected by a processor on account of poor texture and color. Eight thousand pounds of precooked minced fish sticks were rejected by a school system. The order of 8-9,000 pounds of minced pollock portions was cancelled after the first shipment because of rubbery texture. Twenty-six thousand pounds of 2-3 ounce fried portions of minced cod were rejected by another school system. Six thousand pounds of three-ounce minced cod portions were rejected and 600 pounds of that product was actually dumped. Three thousand pounds of one-ounce, fried sticks of minced cod were also rejected because the school children would not eat the product. Reasons given: poor color (grey), product did not appear cooked after preparation probably because of excessive tripolyphosphates, poor texture (tough and rubbery.) It is my understanding that the State of Georgia has now banned any further use of minced products in the school lunch program there and that several other states are considering similar action. I believe this situation could develop into a critical one and impact severely on the acceptance of minced fish blocks. In fact, if we are not careful, we could have a repeat of the situation that developed in the emerging stick and portion industry years ago where adverse market reaction turned consumers off completely for several years.

I think the potential for a repeat with minced products is even greater here because of the technology involved. Not only can we in the U.S. and Canada use this technology, but any country in the world can, who catches some kind of fish, turns it through a machine, puts it into a block and exports it to those countries who consumer this kind of fishery product. Now with respect to industry problems, they are numerous. There is great difficulty in defining raw material requirements and specifications and specie limitations. There is also difficulty in defining processing requirements through this emerging technology. What limitations should be placed on processing? There are problems in developing effective quality control procedures. The products change during storage and we are just beginning to understand about some of these things. Questions in deciding about the use of additives. Which ones? Does EPA approve them or not? There are additional problems in labeling which will be discussed later.

Our inspection program is also facing several problems. First the demand for inspection of minced blocks and product is increasing; yet, we have not tried or tested standards available at this time. Existing product specifications leave much to be desired. We are receiving increased consumer complaints about inspected minced block products. Quality changes during storage and after inspection are one of the principal causes. We, also, recognize that there is a need to make changes in the inspection program to meet current industry needs, particularly in the minced fish area. Now what efforts are underway to deal with these problems? Industry obviously is active in solving many of its own problems. However, some are out of their control so they can only try to encourage the building of additional knowledge. Researchers, universities and others are actively pursuing the answers to many of the technical problems which require further research and study. Our inspection program has also been doing its share. Examples include the joint sponsorship of this seminar and the previous one at Oak Brook, development of an interim specification for minced blocks, the drafting of the U.S. grade standard that are on display at this meeting and will be discussed shortly. Incidentally, I should add that this was done at the request of industry as a resul of the last seminar.

On the international scene, we have been working with FAO and Codex. We were active in getting minced products dealt with at the technical conference in Tokyo previously discussed by Dr. Blackwood. We are also planning to request FAO to develop a code of practice for minced products. We have been testing the potential risks associated with this product. Melvin Waters will discuss this in more detail this afternoon.

And finally, we are making some key changes in our inspection program. Basically, these break into 5 areas.

1. We are modifying the services we offer and are adding some new ones that will be more useful to the industry in the minced area. Examples include the need to conduct source certification and inspect facilities for sanitation purposes. We are going to modify the "Packed Under Federal Inspection" requirements to permit the shield to be used as long as certain parts of the standards are met.

2. We are going to modernize some of our existing standards and make them more flexible without sacrificing quality.

3. We are going to obtain increased FDA recognition of the NMFS program and for the companies that participate in our program, FDA can devote less attention to these firms.

4. We are going to make greater use of state and foreign government inspection programs and provide a framework for cooperation and make agreements with them where we can recognize their activities, and they can take advantage of our inspection program.

5. We will embark on a joint promotional campaign with participating firms in the program. This will be multi-facited so that the consumer/user of fishery products will recognize the advantages that go along with the occurrance of the inspection mark on product they find in the marketplace.

Now the question must be asked, with all this activity on the part of industry, researchers and the inspection agencies, can we solve some of the problem areas more effectively? I think the answer is yes. I would like to make some recommendations and points in this regard.

First, with respect to industry, I think industry must develop better and tighter product specifications not only for raw materials but also for finished product. We use similar tools to conduct inspections and they could be very useful for you also. Industry needs to avoid putting questionnable quality product on the market, and this is a very important point. Industry needs to use inspectio not only in this country but in other countries as well.

With respect to research, we need to develop the needed answers to some of these questions as soon as possible. I think there have been useful discussions in this regard at this meeting already, and it is obvious that a list of answers is still needed. Before we can put good product on the market that has the kind of shelf life that is necessary, research needs to be particularly mindful of quality and wholesomeness in the investigating that they do. We need new improved tests and analytical procedures for minced product. A few examples are parasite detection and determining what species are in the product.

In the government sector, we also need to do a better inspection job. We need to be more active in this area and try to control the situation a little better. We need to provide a better framework for industrial development. This will be done an a cooperative basis in dealing with minced product and their development. But we also need to be tougher in our inspections and related activities. And I should also say in this respect that I am going to send a directive requesting that our inspection people be tougher in the inspection of minced products because we cannot afford to turn off consumers. We need to do this job and do it right.

In closing, I think all of us recognize the tremendous potential that exists. This has been discussed this morning and afternoon by our speakers and most everyone in this room will agree with its potential. But I want to add a note of caution. We need to avoid the mistakes of the past. The NMFS in its inspection program is ready to do its part. We need to embark on this continued development in a cooperative manner much like participation in this seminar today. If we take this approach, I think that minced seafood products will reach their full potential and reach it very quickly.

DRAFT PROPOSED U.S. STANDARDS FOR GRADES OF

MINCED FISH BLOCKS

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276.1 Scope and product description

This standard shall apply to minced fish blocks which are uniformly shaped, masses of cohering minced fish flesh. A block may contain flesh from a single species or a mixture of species without or with food additives. The minced flesh consists entirely of mechanically separated fish flesh processed and maintained in accordance with good commercial practice.

276.2 Product forms

A. Types:

1. Unmodified - no food additives used.

2. Modified - contains food additives (see section 276.5).

B. Styles:

1. Color

a. Degree

1. White
2. Non-white

b. Uniformity

1. Uniform
2. Non-uniform

2. Texture

a. Coarse (fibrous consistency)
b. Fine (puree consistency)

276.3 Grades - quality factors

A. U.S. Grade A. Minced fish blocks shall:

1. Possess good flavor and odor and;
2. Comply with the limits for defects for U.S. Grade A quality in accordance with 276.4.

B. U.S. Grade B. Minced fish blocks shall:

1. Possess reasonably good flavor and odor and;
2. Comply with the limits for defects for U.S. Grade B quality in accordance with 276.4.

C. Substandard. Minced fish blocks do not possess reasonably good flavor and odor and/or exceed the limits for defects for U.S. Grade B quality in accordance with 276.4.

276.4 Determination of grade

A. Procedures for grade determination. The grade shall be determined by sampling in accordance with the sampling plan described in paragraph (B) of this section; evaluating odor and flavor in accordance with paragraph (C) of this section; examining for defects in accordance with paragraphs (D) and (E) of this section, and using the results to assign a grade as described in paragraph (F) of this section.

B. Sampling. The sampling rate of specific lots for all inspections, other than for military procurement, shall be in accordance with the sampling plans contained in Part 260 of this chapter. For examination in the frozen state, an entire block is used. For examination in the thawed state, a subsample of at least 5 pounds weight is used.

C. Evaluation of flavor and odor. Evaluation of flavor and odor shall take place after the sample has been cooked by any of the methods set below:

1. Cut three or more 4-ounce portions from a block or take 12 ounces of thawed fish from the block. Wrap them individually or in a single layer in aluminum foil. Place the packaged portions on a wire rack suspended over boiling water in a covered container. Steam the packaged portions until the product is thoroughly heated, but not overcooked, or

2. Cut and package the portions or bulk fish as previously described. Place the packaged portions on a flat cookie sheet or a shallow, flat-bottom pan of sufficient size so that the packages can be evenly spread on the sheet or pan. Place the pan and frozen contents in a properly ventilated oven heated to 400°F and remove when the product is thoroughly heated, but not overcooked.

D. Examination for physical defects. The sample will be examined for defects using the list of defect definitions, and the defects noted and categorized as minor, major, and serious in accordance with Table 1.

For examination in the frozen state, an entire block is used. For examination in the thawed state, a sub-sample of at least 5 pounds weight is used.

E. Definitions of defects.

1. Color defects refer to deteriorative discoloration from the normal characteristics of the material used. Deterioration can be due to yellowing of fatty material to browning of blood pigments, or other changes.

    a. Slight - refers to a color defect that is slightly noticeable but does not seriously affect the appearance, desirability, and/or eating quality of the product.

    b. Moderate - refers to a color defect that is conspicuously noticeable but does not seriously affect the appearance, desirability, and/or eating quality of the product.

    c. Excessive - refers to a color defect that is conspicuously noticeable and that does seriously affect the appearance, desirability and/or eating quality of the product.

2. Dehydration refers to loss of moisture from the surface of the product during frozen storage.

    a. Slight dehydration - is surface color masking affecting more than 5 percent of the area which can be readily removed by scraping with a blunt instrument.

b. Moderate dehydration - is deep color masking penetrating the flesh, affecting less than 5 percent of the area, and requiring a knife or other sharp instrument to remove.

c. Excessive dehydration - is deep color masking penetrating the flesh, affecting more than 5 percent of the area, and requiring a knife or other sharp instrument to remove.

3. Uniformity of size refers to the degree of conformity to the declared size. A deviation is considered to be any deviation from stated length, width, or thickness, or from the average dimensions if no dimensions are stated. Only one deviation from each dimension may be assessed. Two readings for length, three readings for width, and four readings for thickness will be measured.

   a. Slight - two or more deviations from declared or average length, width or thickness from ± 1/8 inch to ± 3/8 inch.

   b. Moderate - two or more deviations from declared or average length, width or thickness from ± 3/8 inch to ± 5/8 inch.

   c. Excessive - two or more deviations from declared or average length, width or thickness over ± 5/8 inch.

4. Uniformity of weight refers to the degree of conformity to the declared weight. Only underweight deviations are assessed.

   a. Slight - any minus deviation of more than 2 ounces but less than 4 ounces.

   b. Moderate - any minus deviation of more than 4 ounces but less than 6 ounces.

   c. Excessive - any minus deviation over 6 ounces.

5. Angles. An acceptable edge angle is an angle formed by two adjoining surfaces whose apex is within 3/8 inch of a carpenter's square placed along the surfaces For each edge angle, three readings will be made and at least two readings must be acceptable for the whole edge angle to be acceptable.

An acceptable corner angle is an angle formed by 3 adjoining surfaces whose apex is within 3/8 inch of the apex of a carpenter's square placed on the edge surfaces.

Any edge or corner angle which fails to meet these measurements is unacceptable.

a. Slight - two unacceptable angles.

b. Moderate - three unacceptable angles.

c. Excessive - four or more unacceptable angles.

6. Improper fill refers to surface and internal air or ice voids, ragged edges, or damage. It is measured as the number of 1-ounce units that would be adversely affected when the block is cut. For this purpose, the 1-ounce unit is considered to be 4 x 1 x 5/8 inch.

   a. Slight - less than 5 unit cuts.

   b. Moderage - between 5 and 10 unit cuts.

   c. Excessive - over 10 unit cuts.

7. Blemishes - refer to pieces of skin, scales, blood spots, nape (belly) membranes (regardless of color), viscera or other harmless extraneous material. One instance means that the total area occupied by blemishes is measured by a square grid having 1/4 inch sides. Instances are prorated on a per pound basis.

8. Bones refer to any objectionable bone or piece of bone that is 1/4 inch or longer and is sharp and rigid. Perceptible bones shall also be checked by their grittiness during the normal evaluation of the texture of the cooked product (10). Instances are prorated on a per pound basis.

9. Flavor and odor are evaluated organoleptically by smelling and tasting the product after it has been cooked in accordance with 276.4C.

   a. Good flavor and odor (essential requirements for a Grade A product) means that the cooked product has the typical flavor and odor of the indicated species of fish and is free from rancidity, bitterness, staleness, and off-flavors and off-odors of any kind.

b. Reasonably good flavor and odor (minimum requirements of a Grade B product) means that the cooked product is lacking in good flavor and odor but is free from objectionable off-flavors and off-odors of any kind.

10. Texture defects are judged on a sample of the sample of the cooked fish and are not characteristic of a normal product.

a. Slight - fairly firm, only slightly tough, moist but not mushy.

b. Moderate - moderately tough or rubbery, has noticeable tendency to form a mass in the mouth, moist but not mushy.

c. Excessive - excessively tough or rubbery, has marked tendency to form a mass in the mouth, or is very dry or very mushy.

F. Grade assignment. The sample unit shall be assigned the Grade into which it falls in accordance with the limits for defects, summarized as follows:

	Flavor and Odor	Maximum number of physical defects permitted		
		Minor	Major	Serious
Grade A	Good	3	0	0
Grade B	Reasonably Good	5	1	0

Substandard. Any fish not meeting the minimum requirements for Grade B quality. Upon determination of the grade for each sample unit, a lot of minced blocks shall be assigned that grade in which the number of sample units in the next lower grade does not exceed the acceptance number for deviants prescribed in Part 260.61 of the sampling plan, Table II, Title 50.

Sampling for inspection for military procurement shall be in accordance with MIL-STD-105. Lot size shall be expressed in terms of pounds. The sample size shall be in accordance with Inspection Level S-3. Acceptable Quality Levels shall be expressed in terms of defects per hundred units. The AQL's shall be 6.5 for minor and 4.0 for major.

276.5 Additives

Minced fish blocks may be modified, under FDA compliance, with food additives as necessary to stabilize product quality. Examples of potential additives are: protein stabilizers such as polyphosphates, antioxidants such as ascorbate, colorings or flavorings, and texture enhancers such as textured fish alternates in accordance with the applicable requirements of the regulations contained in Parts 210 and 225 in Title 7, Code of Federal Regulations.

276.6 Hygiene

The fish material shall be processed and maintained in accordance with the applicable requirements of the regulations contained in Sections 260.96 to 260.103 in Part 260 of Title 50, Code of Federal Regulations, the applicable requirements of the Good Manufacturing Practice regulations contained in Part 128 of Title 21, Code of Federal Regulations, and, when applicable, requirements promulgated by the U.S. Department of Agriculture.

TABLE I

Physical Defects		Categories		
Types	Degree	Minor	Major	Serious
Frozen State				
Color defects	Slight	101	---	---
	Moderate	---	201	---
	Excessive	---	---	301
Dehydration	Slight	102	---	---
	Moderate	---	202	---
	Excessive	---	---	302
Uniformity of size	Slight	103	---	---
	Moderate	---	203	---
	Excessive	---	---	303
Uniformity of weight	Slight	104	---	---
	Moderate	---	204	---
	Excessive	---	---	304
Unacceptable angles	Slight	105	---	---
	Moderate	---	205	---
	Excessive	---	---	305
Improper fill	Slight	106	---	---
	Moderate	---	206	---
	Excessive	---	---	306
Thawed State				
Blemishes	Slight	107	---	---
	Moderate	---	207	---
	Excessive	---	---	307
Bones	Slight	108	---	---
	Moderate	---	208	---
	Excessive	---	---	308
Cooked State				
Texture defects	Slight	109	---	---
	Moderate	---	209	---
	Excessive	---	---	309

NOTE: The code numbers shown in the above Table are for identification of defects for recording purposes only. They are keyed to the nature and severity of the defect. They are not scores. Procedural information for scoring a sample unit is contained in the USDC Instructions for Grading Minced Fish Blocks. Copies of these instructions are available from the National Marine Fisheries Service, NOAA, USDC, Washington, D.C. 20235.

HAZARDS ASSESSMENT OF MINCED FISH FLESH

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Potential health hazards associated with minced fish products are really no different than other processed fishery products. One must recognize, however, that minced fish can be more vulnerable to certain types and kinds of potential hazards due to the very nature of the processing methods employed during manufacture. The mincing technology employed to remove flesh from the bones by design can allow for the co-mingling of whatever happens to be on or in the fish (i.e., microorganisms, blood, viscera, extraneous materials, etc.) into the finished product which may never be subsequently removed. Consequently, it is a critical control point then to remove all debris and contaminating material from the individual fish prior to deboning. Such can easily be accomplished by a thorough inspection of the fish and a high-pressure water spray wash as the final step prior to deboning.

Let me add that the quality of water used in the manufacture of certain types of minced products is of paramount importance. Obviously, from a public health point of view, the water must be potable and of such quality acceptable to the local officials having jurisdiction in such matters. However, aside from the public health considerations, the water quality from a trace metal standpoint is important in terms of affecting intermediate or final products produced from minced fish flesh.

For example, several weeks ago, two different delegations of Japanese processors and technologists were visiting our laboratory to determine the suitability of Gulf coast croaker for the manufacture of kamaboko, and, hopefully, to negotiate with our industry members to obtain croaker surimi to manufacture the kamaboko. During the course of visiting local plants, one of the Japanese technologists became concerned over the water used in the plant, believing it had a high iron content, which would have a detrimental effect on the finished kamaboko.

In an effort to be helpful to our Gulf processors who may wish to share in this new foreign marketing opportunity with the Japanese, we analyzed water samples from interested processors to determine iron content. Fortunately, the iron content of the water was well within the Japanese processing specifications. The point of this digression is that not only must care be taken to assure proper compliance with hygienic regulations, but also from a final product quality standpoint.

Continuing then, product hazards or potential hazards associated with minced products, or any other products for that matter, can generally be grouped into three broad categories: 1) microbial, 2) chemical, and 3) physical. Any of these categories can either be associated with the product naturally or be induced by processing technology.

Microbiological

Potential microbiological problems run the gamut from bacterial contamination either prior to or during processing to natural parasitic infestation of the starting raw material. In terms of bacterial contamination, one is concerned with the usual microorganisms of public health significance (i.e., coliforms, E. coli, coagulase-positive staphylococci, and Salmonella or Shigella). This year, of course, there is increased concern over Vibrio parahaemolyticus, an obligate marine pathogen. Currently, there is great controversy over the lability of this organism in frozen storage.

Now in terms of minced fish flesh, there may be an added concern relative to microbial contaminates that one does not usually associate with a whole fish or filleting operation. This relates to the boning technology itself. During deboning, and depending upon belt tensioning, product throughput velocity, etc., there is the opportunity for a great deal of tissue masceration to occur which would allow for the release of cellular fluid rich in amino acids providing a most suitable substrate for bacteria growth. Therefore, in our judgment, a critical inspection point is deboning, and extreme care should be exercised to assure that the machinery is kept scrupulously clean, and that the minced flesh is chilled as rapidly as possible. Without a doubt, mincing technology is indeed new to the United States fish processing industry, and can well be expected to sweep through the entire fishing industry.

Most of the equipment we have seen used in the Gulf processing plants, and I admit our expertise is limited to this area, is equipment developed for other industries such as meat or poultry. One suggestion we would have for processors dealing with such equipment would be to work with the manufacturer to see if some sort of in-place cleaning systems could be adapted to the deboners, extruders, etc., to ensure rigid, effective and timely cleaning to prevent microbial build-up. Another idea might be for chill systems to be developed so that the minced flesh can be kept as cold as practicable.

While we are on the subject of possible microbial contamination, a few words on bacteriological standards would seem to be in order. Frankly, our position at Pascagoula has been against the development of such standards for raw or intermediate products since they oftentimes do not achieve the desired end result. As many of you know, in different forums, we have pointed out that in our judgment, since the dawn of progressive microbiology with Pasteur, there are only three bacteriological standards which have stood the test of time and have gained international acceptanc These being: 1) water, 2) milk, 3) thermally processed canned foods as commercially sterile.

To give a little better perspective on this matter, I would like to quote the World Health Organization Technical Report Series No. 399, which was a report of a WHO/FAO Group of Experts addressing the microbiological aspects of food hygiene. The report indicated that there are two types of bacteriological standards for food. They are:

1. Standards for specific types of pathogens.

2. Standards based on total bacterial counts or on the enumeration of certain indicator organisms such as enterobacteriaceae, E. coli, and enterococci.

The report indicated that a combination of both types of standards would be preferable and that such would in many cases offer valuable information on the microbiological status of a food product -- but that such was not an absolute guarantee of safety. The Committee recommended that bacteriological "...standards be formulated mainly for administrative or advisory use..." It further recommended "...that legal bacteriological standards should be restricted to carefully selected foods where they serve a clearly defined purpose..." The Group of Experts pointed out that, "No bacteriological standard is applicable to all kinds of food, since each type of food presents special problems..." and that, "Generally speaking, standards for raw foods offer little or no assurance that such foods are safe for consumption..."

The Group of Experts pointed out that, "In view of the wide variations in food practices and in basic food needs that prevail in different countries, it does not seem practicable to set a single rigid standard for each food. If standards are to be set, that which is desirable and that which is attainable with sound practices must be carefully evaluated. The paramount consideration is the welfare of the people, and such standards should serve to improve the hygienic quality of their food."

"In considering the application of bacteriological standards for foods to international trade, the economic implications of internationally agreed standards should be carefully weighed against the benefits that they could be expected to have for human health..."

It is for all of these reasons that our group in Pascagoula is against the development of specific bacteriological standards for non-cooked minced fish products. Certainly the technology is new, a concept of mixing species from a variety of countries with differing temperature climates is emerging, and numerous processing steps are still being investigated. All of which indicates to us that it is premature for bacteriological standards development for minced flesh.

Please note that I am talking about legal bacteriological specifications which either a processor or purchaser may choose to use as a measure of discrimination. However, much like the WHO/FAO Group of Experts, we believe that such specifications should be mainly for administrative or advisory use.

Parasites

Now another aspect of possible microbiological hazards relates to parasites. I know little about parasites in fish and considerably less about the potential hazards they may present in minced fish flesh. Consequently, much of what I have to say to you on this subject has been extracted from reports and research data prepared by Dr. Donald Norris, Professor of Biology, University of Southern Mississippi, who serves as our consultant on the subject.

The enumeration of parasites in minced fish flesh is a very important aspect in a hazards assessment program and must be a primary concern of any quality control system. It is generally known that from time to time virtually all fish may have parasites, and from an aesthetic standpoint, it is desirable to have as few as possible in the finished products. Also, it is obviously impossible to eliminate parasites during processing; that is why there are inspection standards and tolerances for fillets.

It is suspected that parasites that may inhabit fish utilized in minced flesh can pass through a meat/bone separator with the flesh, and, therefore, in our judgment, a procedure must be developed to properly evaluate this factor. Due to the physical state of the product, any such procedure would have to be different from the one now used for fillets.

We started a project in this regard earlier in the year, but due to the resignation of the researcher assigned to the project, we have made little headway. We have within the past two weeks replaced this researcher, and hope to have this project completed by early January, 1975.

There are two approaches we are taking to develop a rapid in-plant procedure. The first deals with enzymatic digestion. As you know, for many parasites, the life cycle requires ingestion of some parasite form, therefore, many are resistant to enzymatic digestion. The technique we intend to pursue is to determine the possibility of digestion of the minced fish flesh without digesting the parasitic form. Should this be successful, then it would be a relatively simple matter to spindown or centrifuge for enumeratio

Another method to be investigated relates to differential staining and/or negative staining. Differential staining is self-explanatory. Negative staining relates to staining either, but not both, the individual parasite or the fish flesh. To our knowledge, this technique has not been tried with minced fish flesh. Again, we are only getting started in this, and do not expect any definitive results until early January, 1975.

Now, relative to the potential hazards associated with parasites, I would offer the following.

As you know, the severity of any parasite infestation of the product governs the ultimate grade and/or utility of the flesh as human food. According to Dr. Norris, only two kinds of larval nematodes - Anisakis and Phocanema terranova - are currently and potentially significant to public health. These have been commonly found in commercially important fishes from both the North Pacific and North Atlantic oceans. However, only six cases of human infections with these types of nematodes are known from North America. Apparently, just a few nematodes can produce a severe inflammatory reaction in the intestinal wall which tends to confuse physicians in diagnostic procedures. It is important to note that Dr. Norris further states that extensive experimental evidence has shown that freezing or cooking the infected fillets for relatively short periods of time (so that parasites are brought to -20°C for 24 hours or 60°C for 1 second) kills all of these known types and kinds of parasites. Therefore, given the usual methods of fish processing, and of preparing minced fish for consumption in the United States, it is highly unlikely that there is any public health significance associated with such parasites, unless of course, our dietary practices in this country were to change and we became a nation of raw fish eaters, which is hardly likely.

Chemical

Potential chemical hazards can best be conveniently grouped into organics and inorganics. Predominate in the inorganic category are the heavy metals.

Heavy Metals

Before a processor embarks upon a large-scale production system of minced fish, he must be sure that the species he is working with is well within the guidelines for heavy metals as established by FDA.

I want to point out here that when I speak of heavy metals, I am really referring to mercury. As I understand it, there are no guidelines at the present for anything but mercury, but in the future there may well be others. It is the processors' responsibility to see that the product meets these guidelines and should he not have such assurance, a private laboratory should be contracted to conduct analyses or a federal agency should be contacted which may already have this needed information. All of this should be done prior to determining if the product warrants a processing venture.

It would be futile to gear-up for processing only to find out the product exceeds the guidelines for heavy metals. Such a case happened several years ago when commercial quantities of swordfish were found to be available in the Gulf of Mexico and could be fished profitably. A number of boats geared up and fished only to find in a very short time that the fish exceeded FDA's guideline for mercury. Subsequently, the fishermen had to reconvert their vessels, resulting in a costly experience.

The current guideline for mercury in fish is 0.5 ppm, and this guideline may well become an official tolerance before long.

With any minced fish operation, a continual assessment of the product must be maintained to determine the heavy metal content The results should be kept on file and become a permanent record for future reference. The processor may collect data on specific or mixed species from a given area over a given period of time and should he determine that the fish are well within the guideline he may relax the assessments. This should not be done, however, if the species in question is near the upper limits. When the fishing area changes, one must then re-establish the heavy metal content assessment to satisfy that the product meets the guideline.

Our NMFS Technical Center at College Park is, and has been for several months, collecting data on heavy metals in food fish from all parts of the United States on a seasonal basis. For further information along these lines, I would suggest contacting the Laboratory Director at our College Park facility.

Pesticides

In terms of organics, pesticides immediately come to mind as possible hazards.

Certainly, hazards assessment of minced fish should include the analysis for pesticides on a routine basis to obtain base line data. Foods containing such microconstituents are covered under the FDA Food Additives Law and again, the burden of proof of safety is placed upon the producer. Current pesticide tolerances are:

Lindane	0.3 ppm based on fat content
Dieldrin	0.3 ppm
Aldrin	0.3 ppm
Dieldrin & aldrin	0.3 ppm
Endrin	0.3 ppm
Heptachlor epoxide	0.3 ppm
Heptachlor & Heptachlor epoxide	0.3 ppm
DDT (and its analogs, DDD, DDE, etc.)	5.0 ppm
PCB's	5.0 ppm

To the best of my knowledge, there are currently no guidelines for the insecticides toxophene, Mirex, and Sevin.

As mentioned earlier, the processor must maintain surveillance of this product to make sure it does not exceed tolerances set for pesticides. It could become a costly operation to suddenly find that the product on the market must be recalled because it exceeds the guideline.

A case in point. Recently, six million broilers were slaughtered in Mississippi because they were found to contain more than 0.3 ppm of dieldrin. The source of contamination was traced to the feed and subsequently to a vegetable oil product incorporated into the feed. Certainly, publicity such as this pertaining to a food product, regardless of the fact that it dealt with chickens and not fish, casts a shadow on the entire food industry.

Processors finding excessive amounts of pesticides in fish should determine the source of contamination and take whatever steps possible to eliminate the problem. This could mean changing species and/or harvesting locations. At the present time, should a minced flesh operation occasion higher residues than desirable, we could only suggest a partial removal of the oil from the raw fish to reduce the levels. This can be done by cold water washing the minced flesh as has been suggested in some of the procedures for making fish blocks.

The cost of assessing raw fish products for pesticides may seem high when one considers all that is involved, but could be worth the effort.

Histamine

Another form of possible chemical problem, biochemical really, relates to histamine.

It has long been known that histamine can appear in excessive amounts during the spoiling process of fish flesh. Furthermore, it has been firmly established that this substance is produced by the action of bacteria causing spoilage. Research has shown, for example, that the microorganism Proteus morganii is capable, and, does in fact, break down the amino acid "histidine" to histamine through a decarboxylation process. Other researchers have reported that histamine is produced in large amounts during the spoilage process by the normal bacterial flora but not by the generally recognized microorganisms of public health significance. Halstead 1) reported that on rare occasions, scromboid fishes (i.e., tuna, skipjack, bonita, sardines, and mackerel) may cause ciguatera, but more frequently they cause an entirely different form of intoxication. He reported that when these fishes are held at room temperature, a toxic "histamine-like" substance is developed within the musculature of the fish, increasing from about 0.09 mg/100 g of tissue to about 95 mg within 10 hours of storage. It has been shown many times that there is a direct relationship between the severity of histamine poisoning and the level of histamine in the suspected food.

Under certain circumstances, particularly with red meat fish, histamine can be formed in significant quantities. There still prevails some uncertainty as to the identity between the so-called "toxin" and histamine although some researchers believe they are the same. Others believe that, besides histamine, related substances are formed which either are more definitely toxic, or act synergistically to activate physiologically the effect of histamine. These related substances have been given a separate designation of "saurine." The name refers to the fish called in English "saury," the dried form of which causes so many of these toxigenic cases.

There have been several scombroid fish poisoning cases in the United States, the most recent of which was reported by the Center for Disease Control in its morbidity and mortality weekly report ending February 24, 1973.

Now let me say that quite frankly, in any hazard assessment program for minced fish, I think it is useless to include a test for histamine on a routine basis except to establish base line data for a particular specie. However, when the flesh is suspected of having been subjected to elevated temperatures for any length of time, it is essential to determine the histamine levels to indicate the safety of the product. The procedure to be followed in such circumstances is given in the Journal for the Association of Officia Analytical Chemists and other manuals for food analysis.

Ciguatera and Aflatoxin

There are two other toxins of minor importance which should be mentioned. Neither have caused severe outbreaks of food poisoning in the United States, but the processor should be reminded of their existence.

The first is "ciguatera" which was defined by the early Spaniards as "...a disease contracted by persons who eat fish that are affected with disease of jaundice." It has wrongfully been referred to as paralytic shellfish poisoning. Hugh F. Butner during a workshop in Jackson, Mississippi, in 1971, noted that shellfish become toxic during or following a "red tide" occurring over the shellfish bed.

Red tide is caused by the sudden growth (bloom) of a toxigenic marine dinoflagellate "Gymnodinium breve." Initially, this marine organism was presumed to have been ingested by the shellfish and the toxins accumulated in the gut. Later this presumption was confirmed by a group of research workers at Dauphin Island, Alabama, who were able to culture "Gymnodinium breve" in large numbers using synthetic media. From these organisms they were able to extract a ciguatera-like toxin in concentrations lethal for mice when injected intraperitoneally. They also demonstrated that either extractions of the culture would kill mice. These researchers' experience showed that the toxin is much more potent in clams than in oysters and when the two were taken from the same area, toxin in the clams was found to be twice as potent as that in the oysters. When the viscera was separated from the meat, the viscera contained all of the toxin and the remaining meat was negative.

Confusion exists as to the properties of this toxin. Butner reported that this toxin withstands boiling and differs from similar toxigenic cases on the West coast in that the toxin is not soluble in water but rather is oil soluble. Additionally, he reported that the toxin is not fatal. On the other hand, Halstead reported some case fatalities but at a very low rate. Halstead also notes that this toxin is not limited to shellfish but also occurs in fishes such as sea bass, jack, barracuda, snapper, parrot fish, and sturgeon. The difference that exists may well be the difference between true ciguatera and ciguatera-like toxins. Ciguatera was first believed to be caused by tropical fruit finding its way into the water and fish subsequently eating the fruit. Nevertheless, routine assessment for this possible hazard is not necessary and should only be performed when suspected. Methods are available for the assessment of this toxin.

Paralytic shellfish poison is another important potential health problem. It has been shown that Ganyaulax catenella, another dinoflagellate, is responsible for production of this toxin and is distinctly different from the ciguatera and ciguatera-like poisoning.

Another toxin which should be mentioned in passing is a mycotoxin which is commonly referred to as aflatoxin. There are four forms of aflatoxin -- B_1, B_2, G_1, and G_2. This toxin is relatively insignificant in relation to minced fish flesh because it is produced by mold growth. This toxin should never present a potential health hazard unless the flesh is grossly mishandled. The toxins are produced by the mold Aspergillus flavus at a relatively low pH and at higher than refrigerated temperatures. Again, assessments for this substance would not be required unless it is suspected of being present.

PHYSICAL

Finally, any discussion of potential hazards in the manufacture of fishery products must necessarily include a description of physical factors. These in the main relate to bones or bone fragments in the minced fish flesh.

Bones

Any hazards assessment program for minced fish flesh should include determining the number and size of bone fragments and their possible importance to the consumers. As you know, this is an attribute included in the Draft Proposed U.S. Standards for Grades for Minced Fish Blocks which is currently on display.

A procedure for determining the bone content of minced fish flesh has been worked out by Patashnik et al. at our NMFS Pacific Fishery Products Technology Center, Seattle, Washington. This procedure was included in the publication of reports presented at the Oak Brook Seminar, September, 1972, and has also been published in the 1974 May/June issue of the Journal of Food Science. We have tested this procedure in our laboratory using minced croaker flesh and have found it both simple and rapid. It does, however, require considerable experience to recover all the bone fragments since the bone color blends in so well with that of the fish tissue.

During a training assignment at Pascagoula, Mr. Dave Dressel, of our Washington office, suggested using a dye to stain the bone particles to make them easier to differentiate from the flesh and he suggested the use of Alizarin Red S, which combines with the calcium, subsequently causing the bones to take on a red appearance.

Using Patashnik's and Miyauchi's procedure, and incorporating the dye into the initial step, preliminary trials were conducted and the procedure seems to offer great promise although several water washings of the minced flesh sample are necessary to remove the dye from the fish tissue. It was also found that fish scales have an affinity for the dye. Additional work is necessary before this technique can be perfected for routine plant use and such things as staining times, pH of material to be stained, temperatures of the mixture, and dye solvents will be factors involved needing additional study. We intend to have this work completed sometime prior to December of this year.

Another method we have thought of, but have not had time to try, utilizes the principle that industry is already using to separate meat from shell and cartilage in the mechanical picking of crab claws. The idea is to change the density of the meat by immersing the meat plus shell in a saturated brine solution; the meat floats, the bone sinks, and each is subsequently removed.

We have some additional ideas along this line that we also expect to explore.

The number of bones present in the flesh and the size of the bones, of course, is a function of the orifice in the drum used to separate the flesh from the bones. Assessment for this factor is very important since the number and size of the bones may well determine the grade of the product.

SUMMARY

In summary then, potential health hazards associated with minced fish flesh can, as with other foods, be broadly grouped into three categories -- microbiological, chemical, and physical.

In the microbiological category, one should consider the usual microorganisms of public health significance, that is, the coliforms, *E. coli*, coagulase-positive staphylococci, and *Salmonella* and *Shigella*. The technology employed in mincing flesh is such that the deboning procedure, in our judgment, is critical and care must be exercise to ensure that fish fed into the machine is as well chilled as practical.

Furthermore, deboning machines and associated utensils should be kept scrupulously clean throughout the processing procedure. We at Pascagoula do not favor the establishment of legal bacteriological standards for uncooked minced flesh products until such time as the technology and processing procedures have been more considerably standardized throughout the world.

Parasites in minced flesh represent an esthetic as opposed to a public health hazard and definite measures for enumerations of such parasites must be developed.

Possible chemical hazards are those commonly associated with any processing operation dealing with fish as food and relate principally to microconstituents such as heavy metals, pesticides, histamines, and other various toxins. Certainly, the important point here is that a prudent processor needs to have base line data on such things in terms of the manufactured product.

Physical defects deal mainly with bones and scales which can be controlled during the mincing operation.

I trust you have found this presentation helpful. It was not designed nor intended to reveal any new "discoveries" but rather to detail the possible hazards one might expect of a minced fish operation, and to indicate that those possible hazards are really no different than those which could be expected of a conventional food fish operation.

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IDENTIFICATION AND LABELING OF EMERGING ENGINEERED FOODS

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In recent years, the increased worldwide demand for animal protein has led to rapid developments in techniques for greater recovery of edible flesh from the bone, skin, scale and shell of animals for human consumption. Specialized mechanical equipment has been developed to attain a greater yield of edible flesh and the use of this equipment is increasing steadily throughout the world.

Edible flesh that is produced by application of this specialized equipment is usually a relatively formless mass of pieces and particles of various sizes which can be processed into a variety of end products for consumption. In the fishing industry, minced fish flesh is easily processed using fairly standard equipment into uniformly shaped rectangular blocks which have a potential for being further processed into portion-controlled fish sticks and portions.

Historically and traditionally, fish blocks have been understood to refer to a uniform rectangular mass of cohering fish flesh composed predominantly of whole fish fillets of a single species which have been frozen under pressure. An essential difference between the two types of blocks is characterized by the state of the fish flesh prior to processing into blocks, i.e., fillets and pieces of fillets versus small uniform particles.

Over-exploitation of certain traditional species of fish has led to increased use of species which do not readily lend themselves to conventional processing methods. However, production of minced flesh from these species is easily achieved by the application of the specialized mechanical separator equipment. Here again, the most effective and economical way to preserve the minced flesh is in the form of frozen fish blocks. This brings us to a second essential variation between traditional fish blocks and the new type of blocks, i.e., the state of the flesh from less recognized species prior to freezing, and the mixing of flesh of more than one species of fish.

During the past decade, the food industry has developed new methods of using ingredients that have been available for years, as well as uses for ingredients which are, themselves, new products I am referring now to the various food components that are known as protein extenders, flavors, drip inhibitors, preservatives, and coloring agents. These ingredients are easily incorporated in varying amounts, with minced flesh of animals, including fish flesh. Naturally, one of the immediate outlets for these formulated fishery products is to shape the material into frozen blocks for subsequent manufacture into fish sticks and portions or other portion-controlled units.

It is easily recognized, however, that the present situation represents an exciting potential for applying food technology and engineering principles simultaneously in the blending of minced flesh and other ingredients. The result of proper product development effort can be truly designed and engineered foods of various flavors, colors, textures, and nutritional quality levels that are readily reproducible. This, or course, allows a processor to consistently manufacture and market a truly uniform product representing consumers' tastes and desires.

This brings us to the question of meaningful product designations of definitions and the labeling of these products for the benefit and confidence of consumers in using these products. There is a critical need to establish or make adjustments in regulatory policies that will enable innovation in food manufacture while protecting the consumer's right to make a knowledgeable value judgment at the time of purchase. This includes the need for a labeling system which will fully inform the consumer of the nature and composition of animal protein food products that are either new, or made in a new way, or used in a new way. Many processors believe that such a labeling system should also accommodate the continuing use of generic terms for end products such as fish sticks and portions, which now can look the same but are different. What might these choices be?

1. Fish sticks - made from natural fillet blocks
2. Minced fish sticks - one specie
3. Minced fish sticks - several species
4. Fish sticks made of minced flesh of several species fortified with vegetable proteins and other ingredients.

Other processors have expressed a view that minced fish flesh should not be marketed in the form of a fish stick or portion.

This difficult question will be addressed by a panel of four individuals who I believe can shed some expertise and comment for future consideration. They have been invited to address as specifically as possible, the general direction and trends relating to identification and labeling of fishery products that are being developed and which may contain various amounts of vegetable protein and other ingredients.

IDENTIFICATION AND LABELING OF ENGINEERED FOODS

Robert Rice
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It is a pleasure to be here at this minced fish seminar. Listening to the papers and comments made so far there is one primary theme that I detect; namely, that there is a great deal of learning to do and a high degree of interest in the potential made possible by the technology of minced fish. Let me assure you that industry is also vitally interested in this area because it sees tremendous opportunities for the future.

There are many educational and learning experiences that have taken place since the first seminar in 1972. More experience will be needed to adequately cope with this technology. Technicians and researchers have been, and will continue to study, such things as changes in fish flesh and why these changes take place. The use of established and new species of fish must be carefully studied for their application to this technology. Also, problems in the shelflife of minced fish are of concern because we find that they may differ from their fillet block counterparts. New species having high fat contents must be carefully evaluated to minimize the dangers of rancidity during the storage life of the finished product.

Harvesters and processors of raw material also are learning. Exploration of techniques for the mincing of fish can yield benefit in view of the variety of flesh separator machines available. Handling practices for raw material must be reevaluated because we all recognize that the quality level of a finished product starts with the quality of the raw material selected. Although much of the raw material being used in the mincing of fish is a by-product of a filleting or blocking operation, raw material for minced products must be handled properly to preserve its initial quality levels if we are to produce quality end products.

As for processors and marketers, such as Gorton's, we too have new horizons to explore which offer totally new and different opportunities. Such considerations as what new product entries can be generated utilizing this technology; how are quality levels to be defined and at what cost to us and at what price to our customers; what do our customers want and expect and how do we sell these new product characteristics to them.

I think too that the involved government agencies are also going through a learning experience. We participated this morning in a discussion of the USDC proposed minced fish standards. Many questions were raised and there remain many questions yet to be resolved in order to adequately formulate standards for the best interest of all concerned.

However, I want to emphasize that as this technology is refined and new products are engineered through product development, unreasonable restrictions via regulations on product make-up and labeling will make industry's efforts that much more difficult. I do not want to see realization of the full potential of this new technology unreasonably impeded.

To date I have seen certain trends that I think ought to be cited. Initially, the introduction of minced fish products provided an economic motivation at several levels in the distribution cycle. First, raw material producers saw an excellent opportunity for a more complete utilization and upgrading of their by-products such as V-cuts and frames. Incremental economic gains were possible through increased flesh yield. Finished product processors saw new opportunities for product line extensions by the addition of minced products which complemented sticks and portions made from fillet blocks. Processors capitalized on the economic benefit of using less expensive block raw material. The consumer also benefited economically by being able to purchase a seafood value. She could buy more fish sticks and portions for relatively less cost, compared to those made from fillet block products.

However, the economic motivation can create blind spots when it comes to product quality. Initial experience indicates that the purchase value provided by minced products must also be accompanied by satisfactory quality levels if continued consumer interest is desired. It is this latter area that marketers must further evaluate and respond to if we are not to turn-off our customers when it comes to products made with minced fish.

Another obvious trend falls into the product development area where effort has been placed on providing fish protein in new ways that are of interest to consumers. Certainly minced fish technology provides new and different opportunities than ever before presented to the seafood processing industry. New product researchers realizing this potential continue to place a great deal of developmental effort in this area. We are also on the verge of a completely different development plane which will provide additional exciting new product opportunities. I am referring to fabricated products made from minced fish that have a wide range of new shapes made possible by improved forming and extrusion methods. In addition, the ability to combine a wide range of ingredients to provide different textural, color and flavor characteristics offer still more variations for fabricated seafood products. To date, minced fish technology has concentrated on duplicating traditional products such as fish sticks and portions. However, I believe the future impact of this technology lies in the imaginative fabrication of fish based foods which provide completely different product characteristics heretofore not available to consumers.

In addition to the product developmental areas, there are some labeling trends or considerations that must be addressed, particularly as the processing industry views them.

1) Currently, there is a restructured foods proposal that was published in August, 1973 by the FDA which sought to give uniform labeling direction for these types of products. The intent was to inform the consumer that a traditional looking product used different processing techniques and could yield different eating characteristics. I feel that this regulation provided a

benefit in that it established uniform labeling standards and direction for our industry. However, there is one restrictive aspect in the regulation that I cannot consider beneficial. My concern relates to what I mentioned earlier regarding reasonable latitudes for product development. Specifically, I am referring to the stipulation that the percentage of fish flesh in the restructured food must at least equal the fish flesh content of products made from the traditional fillet block.

It is my belief that this requirement of placing appropriate modifying statements to the product name on the primary display panel may unreasonably restrict processors from entering established product areas that might otherwise have been entered. I also might add that since this proposal was issued some nine or ten months ago, no additional indication has been given as to considered changes in the proposal or its subsequent publication as a regulation. As processors, we have large economic investments in packaging inventories and if such a regulation is to be issued, I feel that we should get on with it, know what is to be required and be given sufficient time to make the necessary transition from current labels to new ones.

2) Another area of labeling that certainly must be considered is the addition of protein extenders to seafood products. There are now a number of consumer products, including one seafood item, currently on the market that contain protein extenders which are labeled in a variety of ways. As our seafood industry continues work in this area, it would be beneficial to be aware of any intended

or contemplated regulations regarding the addition of extenders so that development work could take into consideration this labeling intent and avoid time and effort spent that might be nullified by any restrictive regulations. Here I refer to such things as the amount of extender that could be added, what protein quality and nutrient levels may be required and how the labeling of such finished products are to be handled.

3) I think all of us in the seafood industry are aware of the rather confused picture that exists with the nomenclature of fish. We know that what you call the fish ingredient, historically has been important to consumers. There was great concern in our industry when haddock and cod resources diminished and the conversion to Alaskan Pollock, North Atlantic Pollock and Whiting species was contemplated and implemented. Perhaps this conversion tended to reduce the importance of specie names to consumers. However, there remain many species that are candidates for minced fish processing that need more acceptable names. Confusion also results from several names being acceptable for one single specie and selecting the "correct" one may merely depend upon where you live. This presents problems for processors who sell their products in different areas around the country as well as for the one-third of the U.S. population that relocates each year. The subject of nomenclature is now under study by NMFS. They are seeking to simplify specie names and to find marketable names which will be acceptable to consumers. Industry is interested in the project; we feel that it will enhance the future marketing of fabricated foods which will

in turn use an increasing variety of underutilized species now unfamiliar to consumers.

4) The mincing of fish provides another processing opportunity that has economic and perhaps new product developmental benefits. I refer to the comingling of species. The labeling aspects are now being considered by industry and government agencies both in Canada and the United States. A combination of species will enable raw material processors to better utilize the total landed catch of fishing vessels. The mixing of species with complementing flesh characteristics and a scheme for generic ingredient legend statements may make the use of a broader range of fish species possible and acceptable to consumers. These factors have both economic (raw material price) and developmental (balance poor flesh characteristics in one specie with good characteristics in another) implications that should be pursued.

In summary, I would suggest for your consideration some areas of additional effort. First, there is a need for an active and effective exchange of technical information between research labs, industry and NMFS as more and more information becomes available. Second, we should address the questions of upgrading minced fish products that are currently on the market and studying consumer attitudes regarding these products. We must maintain consumer interest in minced fish products so that when newly developed fabricated fish products are available the consumer will continue be interested. Third, there must be continued emphasis on product development, creativity and innovation to generate new shapes and textures. Fourth, we should strive to achieve a simplified and acceptable reference to fish content that will facilitate the purchase of seafood products by consumers. Finally, there is a need for continued cooperation between researchers, industry and government in exploring this new minced fish technology and in providing a workable environment for the product development effort that are now underway by industry. Success in this endeavor will ultimately mean success for all of us participating in the utilization of minced fish technology.

GENERAL DIRECTION AND TRENDS IN CANADA ON THE LABELING OF PRODUCTS PREPARED FROM MECHANICALLY RECOVERED FISH FLESH

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This is a subject that the Inspection Branch of the Canadian Fisheries and Marine Service has, in consort with the fish processing industry, had under continuous review for the past several years. I can state that definite trends have been and are developing in the area of acceptable nomenclature for the new range of products being prepared from mechanically recovered fish flesh. First, may I report that in Canada the word "minced" has become the term most commonly accepted and used to identify comminuted fish flesh. If this were the only labeling problem to arise from the advent of the new range of emerging engineered foods then the role of labeling control agencies would be quite simple. However, hand in hand with the relatively new concept of recovering fish flesh in minced form by means of mechanical separators has come the world need for utilization of 1) unexploited fish species, and 2) the trimmings from conventional products for use as human food. This, of course, has introduced new factors such as 1) the mixing of fish and 2) the addition of protein extenders and 3) the use of natural or artificial fish flavors. In this connection, I would like to report on the Canadian trend or position under two headings as follows:

I. Fish Blocks Made from Mechanically Recovered Fish Flesh

A. minced blocks prepared from a single fish species must be labeled to reflect the fact - e.g., "Minced Cod Block" for a product prepared solely from cod fish.

B. it is permissible to prepare fish blocks from the minced flesh of any two or more species of fish and/or shellfish and to list the species by common names on the label in descending order of proportion. An example might be "Minced Fish Block Made from cod, flounder, hake, halibut, and pollock."

C. consideration is at present being given to adopting, throu regulatory standards, a group name that could be used to identify a block prepared from species of fish that are known to be quite similar in terms of texture, color, odour and flavor. For example, the term "Marine White Fish," might be adopted to identify a block prepared from any one or any combination of like species, e.g., cod, haddock, hake, cusk and pollock, and the product name would simply be shown as "Minced Marine White Fish Block." This approach would certainly give industry the flexibilit needed to develop and identify new minced fish products and in a short period of time would become meaningful to users.

D. in general, permitted additives such as polyphosphates, etc., used in the preparation of minced fish blocks must be listed on the label in a manner that is clear and legible.

E. the need and desirability of using vegetable protein extenders in now recognized and permitted. However, this is one area where several schools of thought remain as to how the blocks and/or end products should be identified. For example:

1. there are those that feel the name of the extender should be part of the common name for a product partially prepared from extenders and an example might be "Minced Cod and Soya Block." The Inspection Branch is opposed to this approach, as it is felt it would be too restrictive in the development and use of coined or fanciful names for the new class of emerging products with a fish flesh base. At the same time, the Branch is of the view that information should be shown in conjunction with the product name to the effect that protein extenders make up part of the product being marketed, e.g., Minced Cod Block - Soya Added."

2. others hold the view that where protein extenders are used, the final product must contain certain minimum levels of protein, vitamins and minerals and that the names of the vitamins and minerals contained in the

extenders must be included in the ingredients listing. There can be no argument against having regulatory requirements relating to minimum nutritive values for protein extenders; however, the Branch does not see the need for both a regulation that would require certain vitamins and minerals to be added to extenders and then require these to be named in a list of ingredients.

F. as with vegetable protein extenders, the concept or principle of using fish flavors in the preparation of certain minced fish products is now recognized and permitted. Such additives, listed in a clear manner on the label, are being used in those instances where experience has shown that the flavor of a particular fish has, because of blandness, not been popular with consumer. Again this approval provides industry with the degree of flexibility considered essential for development of minced fish products from underutilized species. At the same time, objection would be taken to using an artificial or natural fish flavor to enhance the flavor of the particular fish it imitates. For example, a lobster flavor would not be permitted in a minced lobster product.

II. Consumer Products Prepared from Mechanically Recovered Fish Fle

A. As with the minced fish blocks, the term "minced" is the key term to identify consumer products prepared from comminuted fish flesh.

B. The word "minced" should be shown as part of, or in conjunction with, the common name where prepared in such traditional product forms as "Steaks" and "Fish and Chips." For example, "Halibut Steaks made from Minced Halibut" or "Fish & Chips made from Minced Fish."

C. The word "minced" need only be shown in the ingredients listing for that category of products that are prepared from minced fish flesh, e.g., "Fish Cakes," "Fish Burgers," etc.

D. With respect to new minced fish products being marketed under coined or fanciful names, the Inspection Branch has been requesting that there be an indication on the main panel, preferably in conjunction with the coined or fanciful names, to the effect that the product contains minced fish flesh. However, this approval is under current review and in the future, it may not be necessary to show or make reference to minced flesh on the main panel but only in the ingredients list.

E. Other labeling criteria including the addition of artificial or natural fish flavors, the use of vegetable protein extenders, etc., are similar to those outlined above for minced fish blocks.

In summary, may I say that trends are rapidly developing in Canada with respect to the identification and labeling of products prepared from mechanically recovered fish flesh. There can be no doubt as to the need for close international liaison and cooperation on this topic and this is certainly reflected in those present here today who represent a number of countries producing and distributing vast quantities of minced fish material for the world food market. My most sincere thanks to all concerned for the opportunity to express Canada's viewpoint on this important and timely subject.

SESSION IX - SUMMATION

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The processing of fish and shellfish into comminuted form by various deboning equipment offers a significant potential for making available more protein as well as a variety of new products for the consuming public. The potential of this new food form is associated with considerable economic and social benefits. But by virtue of its novelty, as well as its form, minced fish poses severe problems that may slow or even delay its growth into an important commodity source. Most important, we must avoid the mistake of ignoring any factor that lowers its quality. Tom Billy outlined a positive and encouraging course of government action towards that end in his description of a proposal to revamp the Inspection Service. And you also heard of the intensified NMFS activities at our Pascagoula Laboratory to investigate processing parameters that may be conducive to certain hazards. You also heard the recommendations to industry to participate in positive ways to help government meet this goal.

In short, the goal is to assure that the quality of minced fish blocks and the products made therefrom shall not be allowed to degrade to the point of mediocrity, for if we expect to generate and maintain a market for minced fish products they must be of good quality at the retail counter where it counts.

It must be obvious by now that a quality standard for minced fish is necessary to protect the majority of the processors who will surely work towards creating a respectable image for minced fish products. But it is just as obvious that the formulation of this standard will be at the least demanding of all your experience and talents, and at the worst, unsuitable for its intended purpose. Difficult as it may seem, we must produce a standard if we are all agreed that it is needed.

The best possible standard can be written only when we all have contributed our best possible input, and we are asking for your help towards that goal.

DISCUSSION

Q: In your grading scheme, you give the same weight to both color and texture, do you believe texture should be given a better point system than color? Are there any problems with color?

A: In our evaluation of commercial blocks in storage testing we have found some product with excellent white color, but the texture was off and in other blocks the reverse was true. Right now the proposed standard reflects defects for deteriorative color only, not the normal distribution of color across the block.

Q: In the poultry industry they have been forced to accept a maximum of 1% bone, what would this do to fish and your subsequent yields?

A: I don't believe it will be a major problem. In our evaluation of 172 blocks, only 25 had bone and in those we only found a maximum of two bones. In 38 samples of Pollock blocks we found five with bones; however, those five had a lot of bones in them. Bones are not a problem when care and attention is taken to eliminate them. In looking over many samples of commercial blocks, we have not found many problems regarding bones.

Q: If you have strict standards of quality and wholesomeness, do you have to worry about mixed species in a block or species identification?

A: The concern relates to labeling, the requirements are such that we must make sure the species indicated on the label are actually in the block.

Q: Can you elaborate on plans to promote the inspection program and shield to the consumer.

A: Yes, it's just in the development stage now but we plan to produce promotional material that will include T.V. spots, handouts, slide presentations and published articles. We plan to work closely with the participating companies in the program in joint promotional efforts directed toward the consumer and the trade (institutional).

Q: Regarding texture - will you have different standards for different species or one single standard for all fish?

A: Different species have different characteristics, some flesh is firmer than others, the standard defines textural defects as those not characterized as normal for a particular specie, it also addresses itself to coarse and fine textures as well. If soft fleshed fish are a normal characteristic of the specie, the standard will so cover it.

Q: Regarding quality characteristics, we all would like to have a white, flakey, bone free product, but to achieve whiteness we must wash 3-4 times with water, but that produces a rubbery texture, to avoid bones we use strainers, this also gives rubberiness, we enlarge the holes (5mm or larger) to give more texture but this allows some bones and membrane through. We are being penalized both ways. How can you expect to approach this dicatomy with specifications written on a piece of paper?

A: One possible approach to color standards might be to look at setting specific color points as was used in the Canned Tuna Standard where the terms white, amber and light were internationally agreed to.

Q: Would these quality standards be based on raw or cooked product made from blocks? A darker type block when cooked will turn much lighter, the Japanese have demonstrated that effect.

A: As proposed these standards, and they are only proposals, one reason for the conference was to solicit comment such as this, are based on raw uncooked material.

COMMENT: The tuna standards referred to above are based on a cooked product in the can. Additional thought and consideration should be given to this minced block standard from comment given at this meeting regarding alternate approaches to the color problem.

COMMENT: The technology of mincing should never be considered a salvage operation. Because this advancement is economical, it should not be considered cheap, cheap always seems to be associated with poor quality. If quality factors cannot be managed and regulated, then the concept should be considered cheap and the material made into fish meal.

COMMENT: Perhaps the possibility of adding a third category under texture for chewability or fibrosity should be considered, to help determine how close to similation of the original flakey texture we have come.

COMMENT: The quality features discussed here deal with blocks only, not the products that will be derived from the blocks. Block grading will not carry over to fish stick and portion grades, these are two separate and distinct issues.

COMMENT: From a processing standpoint it may be more important for some deboning operations to distinguish the different parts of the fish, i.e. V-cuts from frames, and compare the quality of meat obtained from different parts of the fish and debone and blend accordingly.

Q: Another problem that will be troublesome is that you are proposing one defect table for both coarse minced and fine minced blocks. With coarse minced material your defects like bone and parasites will be more obvious. With the finer minces you tend to puree the defects out of the product. How can this problem be overcome?

A: We are now considering two, possibly three, different tables to take these differences into account. Textures must be separated because of the factors you outlined above.

Q: Will a Grade B Block carry that grade over to sticks and portions made from that block?

A: No, not necessarily, if the sticks and portions are Grade A material, they will be so labeled. This standard only applies to frozen blocks.

Q: We have listened to a great deal of discussion on the establishment of a grading system based on the attributes of MINOR, MAJOR and SERIOUS. Would it be possible to re-consider that system on the basis of points and a numbering scheme for defects?

A: It certainly would be, and it will be seriously considered. This is one reason for the meeting and discussion to solicity new view points.

Q: How will you measure texture? Texture is a very important consumer concern. It seems the standard is too restrictive for texture since everything will be graded on the same level.

A: We do not have a good objective test for texture measurement. We will depend on the experience of our inspectors to judge what will be considered normal for a particular product. Each type of minced product will have to be judged on their individual characteristics.

COMMENT: In re-drafting the standard, keep in mind that the future will enable us to use many underutilized species not presently harvested, and many of these may have darker colors. Our standard should be flexible enough to allow for future new use applications.

COMMENT: With additional research, rubberiness can eventually be controlled. We know, for example, that the Japanese want more fibrosity and they get it, it's a matter of processing technique and control.

COMMENT: The standard seems to ignore some basic problems - blemishes for one. They will be more numerous in the coarse minced material. They can be reduced by removal of the black lining before mincing or by running the coarse minced thru a strainer and diluting them out. They, in fact, are still there but reducing particle size has diminished their visability and physical appearance.

Q: The terms color defect and desication have been used here regarding storage conditions, are they one in the same in your proposed grading scheme?

A: No, desication refers to dehydration and color defects may also include oxidative changes under frozen storage.

Q: I represent a foreign producer of fish blocks and it is very difficult for us to wait until the product arrives here before we find out it's Grade A, B, C or what have you. Your standard as proposed would apply to all fish species but each specie is different, ours happens to be naturally soft and I can see problems in the future. Specifications should be made on a specie basis. How would you suggest I advise my industry in its exports to this country?

A: The NMFS is now contacting foreign countries, hoping to make certain arrangements with them on a co-operative effort to establish inspection and source certification of product prior to shipment to the U.S. This would ensure production of Grade A material there and acceptance by our inspection service here. These agreements will take time to work out, but we are hopeful that they will be successful.

COMMENT: We must all be aware that the world fisheries community through the Codex excercise is also working toward setting standards which the industry will be trading on in future years. One of those standards presently under consideration concerns the topic of this conference.

X.

CLOSING COMMENTS

Joseph W. Slavin
Associate Director for Resource Utilization
National Marine Fisheries Service
Washington, D.C.

Let me try and summarize what I have heard these last several days. Your large attendance, enthusiasm and lively discussions certainly prove the timeliness of this conference.

1. There are technical issues yet to be resolved; differences in stability, texture, yield, flavor, odor and color.

2. Species characteristics are most dominant. Raw material ranges from cod, pollock, carp, blue whiting; these characteristics need much better understanding.

3. Future work might be better focused and targeted toward specific species in depth and toward resolving basic issues that remain. In this context I suggest NFI/NMFS undertake a survey to define some of the major problems for specific species and stimulate work that will be directed toward this end.

4. Quality characteristics are very important. The need for high quality came through every phase of discussion at this conference.

5. I am convinced there is little background information on minced as compared to other seafood products. Traditional relationships are better known, such as fillet blocks of raw material to finished products.

6. There are three major actions underway that will add to our knowledge regarding minced products;

a. preparation of international codex alimentarius standards;

b. preparation of a background paper by FAO and the possibility of a code of practice by FAO; and

c. preparation of a U.S. draft standard for minced fish blocks.

I applaud these efforts and suggest comments be obtained on the draft standard for minced fish blocks. I agree, it would be helpful for NFI to hold a meeting with industry to discuss draft standards in further detail. The draft we discussed here is not set in concrete; we want your comments and will fully take them into account.

7. In the matter of labeling and product identification, I think everyone agrees it should be done in a manner so as to promote product and communicate accurately to the consumer what he or she is receiving. Everyone agrees with this philosophy. But when one gets beyond philosophy into implementation, they have problems. In this regard, I suggest we not back into this matter particularly since so much is involved in precedents already domestically set and for overall international trade. We should establish sound principles of labeling; to do this, I suggest NFI, in cooperation with FDA/NMFS, review this matter in greater detail.

8. More information on end products and their characteristics may be useful.

9. I have some statistics on the meeting and note over 150 people in attendance and notice by far most of those in attendance from industry. However, in looking at the list of speakers, 75 percent Government, 12-1/2 percent industry, 12-1/2 percent universities -- more industry involvement is needed.

10. Finally, NOAA/NMFS has a policy of working very closely with industry. I believe if we are going to make progress, we must continue this closeness. Look forward to the publication of these proceedings and another meeting in the future.

The conference organizers should be noted a special vote of appreciation in calling the question of Minced Seafood Technology II.

XI.

ADDITIONAL REFERENCE SOURCES

BONE PARTICLE CONTENT OF SOME MINCED FISH MUSCLE PRODUCTS

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Introduction

Conventional fish blocks are made from whole fish fillets. In recent years, because of the diminishing supply of and increasing demand for species usually used for processing into blocks, prices for this product have risen sharply. The economics of supply and demand have made it necessary to develop methods for the production of blocks from the flesh of less expensive species and possibly from the flesh left on the trimmings and frames (the skeletal structure and adhering flesh remaining after removal of fillets) of the various species used for fillets and steaks. The use of these "new" sources of fish muscle has been made practical by the development of machines that efficiently separate edible flesh from skin and bones. Such machines are manufactured in the United States (Paoli Intl., Rockford, IL; and Beehive Machinery, Salt Lake City, Utah), Japan (Bibun Kikai Seisakusho, Hiroshima-ken; Ikeuchi Takko Sho, Akeishi; and Yanagiya Machinery, Yamaguchi Prefecture), Sweden (Iwema, Goeteborg), and Germany (Baader, Lubeck). Commercial fish blocks are now being produced in relatively small amounts from minced flesh separated by these machines. The minced muscle turned out by these machines may contain amounts of bone. The frequency of occurrence of bones (fragments) depends largely on the size of the final extrusion opening through which the flesh is passed. Short fragments appear in the minced flesh when the bones are aligned transversely across the extrusion openings and are sheared off and press through with the flesh. Longer fragments appear when, by chance, they are aligned axially with the extrusion openings and are pressed part way through before being sheared off. Bone fragments may be soft and pliable and not easily detected during eating of the cooked product. They may also be sharp-pointed and rigid and potentially harmful. A potentially harmful bone is considered to be one that leaves a clear indentation when it is pressed axially between the fingers. Such bones should be eliminated from the product.

Recent publications on the use of machine-separated minced muscle have not considered bone content (Crawford et al., 1972; Teeny and Miyauchi, 1972; Miyauchi and Steinberg, 1970; King and Carver, 1970). Patashnik et al. (1973) indicate the presence of "a few small bone particles" in the machine-separated minced flesh but did not experience any problems in using it in the several finely emulsified product types they evaluated. However, in fish sticks and portions, a significant effect on consumer acceptance may be anticipated inasmuch as bones can usually be detected more readily.

At a Technical Seminar on mechanical recovery and utilization of fish flesh held in Oak Brook, IL in 1972, there was a surprising lack of information on the bone content of machine-separated minced flesh. Representatives from industry expressed the need for this information as well as for information on other quality attributes of machine-minced flesh. They also made the point that orderly marketing will require the establishment of standard nomenclature and quality criteria for both the raw material and the minced-fish end product. To help assure that these products find their place in the U.S. market, the National Marine Fisheries Service is developing a "Proposed United States Specification for Minced Fish Blocks." This document is intended to answer the immediate marketing needs of industry and to function on an interim basis until a Federal Grade Standard can be developed and promulgated.

To provide data useful in the preparation of the proposed specification, a series of experiments were carried out to 1) develop an objective procedure for determining the bone particle content of minced fish flesh; 2)determine the bone particle content of minced fish flesh produced by some flesh-separating equipment using different types of raw material; and 3) determine the bone particle content of some commercial samples and its possible effect on consumer acceptability. The results are reported here.

Experimental

The bone particle content of minced fish flesh produced under different conditions was determined using a gravity-flotation method. The ease of sensory detection of these particles and their effect on product acceptance by a taste panel was also determined.

Sample of minced fish blocks for bone particle analysis

Experimental. Minced rockfish flesh was obtained from three forms of raw materials: 1) washed, headed-and-gutted (H&G) black rockfish (Sebastes flavidus and S. melanops); 2) skin-on fillets including vee-bones cut from H&G black rockfish; and 3) the remaining separated frames. The raw materials were passed through a commercial-size Bibun Flesh Separator equipped with a rotating drum perforated with 7 mm diameter holes. Minced "lox" flesh was obtained by passing salt-cured, smoked salmon trimmings through a laboratory-size Yanagiya Flesh Separator "Miny" model (Miyauchi and Steinberg, 1970) equipped with a perforated rotation drum with 4 mm diameter holds. Part of the minced flesh of both species was then passed through a Bibun Flesh Strainer (King and Carver, 1970) equipped with 1 mm or 2 mm holes to further debone the flesh which was then frozen into blocks.

For sensory evaluation, minced black rockfish blocks were prepared by the method of Teeny and Miyauchi (1972).

Commercial. Samples of commercialy prepared frozen minced blocks were taken at random off the processing line of a fish-stick plant. The numbered slab samples in Table 5 were taken sequentially from a single block. Partial slab samples (3-oz. subsections of a slab) and unbreaded fish stick samples (0.5-0.6 oz) were taken at random off the production line during a 15 min. period. At the same time, battered- and breaded precooked fish stick samples

(1-oz.) were taken for sensory evaluation.

Sensory detection of bones

Experimental samples. Frozen blocks were sawed into 1-1/8 in. x 1-1/2 in. x 5/8 in. thick (1-1/2 oz.) portions. They were battered and breaded in the frozen state after which they were deep-fat fried at 177°C for 5 min. The sensory panel was instructed to note the number and sizes of the bone particles found.

Commercial samples. The pre-cooked battered-and-breaded fish sticks were heated in an oven at 204.5°C for 15 min. The sensory panel was instructed to chew completely each sample and to rate the sample for acceptability on the basis of the number and size of bone particles detected.

Gravity-flotation method for determining bone content

The method involves two steps: 1) shredding the flesh in water with a low-speed stirring device and 2) gravity separation of the bone, cartilage and other high-density components from the lower density floatable muscle fibers.

Equipment. 1) 8-speed food stirrer-blender-disintegrator (Oster Model 847 or equivalent)-the cutting edges of the blades are blunted or rounded; 2) 5-cup blender jar; and 3) paper towels.

Procedure. 1) Weigh 50 or 100 g or fish sample, which may be either frozen or unfrozen; 2) place sample in 5-cup blender jar and fill with cold tap water; 3) blend at lowest speed for about 2 min; 4) place blender jar in sink and run tap water into it at a flow rate of about 1 gal/min until water is essentially free of floating fish muscle fibers, break up any remaining aggregates of flesh at the bottom of the jar or on cutter blade, and float off fibers with running water; 5) transfer quantitatively the bone, fin and cartilage residue to a paper towel for estimating or counting; 6) for counting, separate into components (bones, cartilage, skin pieces, etc.); and 7) sort bones into various size categories (1/8 in., 1/8 in. to 1/4 in., 1/4 in. to 1/2 in., 1/2 in.), count and report as number per pound of sample: Number of bone particles per pound = (454.4/sample wt) x bone count.

The above size categories and method of reporting bone particles were selected mainly for potential use in preparing the "Proposed United States Specification for Minced Fish Blocks." In practice, the method of reporting bone particles and other non-muscle components will depend upon product specification requirements or the type of quality information needed by the buyer or seller of the products.

To determine the reproducibility of the procedure and to check that bones are not being reduced in size during blending, the following test is suggested: 1) add 10-20 bones of known size to a bone-free sample of minced flesh; 2) run through the above procedure to verify that all bones can be recovered and that there is no bone fragmentation; 3) repeat as required to assure reproducibility of the procedure and that the cutting edges of the blender blades have been adequately blunted or rounded.

Results and Discussion

Bone particle content of experimental samples

By gravity-flotation method. Tables 1-3 show the bone content of various experimental samples put through the flesh separator and separator/strainer. The data in Table 1 compare the average number of bones for each size category per pound of minced flesh after passing headed-and-gutted rockfish through the Bibun flesh separator (7 mm perforations) under minimum pressure and after passing the resultant residue through the separator again but under medium pressure. The total bone particles per pound for the first-pass flesh was 24 and for the second-pass flesh was 127. By putting portions of the first-pass minced flesh through either the 2 mm or 1 mm strainers, the total bone particles contents were respectively reduced to 6.5 and 0.1 per pound; similarly by straining the second-pass flesh, bone particle content was reduced to 38 and 3 per pound, respectively. The 2 mm strainer reduced the bone particle content of the first- and second-pass flesh by 70-73 percent. The 1 mm strainer achieved 98-100 percent reduction for both. Due to the high initial bone particle content of the second-pass flesh, the 1 mm strainer is needed to effectively remove the bones from this material.

On passing "lox" belly trim (slat-cured smoked salmon) through the Yanagiya flesh separator (4 mm perforations) at minimum pressure, the first-pass flesh contained 32 bone particles per pound; second-pass flesh contained 116 bone particles per pound (Table 2). When the first-pass flesh was put through the 2 mm strainer, the bone particle content was reduced by 94 percent to 3 particles per pound. Second-pass material was reduced by only 72 percent to 32 particles per pound. Here too, because of the high initial bone particle content of the second-pass material, the need for a 1 mm strainer is indicated.

The results of experiments to compare the bone particle contents of first-pass Bibun-separated flesh from H&G rockfish, skin-on fillets (H&G rockfish with frames removed), and from frames alone are given in Table 3. As was expected, flesh from the H&G rockfish containing intact frames and flesh from the frames alone contained more bone particles than did the flesh from the skin-on fillets. The flesh from the H&G fish contained more bone particles than did the flesh from the frames -- 24.4 per pound against 17.1 per pound. This somewhat higher total bone particles content may be explained on the basis that more drum pressure is generated during the passage of the H&G fish than during the passage of the considerably thinner frame.

By sensory detection. Table 4 shows the test results of the sensitivity of an experienced sensory panel to the presence of bone particles in some of the experimental samples and compares this with the gravity-flotation method. The sensory panel selected consisted of regular panelists each with 5 or more years of experience in the sensory evaluation of minced flesh products, such that they would be expected to be more sensitive to the presence of bones than the ordinary consumer. Using the flotation method on the first-pass H&G rockfish, we found 24.8 bone particles per pound of minced flesh. The sensory panel found only 1.7 bone particles per pound or about 7 percent of those present. In the minced flesh from skin-on fillets containing 6.0 bone particles per pound by the flotation method, the sensory panel found only 0.6 bone particles per pound or about 10 percent of those present.

The wide difference in results obtained by the sensory panel and that of the objective method is largely due to the differing sensitivities of the two methods. The sensory method involves a lower statistical probability that a bone of detectable size and hardness will be contacted during chewing. Also, small diameter or pliable bones, even when contacted during chewing, are difficult to sense by tactile means. In contrast, the objective method based on specific gravity, is independent of the size or hardness of bones for their reliability of detection.

Bone particle content of commercial minced fish blocks

By gravity-flotation method. Bone particles in minced commercial blocks were determined by the gravity-flotation method and are reported in Table 5. The data show that the bone particle counts per pound of product vary widely and are surprisingly high in some of the samples. They range from an average of 4 per pound for Icelandic cod blocks to an average of 463 per pound for cod blocks processed in Denmark. The Norwegian-processed Atlantic pollock blocks and the Japanese-processed Alaska pollock blocks were intermediate in bone particle content, 60 and 56 per pound, respectively. It should be pointed out that bone particle content appears to be a function of processing methods and raw material, not of species. All cod blocks were made of the same species, Gadus morhus. Atlantic pollock (Pollachius virens) is a distinctly different species from Alaska pollock (Theragra chalcogramma).

By sensory detection. The ability of a nonexpert or consumer-type sensory panel to detect the presence of bone particles in some of the commercial samples was evaluated. The data in Table 6 indicate that only a small fraction of the bone particles actually present could be detected by the panel members even though they had been instructed to chew completely each sample in order to quantify presence of bones. Panelists did not find any bones in the Canadia and Icelandic cod, i.e., those virtually free of bone particles. However, in the cod blocks containing 463 bone particles per pound, 7 or 29.4 percent of the panelists detected bones, but only 1 or 4.2 percent found the product unacceptable because of the bone particles. The granular, crusty nature of the cooked batter and breading combined with the chewy fish flesh apparently conceals the presence of soft pliable bone particles.

Reduction of bone content. Although bone particles are not readily detectable by sensory means, their presence should be reduced to as low a level as feasible.

Straining the minced flesh has been shown to be an effective means of reducing the bone particle content to acceptable limits. However, straining reduces particle size of the flesh and may alter the texture of the cooked product. It probably has an effect on frozen storage characteristics and therefore on acceptability.

Straining also increases product handling and production costs. The degree to which straining may be necessary to reduce the bone content will have to be carefully worked out in terms of product end use and the effect on product quality.

Use of gravity-flotation method as a quality control tool

The gravity-flotation method is recommended as a useful quality control tool to provide reasonably accurate estimates of the bone content. Depending on the accuracy desired, a test may take from a few minutes to 10 min per sample. Where only an estimate of the type and quantity of bones, scales and bits of skin and fins is needed for quality control screening, the procedure may be speeded up and the amount of extraneous material is visually estimated rather than counted.

TABLE 1. AVERAGE NUMBER OF BONES PER POUND OF MINCED FLESH FROM HEADED-AND-GUTTED BLACK ROCKFISH PASSED THROUGH THE BIBUN FLESH SEPARATOR (7MM PERFORATIONS) AND STRAINER (1- AND 2 MM)

Treatment			No. of 50-g samples analyzed	Avg. number of bones, by size, per pound of flesh			
				<1/8"	1/8-1/2"	>1/2"	Total
1st pass (minimum pressure)	Unstrained	(7 mm)	14	9.0	14.0	1.0	24.0
	Strained	(2 mm)	40	6.0	0.5	0.0	6.5
	Strained	(1 mm)	39	0.1	0.0	0.0	0.1
2nd pass (medium pressure)	Unstrained	(7 mm)	12	55.0	67.0	5.0	127.0
	Strained	(2 mm)	20	35.0	3.0	0.0	38.0
	Strained	(1 mm)	19	3.0	0.0	0.0	3.0

TABLE 2. AVERAGE NUMBER OF BONES PER POUND OF MINCED "LOX" (SALT-CURED SMOKED SALMON) FROM TRIMMINGS PASSED THROUGH THE YANAGIYA SEPARATOR (4MM PERFORATIONS) AND 2 MM STRAINER

			No. of 50-g samples analyzed	Avg. number of bones, by size per pound of flesh			
				<1/8"	1/8-1/2"	>1/2"	Total
1st pass (light pressure)	Unstrained	(4 mm)	6	17	13	2	32
	Strained	(2 mm)	6	0	3	0	3
2nd pass (light pressure	Unstrained	(4 mm)	6	53	53	10	116
	Strained	(2 mm)	6	30	2	0	32

TABLE 3. AVERAGE NUMBER OF BONES PER POUND OF MINCED FLESH FROM INTACT HEADED-AND GUTTED (H&G) BLACK ROCKFISH, FROM SKIN-ON FILLETS (H&G ROCKFISH WITH FRAMES REMOVED) AND FROM FRAMES PASSED THROUGH SEPARATOR (17MM PERFORATIONS) AT MINIMUM PRESSURE

	No. of 100-g samples analyzed	Avg. number of bones, by size per pound of flesh			
		<1/8"	1/8-1/2"	>1/2"	Total
Headed-and-gutted rockfish	43	12.0	11.5	0.9	24.4
Skin-on fillets (with vee-bones and belly wall left on)	30	2.0	1.3	0.0	3.3
Frames (Central vertebra) bone with tall and adhering flesh)	35	10.3	6.5	0.3	17.1

TABLE 4. AVERAGE NUMBER OF BONES PER POUND OF MINCED FLESH FROM HEADED-AND-GUTTED BLACK ROCKFISH AND FROM SKIN-ON FILLETS AFTER PASSING THROUGH BIBUN FLESH SEPARATOR (7MM PERFORATIONS). DETERMINED BY GRAVITY FLOTATION AND BY SENSORY PANEL[a]

Treatment	Method of analysis	Samples analyzed		Number of bones, by size, per pound of flesh				
		Number	Size	<1/8"	1/8-1/4"	1/4-1/2"	>1/2"	Total
Headed-and-gutted whole rockfish (1st pass, minimum pressure, unstrained)	Gravity-flotation	36	100g	15.0	5.0	4.0	0.8	24.8
	Sensory panel	392	1-1/2 oz.	0.8	0.4	0.3	0.2	1.7
Skin-on fillets with vee bones & belly wall on (1st pass, minimum pressure, unstrained)	Gravity flotation	15	100 g	4.0	2.0	0.0	0.0	6.0
	Sensory panel	24	1-1/2 oz.	0.0	0.0	0.3	0.3	0.6

[a]An experienced panel consisting of our technical staff was used.

TABLE 5. AVERAGE NUMBER OF BONES, BY SIZE, PER POUND OF MINCED FLESH FROM FROZEN BLOCKS COMMERCIALLY PREPARED FROM FISH OF VARIOUS SPECIES IMPORTED FROM VARIOUS COUNTRIES

Species used, block size, and country of origin	Sample source or description	No. of 100-g samples analyzed	Avg. number of bones, by size, per pound of minced flesh[a]				
			<1/8"	1/8-1/2"	1/4-1/2"	>1/2"	Total
Atlantic pollock (chopped); 13-1/2 lb. Norway	Slab no. 1	5	59.0	33.0	11.0	3.0	106.0
	Slab no. 2	6	17.0	33.0	1.0	2.0	53.0
	Slab no. 3	6	11.0	11.0	5.0	2.0	29.0
		17	27.0	25.0	5.3	2.3	59.3
Cod (minced), 13-1/2, Canada	Slab no. 1 & 2	9	1.5	0.5	0.0	0.0	2.0
	Slab no. 3 & 4	11	1.0	0.0	0.0	0.0	1.0
	Partial slabs	8	6.0	4.0	0.0	0.0	10.0
	Fish sticks	9	4.0	0.5	0.0	0.0	4.5
		37	4.0	1.5	0.0	0.0	5.5
Cod (minced), 13-1/2 lb. Denmark	Slab no. 1 & 2	8	254.0	147.0	65.0	0.0	466.0
	Slab no. 3 & 4	6	294.0	33.0	27.0	0.0	354.0
	Slab no. 4 & 5	8	276.0	105.0	0.6	0.0	372.6
	Fish sticks	17	330.0	162.0	75.0	1.4	568.4
		39	296.0	127.0	40.0	0.3	463.3
Cod, 18-1/2 lb. Iceland	Slab no. 1	5	3.0	0.0	0.0	0.0	3.0
	Slab no. 2	5	0.0	0.0	0.0	0.0	0.0
	Fish sticks	10	6.0	0.0	0.0	0.0	6.0
		20	4.0	0.0	0.0	0.0	4.0
Alaska pollock, 18-1/2 lb. Japan	Slab no. 1	5	35.0	13.0	0.0	0.0	46.0
	Slab no. 2	3	68.0	8.0	0.0	0.0	76.0
	Slab no. 3	5	52.0	6.0	0.0	0.0	58.0
	Slab no. 4	5	51.0	16.0	0.0	0.0	67.0
	Slab no. 5	5	43.0	9.0	0.0	0.0	52.0
	Slab no. 6	5	45.0	4.0	0.0	0.0	49.0
		28	46.0	10.0	0.0	0.0	56.0

[a]Figures shown beneath the solid line for each group of samples indicate the total number of samples analyzed and the average number of bones in the group. Averages were prorated on the basis of sample weight.

THE MEASUREMENT OF THE BONE CONTENT IN MINCED FISH FLESH

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Introduction

Meat separators are being increasingly used to recover edible flesh from previously unused species of fish and from the residue of filleting operations. In one type of machine, the raw material is squeezed between a belt and a perforated metal drum moving at different speeds, and this results in the softer parts such as the flesh being extruded through the holes of the drum, whilst the harder or tougher parts, like bone and skin, are passed on to discard. In another type, called a strainer, the material is forced by a worm-feed into a perforated drum, so that the flesh is forced through the holes and unwanted material is discharged through an opening at the end of the drum. The separation of flesh is not perfect in either machine, and some small pieces of bine and skin will be found in the product, in size and amount depending on the size of the holes in the drum, as well as other operating conditions, and on the nature of the raw material. Bones left in the product, and particularly the presence of large bones or bone particles is a major quality defect influencing the consumer acceptability of cooked products made from the minced flesh. Several reported methods for estimating bone content in comminuted flesh of chicken, crabs, etc., have been examined, and a modification of an AOAC procedure for determining shell in crab meat seems to provide a readily applicable method for use with minced fish flesh. It should be particularly effective for quality control, both in fish plants developing minced fish production techniques, and in those plants incorporating the minced flesh in consumer products.

Method

To 100 g of minced flesh sample weighed into a 600 ml beaker, add 200 ml of 1 molar sodium hydroxide solution (40 g sodium hydroxide made up to 1000 ml with water). Break up lumps with a stirring rod.

Heat the mixture rapidly while stirring to 95°C to dissolve the flesh, then cool in an icebath to 40°C or lower.

Add about 50 ml of chloroform (graduated cylinder) and allow the bones to settle (5 min.). The chloroform sinks to the bottom, carrying the bones with it, although some of the finer particles may stick to the interface between the two layers. Carefully pour off and discard as much as possible of the upper layer containing the sodium hydroxide but without losing any of the material at the interface. Add water to near the capacity of the beaker and pour off after the bones have resettled. Repeat the water addition 3 or more times until the top layer remains clear.

After discarding the last wash-water, filter the bottom layer containing the bones through a dry pre-weighed Whatman #1 filter paper (11 cm) in a 7 mm Buchner funnel with suction. Wash the bones into the filter with a little water.

Dry the filter paper and bones (in small aluminum boxes) in oven at 105°C to constant weight (e.g., overnight), weigh, and calculate the amount of bones.

If desired, the bones recovered from a number of digestions may be pooled and the size distribution determined by passing through a set of standard sieves.

N.B. 1. Take care to use a sample from a well-mixed representative sample of the material. Completely thaw the material first, if frozen.

2. It is convenient to use a combined hot-plate and magnetic stirrer for the heating, and another magnetic stirrer under the ice bath (non-magnetic container) for the cooling. Keep the times of heating and cooling reasonable constant for reproducible results.

3. Sodium hydroxide (lye) is corrosive, especially when hot, so take adequate precautions against accidents.

4. A fume hood or exhaust fan is recommended to avoid accumulation of chloroform vapor.

5. Pigment particles (from skin) and small gelatinous lumps may occur; these add very little to the dried weight, and may be ignored.

<u>Discussion</u>

The conditions outlined above were adopted after a number of tests using different temperatures, strengths of sodium hydroxide, etc. In the course of these, it was found that cod bones, cleaned of any visible flesh, lost about 25 percent of their weight when subjected to the procedure, but did not seem to change in size or shape. This probably means that the sodium hydroxide dissolved some protein (collagen) from the bones, but left the calcified matrix intact. Because of this, the conditions of the test should be followed as closely as possible in order to make results from different samples comparable. Nevertheless, it should be realized that bone is not a simple substance, and that its composition varies from species to species and even from fish to fish of the same species according to season or physiological condition; such changes would affect the results not only of this bone assay method, but of other methods based, for example, on the measurement of the calcium content of the material.

The procedure worked well with deboned meat from cod used as a representative of lean fish. As an example of fatty fish, whole mackerel were passed through the deboner and then assayed for bone content. When digested with sodium hydroxide, this material yielded globules of oil at the surface, and what appeared to be fine particles of bone adhered to them. These particles were lost with the oil when decanted, but would constitute only a negligible amount of bone in any case. Apart from this, no difficulty was encountered in determining the bone content of the mackerel samples.

As examples of the type of result possible with this assay, Figures 1 and 2 illustrate the bones recovered from "deboned" cod flesh, each dish containing the bones found in four 100 gram samples of product. All the fish had been headed and gutted; those of the D-19 series had been prepared as for salt fish making with most of the backbone cut out, while the D-21 series comprised the frames left after normal filleting. The effect of the hole size in the deboners on the size of the bone particles in the product is clearly evident. It will also be seen that much of the bone material occurred as very fine particles, especially in the flesh recovered from the frames D-21, and that the lengths of many of the large pieces considerably exceeded the diameter of the holes of the deboner drum. The weights of bone found in the various samples are given in Table 1. The products made by using 3 mm holes contained more bone than that made with 5 mm holes, but this was probably due to using different machines in the two operations.

To assess the significance of the presence of bone particles, and their size as well as number, on the acceptability of consumer products made from the minced fish, preliminary trials were carried out on cooked samples. Large particles were much more objectionable than fine material, so that the use of the 5 mm drum hole size gave a much more acceptable product than the 7 mm size. It also appears that use of a 2-stage process (meat separator-strainer is not warranted as far as removal of bones is concerned.

Summary

A simple procedure for the estimation of the amount and size distribution of bone particles in fish recovered from meat-separating machines is described. It depends on digestion of the

TABLE I.

Amount of Bone in Deboned Cod Flesh

(milligrams of bone per 100 grams of material, wet basis)

Material	Deboner Hole Size 7mm	5mm	3mm	7mm-2mm
D-19	63 (25-110)	13 (0.2-22)	24 (17-36)	8 (6.8-9.9)
D-21	84 (54-97)	52 (32-76)	59 (45-83)	13 (12-1[illegible]

A Bibun meat separator was used with 7mm and 5mm holes; a Yanagiya machine with 3mm holes. In the last column, material was passed first through the Bibun deboner with 7mm holes, then through a Bibun strainer with 2mm holes. Figures are averages of 4 determinations with the range of results given in parentheses.

meat in hot 1 molar sodium hydroxide and the separation of the bones by flotation with chloroform. One advantage is that the bone particles remain intact, and the size distribution can readily be seen. The method should be useful in quality control and product development work.

Acknowledgment

We gratefully acknowledge the excellent cooperation of Mr. R. Legendre in carrying out the meat-separator runs.

FIGURE I

Bone particles recovered from flesh obtained by deboning headed and gutted cod with the backbone partly removed (preparation D-19). Upper left, Yanagiya deboner with 3mm holes; upper right, Bibun deboner with 5mm holes; lower left, same with 7 mm holes; lower right, Bibun deboner with 7mm holes, then Bibun strainer with 2mm holes.

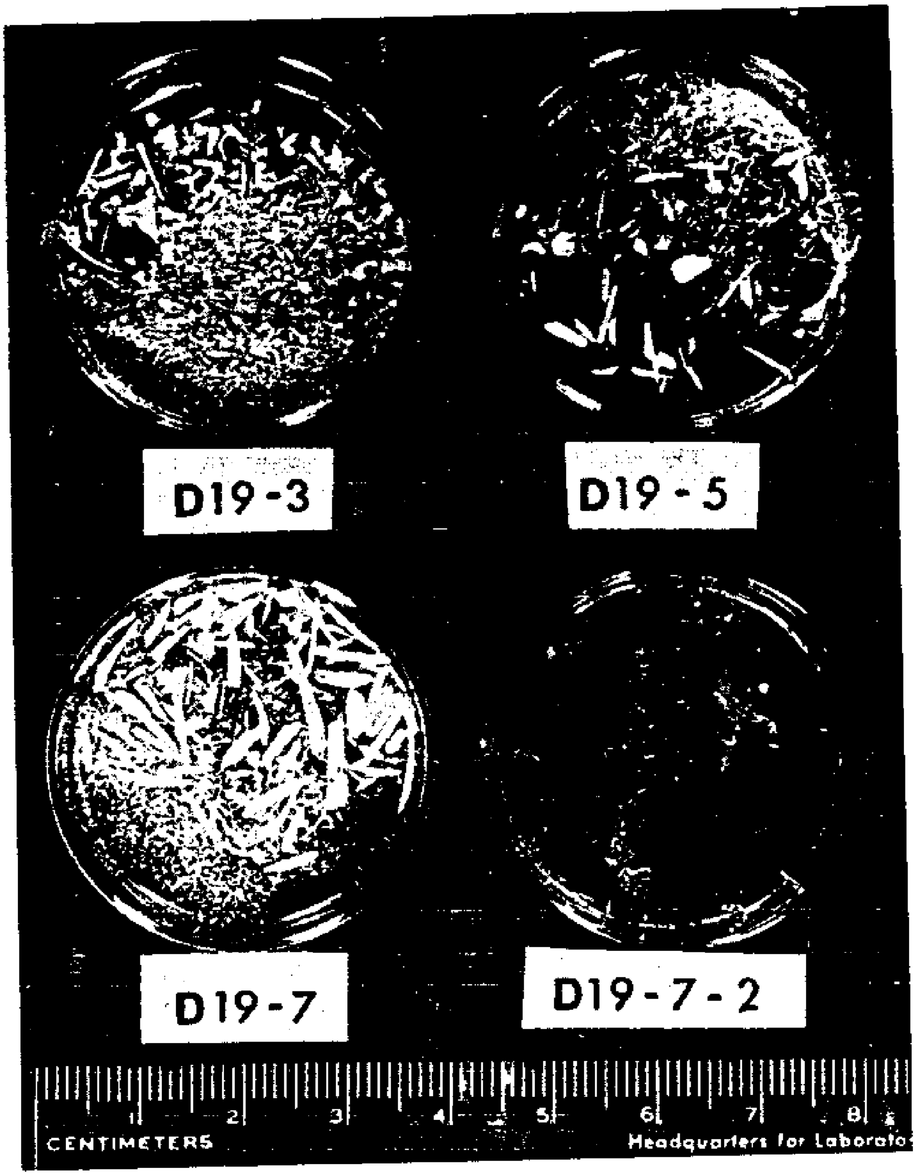
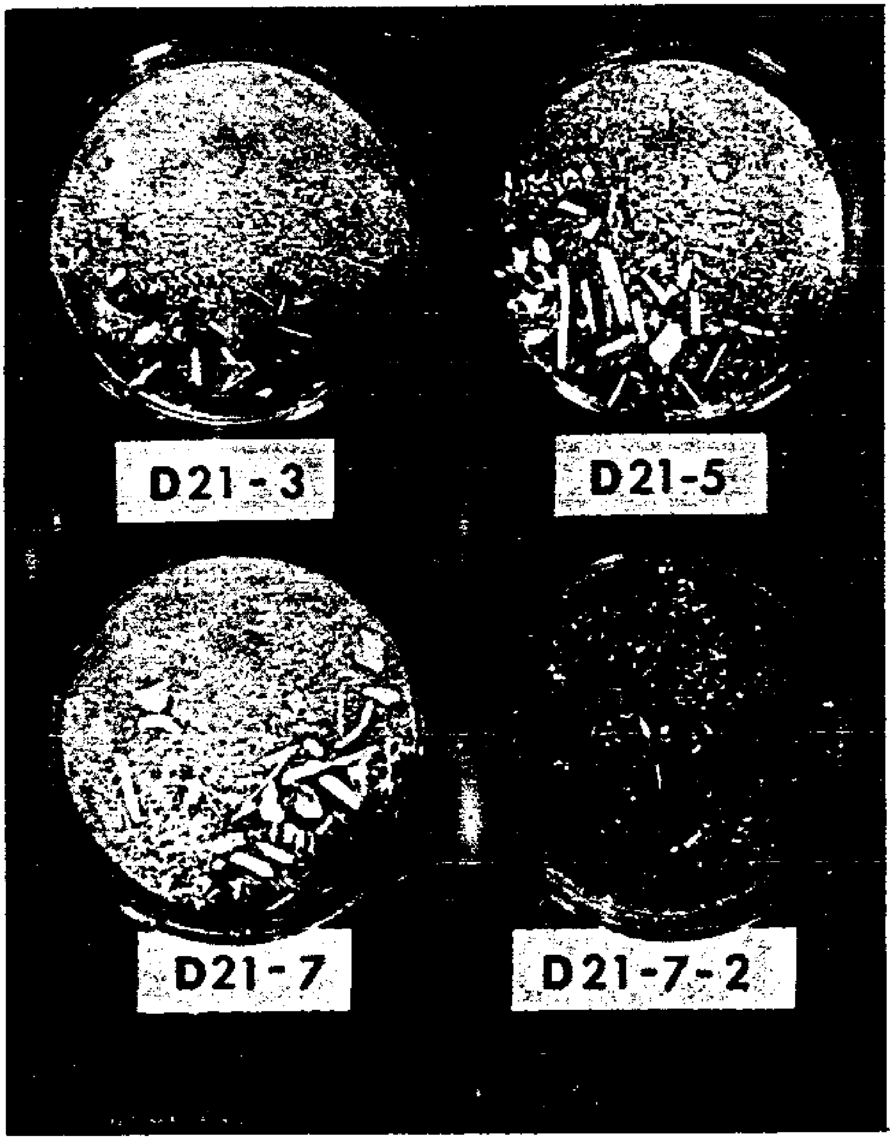


FIGURE 2

Bone particles recovered from flesh obtained by deboning cod frames after filleting the headed and gutted fish (preparation D-21). Upper left, Yanagiya deboner with 3mm holes; upper right, Bibun deboner with 5mm holes; lower left, same, with 7mm holes; lower right, Bibun deboner with 7mm holes, then Bibun strainer with 2mm holes.



MFR PAPER 998

Improving the Supply of Minced Blocks for the Fish Stick Trade: A Progress Report

FREDERICK J. KING

BACKGROUND

The scarcity of fish blocks and the increasing demand for fish sticks have prompted us to develop a process for making minced blocks using fish frames (a fish backbone after fillets have been removed). At present, these frames are utilized for meat or fertilizer even though their flesh is essentially the same as the flesh of the fillets cut from them. Besides this white flesh, the frames contain blood-rich tissues right under the backbone. Since these tissues are as soft as the white muscle, they will pass through with it in a meat-bone separator. The blood pigments will give the minced flesh a red color (similar to ground beef) or if they become oxidized, a brown or gray color. In a fish stick, any color other than white is usually considered as a defect.

A marketplace for fish sticks made from minced flesh has already been established. These sticks are made from minced flesh obtained from V-cuts (fillet trimmings) which do not contain visible blood pigments. The yield of edible meat from this source is only about 2 percent of the carcass weight. In contrast, fish frames contain about 20 percent machine-separable flesh (based on carcass weight). These considerations have stimulated R&D work to find how to utilize flesh from frames in the manufacture of fish sticks.

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ONE SUGGESTION—DILUTE OR BLEND THE COLOR

We found that the intensity of the blood color in minced blocks could be reduced by dilution. For example, if headed and gutted fish are passed through a meat-bone separator, the minced flesh will be whiter because it contains a greater proportion of white muscle. A similar method of dilution is to mix fillet trimmings or V-cuts with the frames and pass this mixture through a meat-bone separator. This method saves the fillet meat for sale as regular fillets; but it, too, does not decolorize the blood pigments specifically. We have also used selective cuts from frames (such as tail sections, belly flaps, etc.) to avoid passing the blood-rich tissues through a separator. This method does reduce the intensity of color in the minced flesh. It also reduces the yield of edible meat from the carcass and introduces the costs of making the selective cuts.

Another method of increasing the whiteness of minced fish flesh is to blend it with a suitable flour or a similar white vegetable product. This method has been used by Japanese firms for several years in making traditional products such as kamaboko (Tanikawa, 1971). It can be applied to occidental seafood products such as fish cakes. However, it is obviously not suitable for the manufacture of all-fish-flesh products.

ANOTHER SUGGESTION—WASH OUT THE COLOR

None of the above methods attempts specifically to decolorize or remove the colored blood pigments. Chemical additives such as hydrogen peroxide or sodium hypochlorite can whiten fish flesh, but their employment can introduce unacceptable deterioration in texture and flavor. The Japanese method of making minced fish blocks (surimi) involves washing minced flesh with copious amounts of water after it has been separated from bone and skin as well as using headed and gutted fish to obtain the minced flesh (Tanikawa, 1971). The advantages of this method of leaching blood pigments from minced fish flesh prompted us to study its adaptability for making minced blocks from fish frames or headed and gutted fish that would be suitable for the manufacture of fish sticks.

TEST METHODS FOR WASHING SUGGESTION

This method of preparing minced fish blocks is based on the following sequence of steps:

1. Remove heads and viscera (if present) from frames or whole fish.

2. Pass raw material through a meat-bone separator and wash the flesh while it is being separated.
3. Dewater the minced flesh.
4. Pass dewatered flesh through a strainer.
5. Prepare minced fish blocks from the strained material.

Several species have been used so far in these tests. Filleting leftovers (backbones or frames) have included: cod *(Gadus morhua)*, tom cod *(Microgadus tomcod)*, cusk *(Brosme brosme)*, flounder, mixed *(Pseudopleuronectes americanus, Limanda ferruginea, Hippoglossoides platessoides,* and *Glyptocephalus cynoglossus)*. Headed and gutted species have included: whiting *(Merluccius bilinearis)*, ocean perch *(Sebastes marinus)*, and herring *(Clupea harengus)*. Fresh water species (all headed and gutted) have included: carp *(Cyprinus carpio)*, sucker *(Catostomus commersonni)*, sheepshead *(Aplodinotus grunniens)*, and white amur *(Ctenopharyngodon idellus)*. With the exception of herring, the edible flesh of these species consists mostly of white muscle with a small amount of dark, lateral line muscle. Again, with the exception of herring, we found that species differences were less important than our processing and handling variables in influencing the quality of our minced blocks.

Heading and Gutting

Removal of heads and viscera (if the fish were not gutted at sea) is presently done by hand labor. Using a band saw to cut off the heads has increased productivity but heading and gutting equipment would be more satisfactory. Such equipment is available for certain species or sizes and shapes, but there is a need for more versatile heading and gutting equipment to match the versatility and throughput of meat-bone separators.

Flesh Separation and Washing

Flesh can be removed from skin and bone in a variety of commercially available meat-bone separators. We are using a Bibun Model 15 separator[1] (Figure 1; see also Figures 2, 3, and 4). This machine contains a wide flexible belt that moves against the outside of a rotating, perforated metal drum. The belt and drum move at different speeds in the same direction. Since these speeds are different, flesh is separated by a shearing action as well as the mechanical pressure between belt and drum. The flesh passes through the holes of the drum while bones and skin are dumped off the end of the belt. Although we have used drums with 3 mm or 5 mm holes, we settled on a drum with 7 mm holes in most of our testing to increase the yield of recovered flesh and to minimize fragmentation of bones in the separator.

[1]The mention of commercial items does not constitute an endorsement by the Department of Commerce over other items of a similar nature not mentioned.

We have found that washing the flesh as it is being separated from bones and skin offers several advantages. The most obvious one is that it leaches a significant amount of blood before the blood clots and becomes insoluble in water. Washing also hastens movement of flesh down the drum and out of the machine. Originally, we used a garden hose with an adjustable nozzle and sprayed the water by hand into the flesh-packed holes of the moving drum. More recently, we mounted adjustable nozzles on the separator itself to eliminate this requirement for hand labor. The amount of water used has been in the order of 2 to 3 times the weight of dewatered minced flesh obtained. This amount of water is considerably less than the ratios of about 7 or more

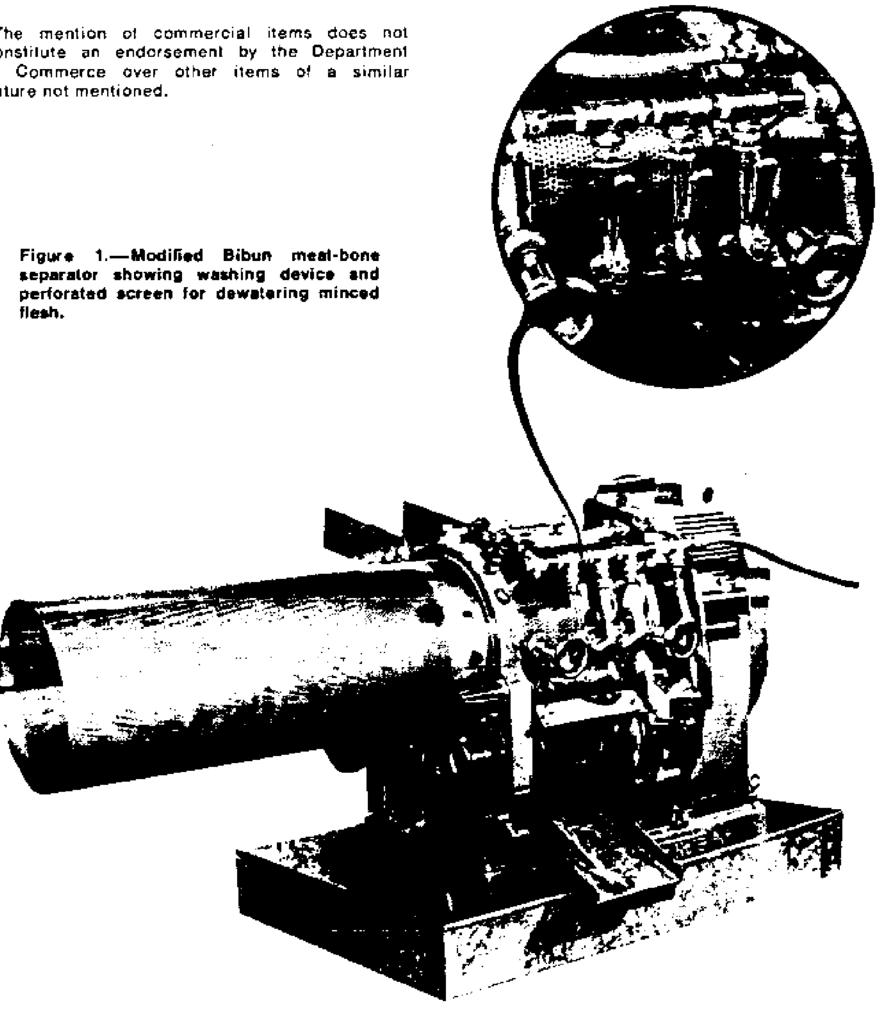


Figure 1.—Modified Bibun meat-bone separator showing washing device and perforated screen for dewatering minced flesh.

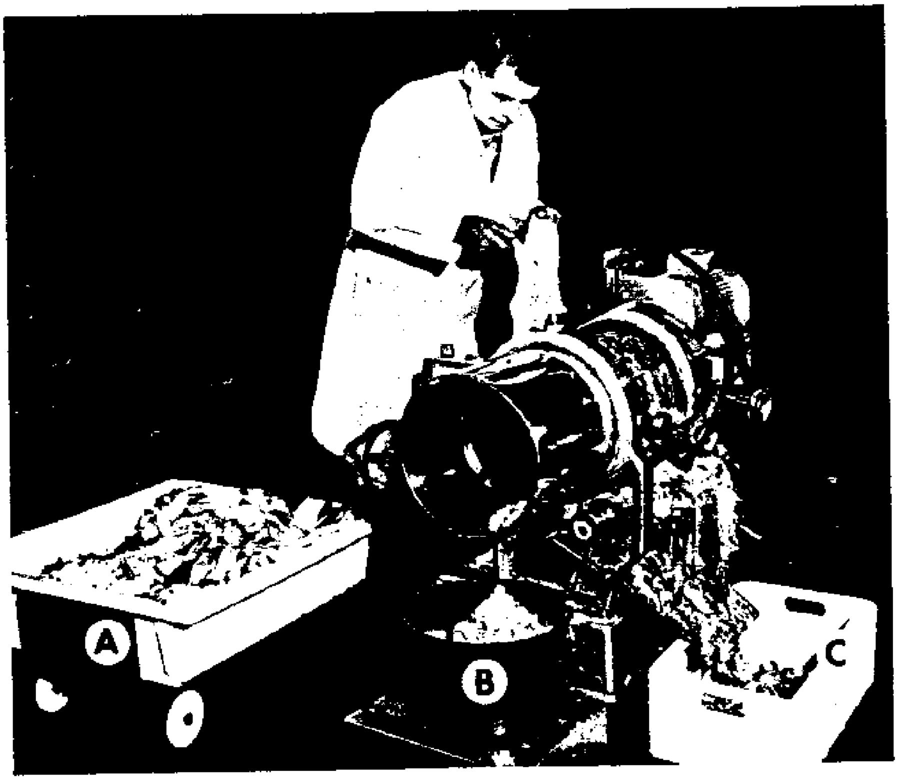


Figure 2.—This Bibun separator is being used to separate minced flesh from filleting leftovers (fish frames), shown at A. The recovered minced flesh is shown at B, the waste at C. This is the machine of Figure 1 without the washing device and the dewatering screen.

Figure 3.—The Bibun strainer is used, as desired, to improve the quality of dewatered and unwashed minced flesh obtained from a separator.

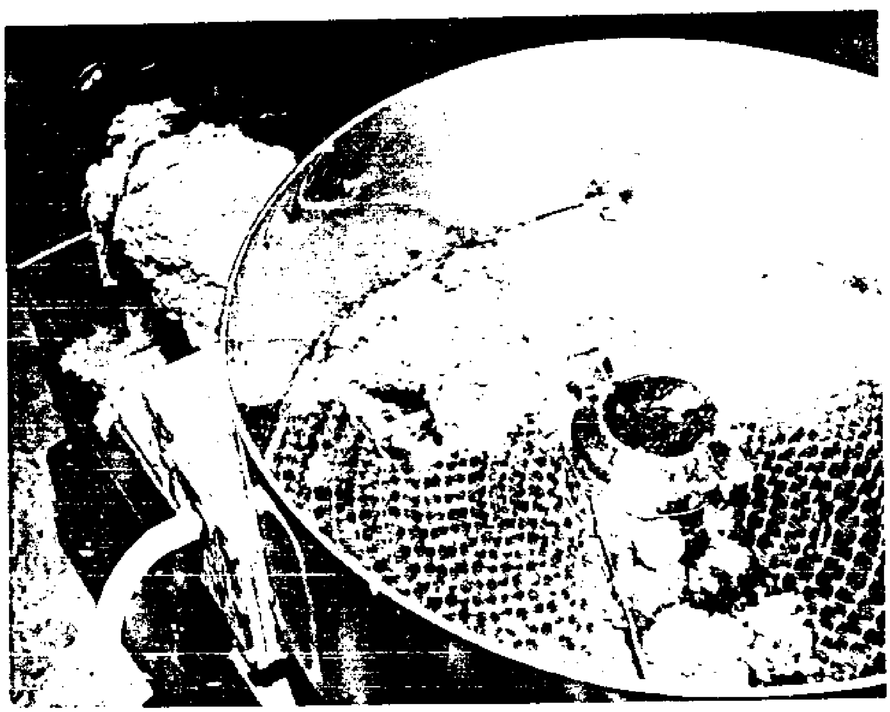
to 1 used by Japanese technologists in washing minced flesh to make surimi.

Although our purpose in washing the minced flesh was to reduce color by removing blood pigments, other soluble components were presumably leached out as well. The total amount of solids washed out was estimated at 10 percent of the weight of the unwashed minced flesh. The weight of the washed flesh itself was variable. The capacity of muscle proteins to hold water is well known. This capacity is affected by particle size, amount of water used, intimacy of mixing as well as temperature, and time conditions.

Dewatering

Dewatering the minced flesh is the next step in the process. We have put a perforated screen around the end of the drum in the separator. This screen has ⅛-inch holes and is 3 feet long. Most of the water which was mixed with the minced flesh in the

Figure 4.—Close-up view of Bibun strainer to show separation of minced flesh from skin or bone fragments.



drum drops out during the first third of the minced flesh's travel down this screen. How much water to remove from the minced flesh which drops off this screen and what equipment to use for this dewatering are two problems for which we have only partial answers at the present time.

Removal of excess water is necessary from a technological as well as a consumer viewpoint. For example, in the manufacture of fish sticks, the blocks from which these sticks are cut should have less than 5 percent "drip" (a measure of excess water). If these blocks have more than 5 percent excess water, sticks made from them tend to have too loose a coating of batter-breading and are apt to "explode" during cooking.

On the other hand, removal of too much moisture from minced flesh can accelerate deterioration of the flesh during frozen storage. The relation of moisture content or water activity to rate of lipid oxidation has been worked out in several model system studies as well as in various foods (review by Karel and Flink, 1973). The irreversible denaturation of fish muscle proteins, especially the myofibrillar protein, during frozen storage has been studied from this and other aspects (reviews by Connell, 1968; Dyer, 1968). The rate of this denaturation or loss of water holding capacity might be slowed down by holding the muscle protein under more favorable conditions (King, 1966). To reverse the loss of water-holding capacity by fish muscle proteins, chemical conditions such as the use of detergents or a highly alkaline pH have been suggested, but such conditions are generally unsuited to storing edible fish muscle.

It may be difficult to stop a dewatering operation at the proper time if one relies solely on analyses for moisture content. It is possible for one to develop a rapid, intuitive procedure with a bit of practice and follow-up analytical determinations. After several opportunities for practicing this art, I found that a sample of minced flesh should not form a puddle of water in the open palm of my hand, but this flesh should form a small puddle if I squeezed it gently. This subjective judgment had a surprisingly good correlation with the analytical data obtained from the minced blocks produced from this washed flesh.

Apart from the problem of how much to dewater the minced flesh after it leaves the separator, we are also investigating dewatering equipment which is feasible on a commercial scale. This equipment can be classified into three broad categories: screens, presses, and centrifuges.

On a pilot plant scale, we found that nylon mesh bags ("laundry bags") were a satisfactory type of screen for dewatering. After several empirical tests, we settled on placing about thirty pounds of wet minced flesh in a bag and hanging it on a support in a chill storage room (36° - 40°F). The bag was hung for one hour or less, depending on the time needed to dewater the flesh.

On a commercial scale, the use of nylon mesh bags can introduce problems such as slow throughput rate, high space requirements, and laundry expenses. With the cooperation of commercial processors, we are testing a Sweco vibrating screen for dewatering minced flesh. Several options are available with this equipment. Some of these options affect the throughput rate as well as the amount of dewatering of the washed minced flesh. For example, larger perforations in a screen increase throughput rate (partially because more "fines" escape with the liquid), and a larger diameter screen allows more time for dewatering the flesh. At present, we are using a single No. 20 screen (opening 840 microns, 0.0331 inch) five feet in diameter in a Sweco unit. This may not be the best combination for all applications, and for example, we are contemplating the use of a second Sweco unit to recover the "fines" that pass through the No. 20 screen with the water.

Presses are commercially available in a wide variety of capacities and pressures which can be applied for dewatering. We have used a simple cider press on a pilot-plant scale with essentially the same results as obtained by hanging a nylon mesh bag of minced flesh to dewater it. We are still looking for a press with a commercially feasible throughput and with quite low applied pressures.

Centrifuges are also available in a wide variety of equipment. Our initial experiments in dewatering minced flesh were based on a domestic type washing machine on a spin-dry cycle. The capacity of this batch centrifuge was obviously too small for commercial use, but we gained some useful data using it. Originally, it was capable of generating a centrifugal force of about 70 pounds per pound of flesh. This force tended to overdry the minced flesh so we geared it down to provide a centrifugal force of about 30 pounds per pound of flesh. This lower force was an improvement, but minced blocks made from this dewatered flesh had no drip at all.

On a commercial scale, centrifuges offer advantages of complete recovery of solids (including "fines") and continuous operation. We have used a DeLaval solid bowl centrifuge to dewater minced fish after it had been put through a strainer as well as the separator. By using centrifugal forces of 100 to 500 pounds per pound of flesh, drip was reduced from 8 percent to 3 percent even though the moisture content of these dewatered "fines" was 85 percent.

Flesh Separation by Straining

It is possible to prepare minced blocks from dewatered flesh that has not been put through a strainer. The texture of such blocks is at least equal to to the texture of minced blocks prepared from V-cuts. However, these blocks may not have a uniform appearance. They may have a few blood clots (not soluble in water), small pieces of skin or belly membranes. This non-uniformity in appearance may be disadvantageous in preparing fish sticks from such blocks. Occasionally, a few small bone chips may be found in these blocks; and if found in a fish stick, these chips are not desirable.

To improve uniformity of appearance and freedom from bone chips, we have been putting the dewatered flesh through a Bibun strainer before making minced blocks. This machine uses an auger or "wiper" blade to place the incoming material against a perforated cylindrical screen. A conical tube is used at the far end of the screen to create a slight back pressure which helps squeeze the flesh through the holes of the screen. Bone chips or skin pieces pass through the conical tube along with some of the flesh. This "waste" can be put into a second strainer to increase the yield of flesh if desired.

The perforated cylindrical screen can be fabricated with a variety of different sized holes. We have used screens with holes between 1 and 3 mm diameter. Choosing a size for a particular application involves three considerations: desired size of flesh particles, freedom from skin pieces, and yield of flesh. With a larger hole, the flesh is not minced as thoroughly, but there is a possibility that some small pieces of skin may be forced through the holes. These pieces would give the flesh a non-uniform appearance. This possibility can be avoided by using a very low back pressure in operating the strainer and, if desired, by using a second strainer to separate minced flesh from the "waste" mixture of flesh and skin pieces discharged by the first strainer. On the other hand, using a screen with a smaller hole enables one to use a wider range of back pressures to increase the yield of flesh from a single strainer although this flesh is more thoroughly minced.

Making Blocks

Usually, we have frozen the minced flesh to preserve it. Our techniques were similar to commercial methods for freezing fillets into blocks. The minced flesh was weighed into either a 13½ pound or a 16½ pound waxed chipboard carton, frozen in a plate freezer, then stored at 0°F. We have not used flexible films to inhibit desiccation or oxidative deterioration during storage. Such overwraps have been used successfully to preserve a variety of frozen foods, in general, and to preserve surimi, in particular, by the Japanese industry. However, such overwraps are not common in our regular block industry, and their effect on the storage life of minced blocks has not been determined.

We have not determined the effect of specific compounds on the frozen storage life of minced blocks. In the Japanese method of making surimi, the washing step is designed to remove components which, if left in the minced flesh, can accelerate deterioration in its quality during storage (Tanikawa, 1971). The Japanese method also includes adding salt, sugar, condensed phosphates, or other additives to inhibit protein denaturation (loss of water holding capacity) in the surimi during storage (Tanikawa, 1971). These additives and antioxidants have also been used for storing minced black rockfish blocks to be made into fish sticks (Teeny and Miyauchi, 1972). Unlike most of the species we have used, black rockfish itself is notorious for poor frozen storage life due to lipid oxidation. Our limited experience suggests that, without additives, the useful frozen storage life of minced blocks can be extended by improving the time, temperature, and sanitary conditions of making these blocks, as well as the frozen storage conditions.

EVALUATION OF MINCED FISH BLOCKS

The quality of our minced blocks was evaluated by two organizations, the NMFS Inspection Service and a private consulting laboratory. Both evaluations were made in Gloucester, Massachusetts, on a frozen sample that we provided. Both organizations used the criteria given in Figure 5. Descriptive analyses were based on a 4-point scale (Excellent, Good, Fair, Unacceptable), and numerical analyses were based on standard AOAC methods.

Appearance and Color

Washing the minced flesh did improve the appearance of the minced blocks. The color of these blocks was described as reasonably off-white rather than snow-white. Clotted blood was not removed by the washing treatment, but the strainer treatment broke up these clots and diffused their color into the rest of the flesh. Some variation in color results from the choice of species or form of raw material from which the minced flesh is obtained. We have found that a slight pink color (the color of very dilute normal blood) in a minced block has been synonymous with good odor, flavor, and low total plate counts. In contrast, minced blocks which have a brownish tint (the color of dilute oxidized blood) may have developed a rancid, bitter flavor and/or a higher total plate count.

Odor and Flavor

The majority of the samples received a rating of good or fair by both inspection agencies. Those samples receiving the higher ratings were described as "bland flavor" and having "less odor."

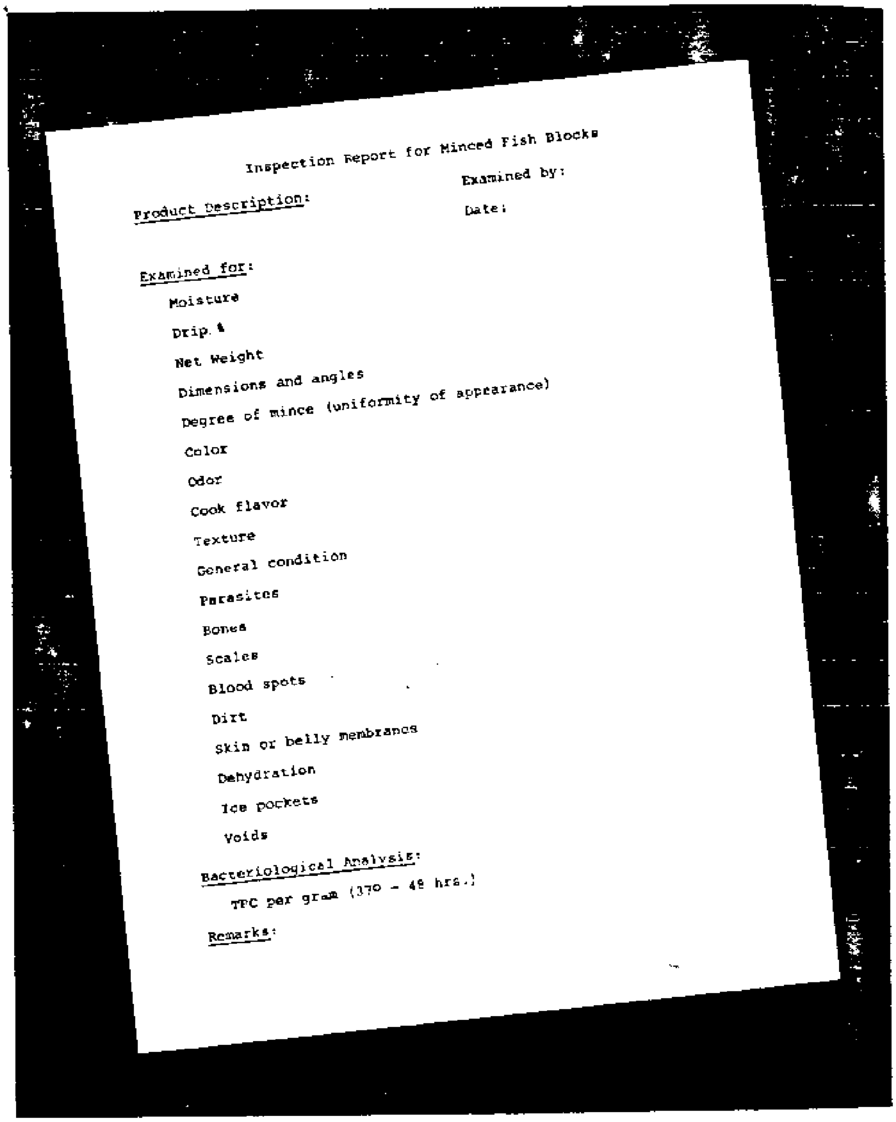
Texture

Comments were made on the texture or "mouth feel" of these minced block samples. These comments were made more frequently on the blocks which had the better ratings for color, odor, and flavor. They included adjectives such as "rubbery" or "tacky." It is not clear whether these adjectives were based on subjective comparison with a typical regular (fillet) block or with a typical minced cod block made from V-cuts. Although textural evaluations tend to be more subjective than taste evaluations, it appears that further R&D work is appropriate to make the textural qualities of minced blocks more acceptable to American consumers.

Moisture and Drip

The moisture content of minced fish blocks prepared from washed flesh has been in the order of 75-85 percent. From the results of our sensory data, we suspect that the flavor and texture of minced fish blocks might be improved if they have a moisture content in the order of 5-10 percent greater than the original fish muscle. Love (1970) has reviewed factors which affect the moisture content of fish muscle itself.

The drip content of the same blocks varied from 0 to 10 percent. Unlike moisture content, drip is a measure of protein quality or water-holding capacity. We have prepared good quality minced blocks with 80-85 percent moisture on several occasions; however, we do not have enough storage data to indicate the suitability of such moisture contents on prolonging the useful storage life of these minced blocks. Our limited experience in storing minced blocks does indicate that minced fish flesh has a greater water holding capacity than intact fish muscle initially, but the minced flesh can be dehydrated more easily by fluctuations in time-temperature storage conditions as well as moisture permeable packaging.


Inspection Report for Minced Fish Blocks

Product Description: Examined by:

Date:

Examined for:

Moisture
Drip %
Net Weight
Dimensions and angles
Degree of mince (uniformity of appearance)
Color
Odor
Cook flavor
Texture
General condition
Parasites
Bones
Scales
Blood spots
Dirt
Skin or belly membranes
Dehydration
Ice pockets
Voids

Bacteriological Analysis:

TPC per gram (37° - 48 hrs.)

Remarks:

Figure 5.—Inspection report for minced fish blocks.

Bacteriological Analysis

The lowest total aerobic plate counts in our minced blocks were in the order of 10^3 to 10^4 per gram. These counts were highly dependent on the freshness of the raw material. They were influenced by the speed with which we processed this material. They were lowered only slightly by washing the minced flesh before freezing it. When we used freshwater species, coliform and coagulase positive staphlycoccus were also estimated. The results (MPN per gram) did not indicate excessive contamination.

Miscellaneous Materials

Under this heading are categorized such things as parasites, bones, scales, blood spots, dirt, membranes. True parasites such as codworms or Sphyrion buttons were not found, presumably because our raw materials did not contain them. Occasionally a curled piece of white belly membrane was found which superficially resembled a codworm. Bones were not found partly because we excluded bone chips less than ⅛-inch long from our definition of bone. Scales and dirt (foreign materials) were eliminated by separating handling of the raw material from handling of the minced flesh. Blood spots (clots), pieces of skin or belly membrane and bone chips were sometimes found in separated, but not strained, flesh due to the hole size of the separator's drum (3, 5, or 7 mm) and the tension of belt against drum. These pieces were removed by putting the separated flesh through a strainer (1 mm holes in its screen) and avoiding excessive back pressures while operating the strainer.

Physical Characteristics

Physical characteristics (dimensions and angles, dehydration, ice pockets, voids) relate to the techniques used to form and freeze a block. Our method of forming minced blocks by hand was satisfactory, but the extrudability of this minced flesh suggests that a faster, more productive method could be developed for commercial use. Dehydration was hardly ever observed because our blocks were usually not stored long enough for this characteristic to develop.

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People from several firms worked with us in one or more parts of this study, let us use their equipment or their expertise. They include Mr. Emil Cefalo, North Atlantic Fish Co., Boston, MA; Mr. Georges Vedie, Food Masters, Inc., Boston, MA; Mr. Don Wilson, Sea-Pro, Inc., Rockland, ME; Mr. Lee Harrington, Mass. Coastal Seafoods, Inc., Gloucester, MA; Mr. Daniel Tichon, Tichon Seafood Corp., New Bedford, MA; Mr. Charles Amory, L.D. Amory, Inc., Hampton, VA; Mr. Prescott H. Brown, Sweco Inc., Acton, MA; Mr. James T. Costigan, Pennwalt Corp., New York, NY; Mr. Theodore W. Reed, Goodwin Hydrodynamics, Inc., Weirs Beach, NH; Mr. Frank Kawana, Yamasa Enterprises, Inc., Los Angeles, CA; Mr. Kazuo Kato and Mr. Ray Kato, Marutama Co., Los Angeles, CA. We are also grateful for the assistance of Mr. Paul Earl, NMFS, Gloucester, MA.

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MFR PAPER 1020

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

Surimi—A Semi-Processed Wet Fish Protein

DAVID MIYAUCHI, GEORGE KUDO, and MAX PATASHNIK

ABSTRACT

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

INTRODUCTION

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

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

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

PROCEDURE FOR MAKING SURIMI

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

Heading and Gutting Fish

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

Separation of Flesh

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

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

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

Grades	Freshness of fish	Moisture content of washed flesh	Additives used: Sugar (sucrose)	Additives used: Sorbitol	Additives used: Glucose	Additives used: Poly-phosphate	Amount of starch used in "Kamaboko" prepared for folding test[1]
		Percent					
SA (Special Grade A)	Day boat fish in rigor	79	—	5	—	0.2	0
A	Day boat fish post rigor	80	5	—	—	0.2	3
			—	5	—	0.2	
			—	—	5	0.2	
B	1- to 3-day iced fish	82	5	—	—	0 2	7
			—	—	5	0.2	
C	3- to 4-day iced fish	83	5	—	—	0.2	10
			—	—	5	0.2	

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

Washing and Dewatering the Minced Flesh

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

Straining the Flesh

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

Mixing With Additives

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

Packaging and Freezing

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

DIFFERENT GRADES OF SURIMI

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

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

U.S. INTEREST IN PRODUCING SURIMI

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

Fish Raw Material

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

Processing Equipment

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

Quality Standards

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

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MFR PAPER 1019

"Kamaboko," an immensely popular staple in the Japanese diet, gives U.S. fishery products researchers food for thought.

"Kamaboko"—The Giant Among Japanese Processed Fishery Products

MINORU OKADA, DAVID MIYAUCHI, and GEORGE KUDO

ABSTRACT

About 25 percent of the Japanese fish catch is processed into "Kamaboko," an elastic heat-pasteurized fish cake. In 1970, over 1 million metric tons of "Kamaboko"-type products were produced. 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. The fish paste is then shaped and heat-pasteurized. The authors describe factors affecting the quality of of "Kamaboko."

INTRODUCTION

The fish catch of the United States in 1970 totaled 2,758,300 metric tons, of which about 66 percent was utilized as food. About 40 percent of the total catch was marketed fresh or frozen, 24 percent was canned, and 2 percent was cured. Even though the per capita consumption of fishery products remains at about 10 to 12 pounds, the consumption of fishery products in the United States has been increasing owing to the increase in population.

Most species of fish for which a strong consumer demand exists are fished intensively. Many are overfished. To provide for this increasing demand, we must therefore look toward those few resources that remain underutilized and develop methods of preservation and processing into products that will be attractive to the domestic consumer.

In comparison, the consumption of fish in Japan is among the highest per capita in the world. The fish catch of Japan in 1970 totaled 9,314,300 metric tons, of which 80 percent was utilized as food (Figure 1). The Japanese use several hundred different species of fish to produce a wide variety of processed fishery products. Dependence on seafood as the principal source of animal protein has resulted in the use of this protein in many ways that are unique to the Japanese. Some of these products and processing procedures could have application to the use of the fishery resources of the United States for food. This paper is the first in a series to describe some Japanese fish products, processing techniques, and how we might apply them in the United States.

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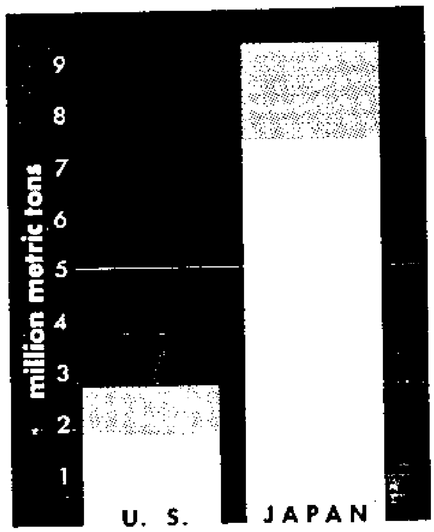


Figure 1.—The U.S. fish catch in 1970 totalled 2.7 million metric tons, of which about 66 percent (unshaded area) was utilized as food; the 1970 fish catch in Japan totalled 9.3 million metric tons, of which 80 percent (unshaded area) was utilized as food.

The products that may be of most interest to American food processors appear to be "Kamaboko" and fish sausage. "Kamaboko" and fish sausage are produced by grinding raw fish muscle with salt and other ingredients and then cooking. They are marketed in a variety of forms, textures, flavors, and even colors. All of these properties can be modified to suit the demands of U.S. consumers. This paper describes the preparation and properties of "Kamaboko"—a Japanese-style fish cake.

The Japanese word "Kamaboko" is used in two ways. As a generic term, it is the name of an elastic or rubbery Japanese-style fish cake. As a specific term, kamaboko (used in this paper with no quotation marks) is the name of a particular type of fish cake.

"Kamaboko," the elastic fish cake, is made with ground fish muscle as the principal ingredient; starch as a thickening agent; and sugar, salt, and monosodium glutamate for flavoring. The mixture is heat-pasteurized by steaming, broiling, immersing in boiling water, or deep-fat frying. "Kamaboko" is described by others as a Japanese-style fish paste (Tanikawa, 1971) and as a fish product resembling meat loaf (Amano, 1965). It is a traditional food relished by the Japanese and its method of production can be found in written Japanese documents of the 15th century.

PRODUCTION

In 1968, about 25 percent of the Japanese catch was processed into "Kamaboko" products and fish sausages. Close to 1 million metric tons of product were made as follows (Tanikawa, 1971):

Product	Production (metric tons)
Chikuwa	194.035
Kamaboko	336.365
Satsumaage	289.501
Fish sausage and hams	161.753
Others	17.722
Total	999.376

In comparison, the total production of these products in 1958 was 436.592 metric tons (Figure 2) and in 1970 was 1.08 million metric tons (Anonymous, 1971).

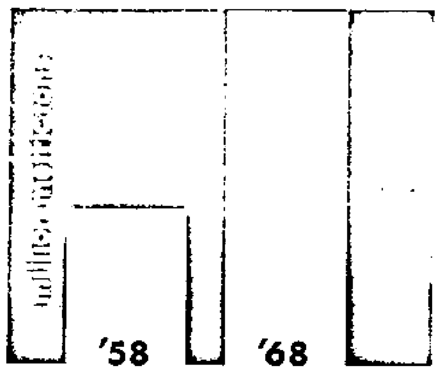


Figure 2.—Production of "Kamaboko" products and fish sausages in Japan more than doubled from 1958 to 1968.

The following factors were instrumental in the rapid growth of "Kamaboko" production:

1. With the recent rise in incomes, changes in the dietary patterns resulted in a greater consumption of proteinaceous and ready-to-eat types of foods.
2. Appearance and flavor of "Kamaboko" can be easily altered to meet consumer demands by adding various ingredients to the minced flesh.
3. Underutilized species and fish having low acceptance because of flavor deficiencies or poor appearance in the fresh state can be used successfully as raw materials.
4. Recent development in processing machines permits large-scale production.
5. Keeping quality has been improved with recent advances in packaging and processing.
6. Basic studies on fish muscle protein have hastened the development of a technology that improves quality and the economics of production.

TYPES OF "KAMABOKO"

"Kamaboko" is made in various shapes, colors, and flavors depending upon the ingredients and heating methods used. The three main types are as follows:

1. Kamaboko (used as a specific term): a fine-textured white elastic fish cake that is mounted on a small board and cooked by steaming and/or broiling.
2. Chikuwa: a tubular-shaped fish cake, which is cooked by broiling.
3. Satsumaage: a deep-fat fried fish cake made in various shapes such as a ball, square, disk, or cylinder.

MANUFACTURING PROCEDURE FOR "KAMABOKO"-TYPE PRODUCTS

In making "Kamaboko," the muscle from headed-and-gutted fish is separated from skin and bones, washed with water, and mixed with other ingredients while being ground into a homogeneous sticky paste. The fish paste is then shaped and heated.

Separation of Flesh

The fish are headed and eviscerated. After washing, the headed-and-gutted fish are put through a flesh-separator machine, which has either a perforated steel drum or plate and a press. The fish is passed under the press, which forces only the muscle through small holes of the perforated drum or plate, thus conveniently and effectively separating muscle from skin and bones.

The yield of minced flesh depends on the pressure applied to crush the fish as well as on the species of fish used. The yields of flesh from Pacific Ocean fish using a small drum-type separator varied from about 28 percent for Pacific cod to 66 percent for Pacific herring (Miyauchi and Steinberg, 1970).

Washing the Flesh

The separated minced flesh is washed well with chilled water to remove blood, flesh pigments, mucus, and fat. Washing improves the color and odor of the muscle and significantly improves the elasticity of the processed product.

One part by weight of flesh is stirred with five to seven parts by weight of water in a tank, the flesh is allowed to settle, and the supernatant is removed. The same volume of chilled water is added again to the flesh and stirred. The washing operation is repeated three to five times. The washed flesh is dewatered by pressing or centrifuging.

Grinding Fish Muscle with Ingredients

The dewatered minced flesh is reduced to a pulp in a meat chopper and then ground with salt and other ingredients in a stone mortar for 30 to 50 minutes. The stone mortar has three or four pestles which rotate while pressing the inside of the mortar. By the kneading and crushing action of the pestles, the texture of the muscle is gradually demolished and ingredients are mixed uniformly into a sticky paste. The temperature of the flesh mixture is kept below 15°C (59°F) during this grinding by using prechilled or refrigerated stone mortars, which serve to absorb the heat generated during this operation.

The ingredients used in "Kamaboko" vary widely according to the type of product, the cost, or the locality of the production. Salt content ranges from 2.5 to 4 percent. Lower salt content results in poor texture, and a higher content gives too salty a taste. Sugar and monosodium glutamate are most commonly used as flavoring ingredients. Sodium inosinate, flesh extractives, or "mirim" (specially flavored rice wine) are also used as flavor intensifiers. Egg white is added to improve the glossiness of the product. Starch is added when necessary to improve elasticity of the product. More starch is used in cheaper products because starch enables the addition of as much as two to three times its weight of water while maintaining the desired cohesiveness.

Shaping

"Kamaboko"-type products are made into different shapes and sizes by machines. Each of the three main types—kamaboko, chikuwa, and satsumaage—has its own shaping machine. The ground fish paste is shaped as soon as possible after preparation because the fish paste often sets, if stored, and then cannot be shaped. Since setting occurs more rapidly at higher temperatures, the fish paste is kept chilled to prevent setting.

Cooking

Three main types of cooking processes are used: steaming, broiling, and deep-fat frying.

Steaming is used for most kamaboko today; the raw kamaboko on the wood board is cooked continuously as it is conveyed through the steam box.

Broiling, formerly the cooking process for all kinds of "Kamaboko," is now used mainly for chikuwa, the tubular fish cake, and for a high quality "Kamaboko" called "yakinuki kamaboko" (broiled kamaboko).

Deep-fat frying is used for satsumaage. Soybean, rapeseed, and sesame seed oils are the usual frying oils.

After cooking, the fish cakes are rapidly cooled and packaged.

FACTORS AFFECTING QUALITY OF "KAMABOKO"

Elastic Quality or "Ashi"

The distinctive eating characteristic of "Kamaboko" is its elastic quality, called "ashi" in Japanese. Elasticity and flexibility are the basic characteristics of a good "ashi." In addition to being a determining factor of the eating quality, "ashi" also affects the appearance, especially glossiness, and the keeping quality. "Kamaboko" with better "ashi" has better appearance and better keeping quality.

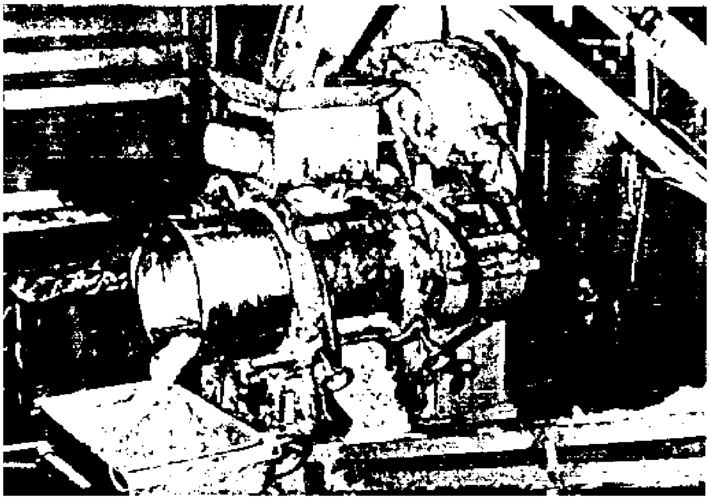
The "ashi" of "Kamaboko" depends on factors such as the species of fish used, freshness of the fish, and processing techniques. The best quality "Kamaboko" is produced from fish that have the proper gel-forming capacity and by the use of good established processing techniques.

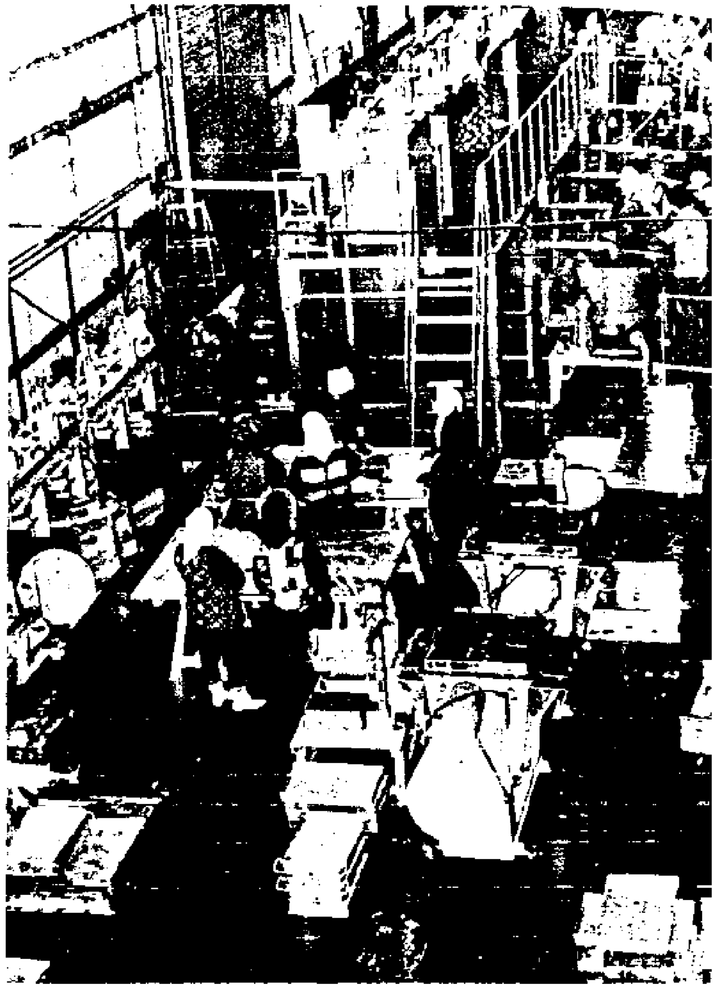
Species

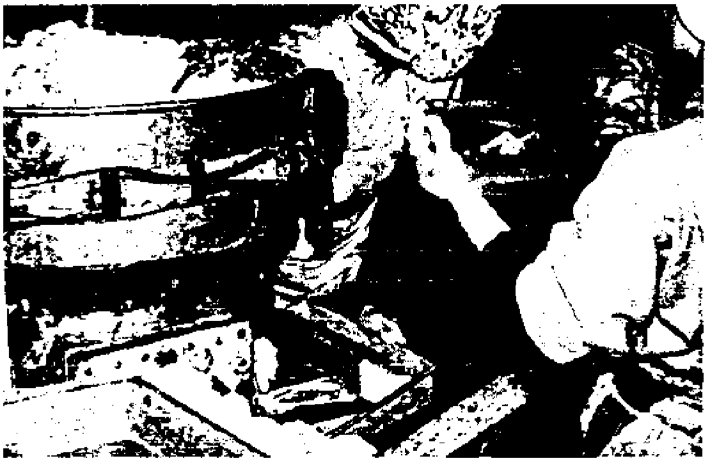
It is well known that "ashi" or elasticity of "Kamaboko" made from different species of fish varies greatly. For example, fish such as black marlin or croaker will make a very elastic product but many small pelagic fish and fatty fish such as sardines, mackerel, or saury will make products with very poor elasticity. Some of these fatty fish immediately after death, however, will make good elastic products, but their "Kamaboko"-forming capabilities decrease rapidly after rigor mortis sets in. After these fish have been iced for two or three days, they make only a crumbly product.

Lizardfish is considered one of the best raw materials for "Kamaboko" in those areas where fish can be caught in nearby waters and can be processed soon after catching; but lizardfish loses its high "Kamaboko"-forming capabilities within three or four days of iced storage after catch. The gel-forming capability of black marlin and croaker, on the other hand, is not markedly affected by their freshness. Even after being iced for periods as long as two or three weeks, they make an elastic "Kamaboko." Thus, the classification of species on the basis of their "Kamaboko"-forming capabilities is not easy. Fish having good gel-forming capability irrespective of freshness are regarded as the best raw material; and fish whose gel-forming capability is rapidly lost after catch are considered an inferior raw material. The suitability of a species for making "Kamaboko" must be judged by the functional properties of the muscle proteins at the time the fish is processed into "Kamaboko."

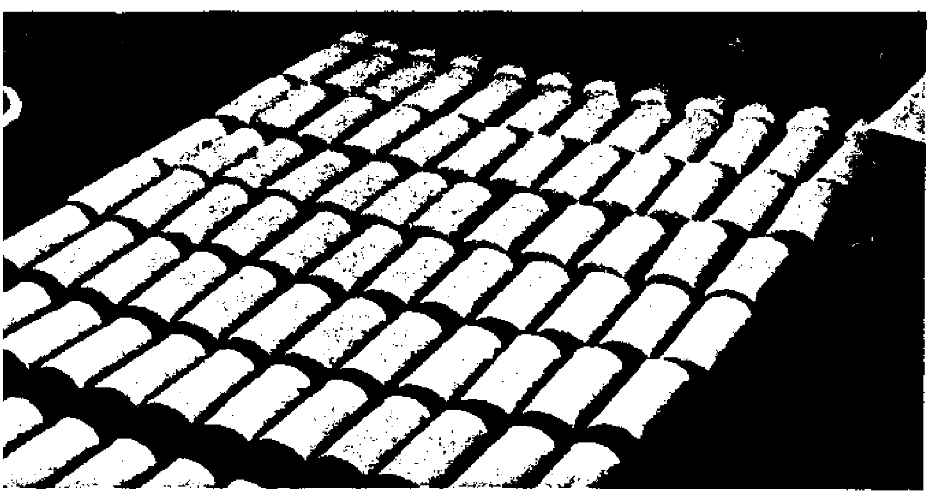
According to experienced "Kamaboko" producers, the age of the fish, fishing ground, and the time of year are important factors. Young fish have better "Kamaboko"-forming capability than old fish, and fish immediately after spawning have the lowest "Kamaboko"-forming capability.







Some of the various parts of the process in producing surimi and "Kamaboko," from top left, counterclockwise: Flesh separation by machine; surimi ready for packing in polyethylene bags; conveyer bringing "Kamaboko" from continuous cooker; cooling "Kamaboko"; storage of frozen surimi; a view of the interior of a Japanese surimi and "Kamaboko" plant (1967 model) including wash tanks for extruded flesh, a centrifuge, hydraulic press, strainer, and block former.



Relation of "Ashi" to Extractability of Myofibrillar Proteins

"Kamaboko" with good "ashi" is produced from fish muscle containing nearly maximum amounts of extractable myofibrillar protein. It cannot be produced from denatured muscle proteins such as those found in dried, salted, or poorly stored frozen fish.

A concentration between 1.2 and 1.5*M* NaCl gives maximum extraction of myosin from fish muscle as well as the best resiliency in the finished product (Shimizu et al., 1954; Shimizu and Simidu, 1955). The use of salt at these concentrations, however, would make the product too salty, and 2.5 to 3.5 percent (0.4 to 0.6 *M*) NaCl is used in the commercial "Kamaboko" production. The enhancing effect of polyphosphates on the elasticity of the product is attributed in part to their ability to extract myofibrillar proteins.

Formation of Network Structure

Elasticity of the finished product is also a function of cooking temperatures (Okada, 1959). "Ashi" is usually the poorest when the fish paste is cooked between 60°C (140°F) and 65°C (149°F) and is best when cooked rapidly at higher temperatures. This suggests that there is another important factor besides extraction of myofibrillar proteins that influences the elasticity of "Kamaboko." This factor is the formation of a network of myofibrillar proteins. The threadlike shapes of the myofibrillar proteins are suitable for building up the network structure of "Kamaboko." The increase in elasticity that results from the addition of very small amounts of oxidants indicates the existence of such a structure (Okada and Nakayama, 1961). Thus, the addition of 0.1 to 0.2 percent potassium bromate to horse mackerel muscle during grinding with salt improves the jelly strength of the cooked product. Comparative measurements of elasticity and the content of free sulfhydryl groups of "Kamaboko" showed that elasticity is increased as free sulfhydryl groups are decreased by the addition of bromate. The effectiveness of bromate might be attributed to crosslinking of polypeptide chains by the reaction:

$$-SH + -SH \longrightarrow S-S$$

Thus, formation of good "ashi" requires both the extraction of myofibrillar proteins from the muscle and the formation of a network structure of the extracted proteins.

Water-Soluble Proteins and "Ashi"

Elasticity of "Kamaboko" can be improved significantly by washing the muscle before grinding. A large amount of the fat and water-soluble substances can be removed from the muscle by the washing process. The improvement in "ashi" of the product, however, is not attributable to the removal of fat because no significant decrease in "ashi" is observed by the addition of as much as 10 percent fat to the washed muscle. Okada (1964) has demonstrated that water-soluble proteins have deleterious effects on "ashi" formation. When concentrated water-soluble substances were added to the washed muscle, a significant decrease in "ashi" of "Kamaboko" was observed. Removal of the water-soluble protein from concentrated washings by heat coagulation before addition to the washed flesh produced no decrease in "ashi" of the "Kamaboko." The explanation has been offered that the water-soluble proteins reduce the elasticity of the "Kamaboko" by interrupting the continuum of cross-linked myofibrillar proteins or by interfering with the cross-linking process itself. It has also been proposed that proteolytic activity of the water-soluble protein fraction may adversely affect the ability of the myofibrillar protein to form cross-linkages.

KEEPING QUALITY OF "KAMABOKO"

Keeping quality of "Kamaboko" depends on a variety of factors but the ingredients used, processing temperatures, and packaging seem to be critical.

Ingredients

Owing to the nature of minced flesh, the potential for high bacterial contamination of the minced flesh during processing exists. Chilling, rapid handling, and thorough cleaning of the fish and good sanitation practices are essential for keeping the microbiological load of the minced flesh low. Other ingredients, in addition to the fish, affect keeping quality.

Kimata (1951) found that different types of spoilage of "Kamaboko" were due to the kinds and amounts of carbohydrates (sugar or starch) used as ingredients. Several investigators (Kimata and Kawai, 1951; Kimata and Sosogi, 1956; and Suzuki, 1959) have shown that starch is the primary source of thermotolerant bacteria responsible for spoilage. Potato starch, among the starches, is reported to contain the largest number of bacteria (as high as 5.0×10^4 per g) with about 70 percent of them thermotolerant.

Processing Temperature

During the processing, the temperature at the center of "Kamaboko" is highest when broiled, next highest when deep-fat fried, and is lowest when steamed. In one study, Yokoseki (1958), starting with raw fish paste containing about 10^7 bacteria per gram, found a considerable number of surviving micrococci when the "Kamaboko" was cooked to an internal temperature below 70°C (158°F); found 1.3×10^4/g of aerobic spore-forming rods of *Bacillus* species and no anaerobes in "Kamaboko" cooked to 75°C (167°F); and found only 6.0×

10^3/g of aerobic *Bacillus* in "Kamaboko" cooked to an internal temperature of 85°C (185°F). On the other hand, he usually found cocci in "Kamaboko" with starch cooked to an internal temperature below 70°C and found survivors that were mainly strict aerobic organisms such as *Bacillus megatherium*, *B. subtilis*, and *B. cereus* in those cooked to an internal temperature of 75°C and higher. Commercially, "Kamaboko" is cooked to an internal temperature about 75°C to give the product good keeping quality.

Packaging

Prevention of contamination by microorganisms in the air by packaging "Kamaboko" before or immediately after cooking is very effective in improving the keeping quality. Even a simple package such as a cellophane overwrap can increase the keeping quality as much as twofold. Vacuum packaging with laminated cellophane is a much better means of preventing bacterial growth. After vacuum packaging, the product is cooked again to kill the bacteria on the packaging material as well as the bacteria in the product.

The most effective method of preventing bacterial contamination is sealing the raw flesh paste tightly with a plastic film and then cooking above 75°C. The plastic film should be heat-resistant, gas- and water-impermeable, and heat-shrinkable. Vinylidene chloride fulfills these requirements. Fish sausage, a semi-processed food, is a product packaged by this method; fish paste is packed into a casing of vinylidene chloride, sealed tightly with aluminum wire, and finally cooked in a hot water bath at 85° to 90°C for about 50 minutes.

"KAMABOKO"-TYPE PRODUCT AND THE U.S. CONSUMER

"Kamaboko" and fish sausage are produced by mixing fish flesh with salt and other ingredients, shaping in various forms, and then cooking to get elasticity or cohesiveness. These products are higher in protein and lower in calories than many processed meat products, such as wieners and bologna. As each nation has its own food preferences, the flavor and texture of Japanese "Kamaboko" is not always appealing to others. Whereas the Japanese prefer a rubbery "Kamaboko"-type product, the Americans generally prefer a wiener-like, only slightly elastic product. The flavor, texture, and appearance of the "Kamaboko"-type products can be easily modified to suit the preferences of the U.S. consumer by blending various species of fish and by varying the other food ingredients to obtain the desired flavor, texture, and appearance. The results of our studies along these lines are presented in some of the following papers.

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smooth, white spread from separated fish flesh forms a base for flavored dips, snack items

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MACHINE-SEPARATED fish flesh from under-utilized species offers a potentially ample supply of cost-competitive fish protein for the snack field. The process described produces a bland, unflavored spread base with smooth texture, appealing white color, and excellent stability. Textural smoothness and spreadability are attained by physical size reduction and controlled heat processing in the presence of an enzyme and other additives. White color results from light reflected from the surfaces of finely emulsified oil globules in the oil-protein-water emulsion formed during processing. Flavor of the bland fish substrate is enhanced by using food approved additives. The formulation permits diversification into dips or fried snack items with only slight modification of ingredients or processing.

Wet comminuted fish muscle protein has excellent nutritional and functional properties. With the exception of Japanese-style fish cakes, it has been used little in fabricated foods largely because information was lacking on how to process this raw material into suitable forms. The processing technique described can broaden the uses for fish muscle.

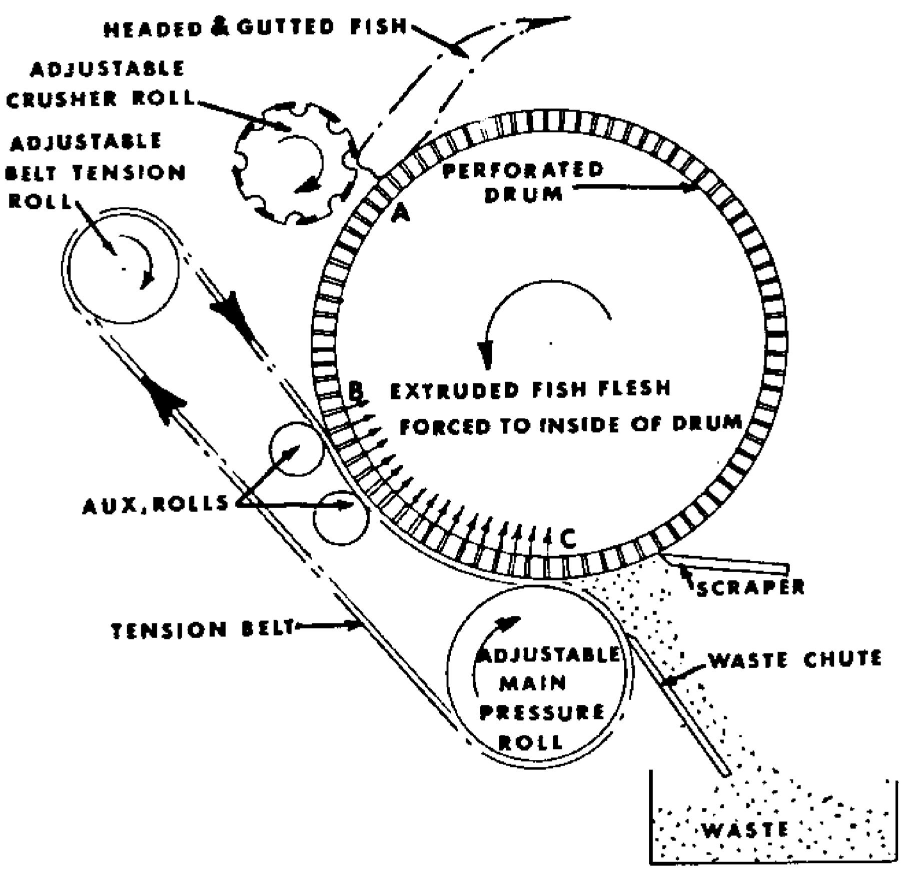

Figure 1. Operation of a fish-flesh separator (schematic sectional view).

Used Raw Fish Muscle

The basic processes for mechanically removing muscle from fish or from trimmings and frames are similar (frames are the spinal column and adhering muscle remaining after removal of fillets). The procedure differs only in that whole fish must be headed, gutted, and washed free of blood, viscera, and scales. Commercial flesh separators such as shown in Figure 1 are currently available in the U.S., Japan, Germany, and Sweden. Dressed fish, frames, or trimmings enter the flesh separator at the crusher roll (point A, Figure 1). They are conveyed from B to C between a rotating stainless steel perforated drum and a continous rubber belt under tension. The rubber belt's pressure squeezes the relatively soft muscle through perforations of the drum while the skin and bones mat on the drum's outside and are scrapped off into a waste chute. The drum is open at one end allowing the separated fish muscle to exit continuously. A slight difference in speed between the rubber belt and drum helps shear muscle off the skin.

In species of low muscle lipids, the dark flesh located just under the skin is considerably higher in lipids than the white flesh that forms the bulk of the muscle. It is frequently desirable to collect white flesh separately. The dark flesh's location under the skin permits some control by regulating the belt pressure exerted against the drum by the main pressure roll. A single pass at low pres-

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sure results in a product with virtually all light meat. A second pass of the resultant waste at maximum pressure recovers the balance of the light meat plus a high percentage of the dark meat that was attached to the skin. This offers the possibility of two grades of flesh to suit end use and cost requirements. A single pass at maximum pressure results in a product containing both light and dark meat.

If the headed-and-gutted fish, trimmings, and frames have not been adequately washed and/or refrigerated, a "fishy" flavor may be detected in what would otherwise be a bland or unflavored product from machine-recovered muscle. However, washing the minced muscle in five parts cold water (32 to 40°F) to one part fish will remove superficial "fishy" off-flavors. Properly handled, adequately washed fish do not present this problem.

Machine-separated flesh is largely coarse-ground, 4 to 7 mm in size, and contains a few small bone particles. The number of particles depends on the roll pressure used. Bone particles can be removed by pressing separated flesh through commercially available cylindrical-type strainers with openings that range from 1 to 2.8 mm. In this study, we used strained muscle passed through 2 mm openings.

One possible use of fish muscle is in a smooth-textured, spread-type product characterized by high acceptability, low cost, relatively long refrigerated storage life, and versatility of application. Using minced or strained fish muscle as a raw material presents potential problems which may include:

- Mild but distinctive fish-flavors not usually associated with spreads,
- Oxidative instability of the lipids,
- Inadequate water-holding capacity, the tendency of muscle of some species to release water and form drip when heated or when frozen and thawed,
- The granular mouthfeel usually associated with fine minced or ground muscle, and
- Color variability (i.e. particles of dark and light flesh).

Black rockfish (*Sebastes flavidus* and *S. brevispinis*) were used in this study because the species' dark fatty muscle rapidly becomes rancid during frozen storage. Successful use of this species we felt, would assure success in the use of most species. Prior work with Japanese-type fish sausage emulsions indicated that a fish flesh emulsion or purée containing appropriate additives offered the best means of overcoming anticipated problems (*1*).

Basic Processing

The basic product is a heat-processed emulsion of fish muscle and vegetable oil. It contains added salt to increase hydration and solubilization of the myofibrillar protein and proteolytic enzyme to control texture. Texture is controlled by the enzyme concentration and the rate of temperature rise during heat treatment prior to heat inactivation of the enzyme. The product may be prepared with the silent food cutter or emulsifier ordinarily used in the sausage industry.

Four types of spreads, a white unflavored base and three flavored or colored spreads, were prepared (Table I). Ingredients were minced, emulsified, blended, packaged, and heat pasteurized.

First, washed, minced fish flesh, chilled to about 32°F, and other ingredients were loaded into a Hobart Silent Food Cutter (*Model 84181-0*) and minced for about 15 minutes, chilling as required to keep cool. The large color or flavor enhancing ingredients such as chive, pimento, or olives were blended into the mixture during the last half minute to minimize size reduction.

In an alternate procedure, "soft frozen" minced fish flesh (25 to 28°F) along with other ingredients are loaded into a Hobart vertical cutter/mixer (*Model VCM-15*) or equivalent and cut for three to five minutes, holding the temperature below 30°F. This material is gravity fed through a Hobart micro-cut emulsifier (*Model MCV-12*) or equivalent

Table II. Panelist evaluation of three spreads comparing preference before storage with preference after storage (2 months at 38°F followed by 16 months at 0°F)

	Preference Before Storage						Preference After Storage					
	Scallop		Chive		Smoked		Scallop		Chive		Smoked	
Degree of Preference	No. of Panelists	%	No. of Panelists	%	No. of Panelists	%	No. of Panelists	%	No. of Panelists	%	No. of Panelists	%
9 Like extremely	8	12.1	2	3.1	8	12.1	2	10.0	2	6.7	2	6.7
8 Like very much	12	18.2	15	23.4	28	42.5	2	10.0	10	33.3	8	26.7
7 Like moderately	22	33.4	27	42.2	18	27.3	6	30.0	8	26.7	4	13.3
6 Like slightly	13	19.7	12	18.8	6	9.1	5	25.0	8	26.7	10	33.3
5 Neither like nor dislike	7	10.6	2	3.1	2	3.0	—	—	1	3.3	2	6.7
4 Dislike slightly	2	3.0	5	7.8	3	4.6	4	20.0	1	3.3	3	10.0
3 Dislike moderately	1	1.5	1	1.5	1	1.5	—	—	—	—	—	—
2 Dislike very much	1	1.5	—	—	—	—	1	5.0	—	—	1	3.3
1 Dislike extremely	—	—	—	—	—	—	—	—	—	—	—	—
Total panelists	66		64		66		20		30		30	
Average preference		6.8		6.8		7.3		6.2		7.0		6.5

using a 0.2-mm cutting head. Material is passed through twice for maximum whiteness and minimum particle size, chilling as required to keep the product cool. Larger-size ingredients are blended into the product in the vertical cutter-mixer for about half a minute.

Next, the product is filled into cans, jars, tubes, or other containers. The spread can be pasteurized by steam or water at about 185°F so that the product at the container's slowest heating point is 180°F for at least 30 minutes.

Finally the product is quickly cooled and stored at 38°F or less until used. If the product is to be stored for more than one month, it should be frozen and stored at 0°F or lower.

Formula Modifications

The basic pasteurized spread can be modified in formula and processing to produce a wide range of other products.

Flavor. The unflavored spread is bland, and the product can be given any of a wide range of appropriate flavors.

Color. The unflavored spread is "cream cheese" white because of light reflected from the surface of finely emulsified fat globules in the oil-protein-water emulsion. This base is suitable for a white-colored product such as a scallop-flavored spread or a product with contrasting color such as chive-flavored spread. Addition of food grade dye can yield a uniformly colored product such as a pink smoked spread (Table I). For additional variety, the spread can be prepared in multiple contrasting colors such as in parallel or concentric layers, in wedges, or in swirls. Ingredients such as olives, caraway, pimento, and pepperoni can create a variety of contrasting colors and flavors and offer a potential for a broad line of high-protein products for retail or institutional markets.

Texture. Texture can be controlled over a wide range from cream cheese smoothness and spreadability to a "wiener-like" elasticity. In the spread-type product, smoothness and spreadability are of primary importance. Best spreadability is attained by reducing muscle particles to the smallest size practical and employing the longest mincing time feasible in the presence of salt to partially solubilize the myofibrillar protein. This permits the enzyme to function effectively during pasteurization.

High heating rates inactivate the enzyme relatively rapidly and spreadability is lost. Thus, pasteurizing the spread containing 0.003 per cent papain at 185°F in thickness of about 1½ inches results in a product with good spreadability. Pasteurization at 212°F results in a somewhat firm, elastic, sliceable product resembling processed cheese but without spreadability. sterilization at 250°F results in a firm, cuttable product. On the other hand, pasteurization of the spread formulation at 185°F followed by either heating at 212°F or by sterilization at 250°F still results in a spreadable product. However, since the use of 0.003 per cent papain causes a bitterness to develop at a point close to commercial sterility, lower concentrations of papain and/or other treatments and enzymes need to be evaluated.

Storage. The pasteurized spreads were organoleptically and oxidatively stable over a wide range of storage conditions. Pasteurized spread stored in hermetically sealed cans up to 1½ years at 0, 27, and 38°F were stable to oxidation. Although the quality of the pasteurized spreads appeared completely acceptable after storage at 38°F for 1½ years, any storage for more than one month should be at 0°F or lower until adequate microbiological and thermal process studies are carried out.

Storage life of the spreads at temperatures from 35 to 40°F in unsealed, covered containers provided information relative to consumer conditions. Storage life of spreads containing 0.1 per cent potassium sorbate was one to two months. Without sorbate, it was about two to three weeks. The end of storage life was determined by the first visual sign of organism growth or by presence of any atypical odors. Spoilage usually involved mold and occasionally yeasts.

A problem of freeze-thaw syneresis was experienced in early formulations containing corn starch. However, the problem was resolved by either entirely replacing the corn starch with a phosphate-modified starch or by adding 0.2 per cent carboxymethylcellulose or 0.2 per cent guar gum along with the corn starch.

Comparison of preference ratings for the flavored spreads before and after storage (2 months at 38°F followed by 16 months at 0°F) is given in Table II. Samples were rated using

Table I. Formulae for preparing spreads from finely minced fish flesh

	Percentage of Ingredients			
Ingredients and Function	Unflavored Base	Scallop-Flavored	Chive-Flavored	Smoke-Flavored
Fish flesh (nutritional base, emulsifier and texture)	65.0	62.6	65.0	65.0
Oil (texture, lubricity, whiteness, carrier for surfactants)	18.0	18.0	18.0	18.0
Water (spreadability, texture)	8.0	8.0	7.7	6.45
Phosphate-modified starch (freeze-thaw syneresis, texture)	5.0	5.0	5.0	5.0
Corn syrup solids (texture, flavor)	2.0	2.0	2.0	2.0
Salt (solubilize protein, texture, flavor)	1.1	1.1	1.2	1.2
Monosodium glutamate (flavor intensifier)	0.5	0.5	0.5	).5
Sodium tripolyphosphate (water-holding capacity)	0.15	0.15	0.15	0.15
Potassium sorbate (mold inhibitor)	0.10	0.10	0.10	0.10
Ribotide[a] (flavor enhancer)	0.05	0.05	0.05	0.05
Span 80[b] (lipophilic surfactant)	0.035	0.035	0.035	0.035
Tween 80[b] (hydrophilic surfactant)	0.035	0.035	0.035	0.035
Papain (spreadability, texture)	0.003	0.003	0.003	0.003
Commercial scallop flavor[c]	–	0.3	–	–
Sugar (flavor)	–	2.1	-	–
Dimethylsulfide (shellfish flavor)	–	0.0065	–	–
Freeze-dried chive[d] (flavor, color)	–	–	0.25	–
Rose-pink food-grade dye (color)	–	–	–	0.0022
Paprika (color)	–	–	–	0.06
Tomato paste (color)	–	–	–	0.25
Heller's Charsol H-10[e] (liquid smoke flavor)	–	–	–	0.22
Heller's soluble spice #2700[f] (flavor)	–	–	–	0.85
Heller's meat flavor intensifier	–	–	–	0.10

[a] 1:1 mix of disodium inosinate and disodium guanylate (Takeda U.S.A., Inc., New York).
[b] Sorbitan mono-oleate and polysorbate 80 (Atlas, Wilmington, Del.).
[c] Imitation scallop flavor #V-1367 (Norda Essential Oil & Chemical Co., New York).
[d] Freeze-dried chives (G. Armanino & Son, Inc., San Francisco, Calif.).
[e] Liquid smoke Charsol H-10 (J. A. Jenks Co., and B. Heller and Co., San Francisco).
[f] Soluble spice #2700 (J. A. Jenks Co., and B. Heller and Co., San Francisco).
Equivalent or similar food-grade ingredients may be substituted for any of the above ingredients.

the 9-point hedonic scale. Corn starch was still used in formulating spreads evaluated in these tests, and panelists generally down-scored various samples for the wetness. In spite of this, the average preference was still on the "like" side.

Diversified Uses

The basic spreads (Table I) demonstrate a concept for diversified use of finely minced fish muscle in fabricated foods. They may be used pasteurized, unpasteurized, or modified to suit market needs.

PASTEURIZED SPREADS. Their oxidative stability allows frozen storage and use. They can be portioned like butter or jam for foodservice use. Frozen spread cut into small rectangles and wrapped as roll dough can be heated in an oven from the thawed or frozen state and produce an attractive, pleasantly flavored, high-protein roll. This type product received high preference ratings by the laboratory taste panel and by consumer-type groups.

Frozen pasteurized spreads also have uses based on whipping and emulsifying properties which are retained even after two years of storage at 0°F. By adding water and homogenizing for a few minutes, the thawed, flavored spreads can be made into smooth, creamy, refrigeration-stable dips. By adding dehydrated cheeses or other flavors in an aqueous or buttermilk base, unflavored spreads can be homogenized into relatively high protein, flavored spreads or mayonnaise-like dips or salad dressings, depending on added moisture. Whipping and emulsifying properties are retained in the 3 to 4 pH range.

UNPASTEURIZED SPREADS. These may be frozen in block form and later cut, battered and breaded, and deep-fat fried as small cubes, sticks, or portions. The product has different textures—a crisp exterior, an elastic inner layer (surface inactivation of enzyme), and a soft inner core. Varying product thickness or lowering enzyme concentrations further accents elastic properties. These product variations were well received by laboratory taste panels.

MODIFICATIONS. Proximate composition of the fish spread is given in Table III. If favorable market potential exists for a spread with a higher protein content, the processor may replace part of the moisture and/or carbohydrate with casein, soya, or fish protein concentrate. The elastic and binding properties of wet fish protein in the formula offer other applications. By omitting the enzyme from the formula and controlling the heating rate, the product can be sliced like cheese or made highly elastic like a wiener. This type of product can be pasteurized or commercially sterilized. Lesser amounts of enzyme produce intermediate textures. By selecting the proper processing conditions, the use of finely emulsified fish muscle offers the possibility of contributing a wide variety of textural properties to other food systems. By omitting the enzyme and water altogether, fish protein's high binding power in the presence of salt can bind natural products such as oysters, clams, scallops, mussels, geoducks, and sea cucumber into textured products with high flavor appeal. These products may be frozen into blocks and portioned with or without batter for foodservice use. Such products now under test show frozen storage stability and trained taste panel acceptance.

Table III. Proximate composition of pasteurized fish spreads

INGREDIENT	PERCENTAGE
Moisture	60.0
Protein	12.0
Oil	19.0
Ash	2.5
Carbohydrate	6.5
Total	100.0

Conclusions

Current market potential for protein ingredients appears to be three billion pounds per year (3). Wet fish muscle, because of its excellent functional properties, can compete with other proteins in fabricated foods. Concern over poor stability and development of strong flavors in this type of fish material is not valid. Wet fish muscle offers great potential in the protein ingredient field on the basis of cost and properties.

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XII.

SECOND TECHNICAL SEMINAR ON THE MECHANICAL RECOVERY AND UTILIZATION OF FISH FLESH

ATTENDEES

Ackert, J.	The Gorton Corporation	Gloucester, MA
Addesso, R.	T. S. Lipton, Inc.	Englewood Cliffs, NJ
Adolphson, L.	Div. Coord Protein Specialties	Decatur, IL
Aisenberg, M.	Modern Maid Food Products	Garden City, NY
Alsmeyer, R.	Product Stds. Tech. Services	Washington, D.C.
Archibald	Prince Edward Island, Dept. of Fisheries	Charlottetown, P.E.I.
Augello, R.	Mr. Boston Seafoods Corp.	Boston, MA
Babbitt, J.	Oregon State University	Astoria, OR
Babigian, S.	Pocasset Food Sales, Inc.	Cranston, RI
Baer:nger, R.	Seafood Packers Reps., Inc.	Philadelphia, PA
Baker, R.	Cornell University	Ithaca, NY
Barbour, D.	British Columbia Packers	Richmond, B.C.
Barror, W.	Raytheon Company	Waltham, MA
Barrows, R.	Walter Meier, Inc.	Waterloo, IW
Bartolotta, T	King-Bartolotta, Inc.	Erie, MI
Bellas, B. J.	Bettcher Industries	Vermilion, OH
Benore, D. J.	King-Bartolotta, Inc,	Erie, MI
Betancourt, O. J.	Camplan Consultants Ltd.	Halifax, N.S.
Bezanson, A. F.	Raytheon Company	Waltham, MA
Billy, T.	Nat'l. Marine Fisheries Serv.	Washington, D.C.
Binns, R.	National Sea Products, Ltd.	Lunenburg, N.S.

Blackwood, C. M.	Dept. of Environment, Canada	Ottawa, Canada
Bond, R. M.	Dept. of Environment, Canada	Ottawa, Canada
Boothby, G.	Canadian Fishing Co., Ltd.	Vancouver, B.C.
Borochoff, E. H.	General Mills, Inc.	Minneapolis, MN
Brokans, A.	Iceland Products, Inc.	Camp Hill, PA
Brooker, J.	Nat'l. Marine Fisheries Serv.	Washington, D.C.
Brotsky, E.	Merck & Company	Rahway, NJ
Brown, C. B.	T. J. Lipton, Inc.	Englewood Cliffs, NJ
Brown, H.	Commodore Foods	Lowell, MA
Burke, M. J.	McFisheries, Inc.	Boston, MA
Carrol, J.	Booth Fisheries	Portsmouth, NH
Charm, S.	Tufts Medical School	Boston, MA
Cherny, J. F.	Intercontinental Industries	Chicago, IL
Christensen, P.	North East Cold Storage	Portland, ME
Cobb, B.	Texas A & M University	College Station, TX
Constantinides, S.	University of Rhode Island	Kingston, RI
Dannert, R.	General Mills, Inc.	Minneapolis, MN
Davis, B.	Canadian Consulate	Boston, MA
Davis, J.	Robert Reiser & Company	Boston, MA
Dawson, L.	Michigan State University	East Lansing, MI
Demarest, R.	The Laitram Corporation	New Orleans, LA
Drebot, M.	Nova Scotia Dept. of Fisheries	Halifax, N.S.
Duddleston, W.	Hasxon, Inc.	St. Paul, MN
Dugal, L.	Dept. of Environment	Winnipeg, Canada
Dyer, W. J.	Fisheries & Marine Service	Halifax, N.S.
Dagbartsson, B.	Icelandic Fisheries Labs	Reykjavik, Iceland

Earl, P.	Nat'l. Marine Fisheries Serv.	Gloucester, MA
Ebert L.	National Provisioner Magazine	Chicago, IL
Elfert, G.	Prince Rupert Fishermen's Coop. Association	Prince Rupert, B.C.
Evanow, R.	Eureka Fisheries	Crescent City, CA
Fattore, R.	Pocasset Food Sales, Inc.	Cranston, RI
Focht, D. E.	Ralcon Foods	Chicago, IL
Frohman, A.	L. H. Frohman & Sons, Inc.	Chicago, IL
Fulham, P. D.	Nat'l. Marine Fisheries Serv.	Galveston, TX
Ganung, S.	Commodore Foods	Westford, MA
Garm, R.	FAO of the United Nations	Rome, Italy
Giddings, G.	North Carolina State Univ.	Raleigh, NC
Gillespie, S.	Texas A & M University	College Station, TX
Goodick, E.	Booth Fisheries	Portsmouth, NH
Gould, W. A.	Ohio State University	Worthington, OH
Gramlich, W. O.	Vita Food Products, Inc.	St. Louis, MO
Grant, D. E.	Hercules, Inc.	Wilmington, DE
Gravani, R. B.	Cornell University	Ithaca, NY
Grondal, T. S.	Iceland Products, Inc.	Camp Hill, PA
Gullotta, J. D.	Trident Seafoods	Medway, MA
Harrington, F.	Commodore Foods, Inc.	Westford, MA
Hayman, H. M.	Robert W. Hayman, Inc.	Edgartown, MA
Hayman, R. W.	Robert W. Hayman, Inc.	Bronxville, NY
Heiligman, F.	U.S. Army Natick Lab	Natick, MA
Hemming, T.	Dept. of Industry & Trade	Ottawa, Canada
Hirway, S. C.	Raytheon Company	Waltham, MA

Holmsen, A.	University of Rhode Island	Kingston, RI
Holst, J.	Frionor Kitchens, Inc.	New Bedford, MA
Howlett, R.	Sea Pak	Gloucester, MA
Howe, J. L.	University of Rhode Island	Narragansett, RI
Hubbell, R.	World Wide Information Serv.	New York, NY
Hulgaard, E.	Danish Consulate General	New York, NY
Iredale, D. C.	Environment Canada	Winnipeg, Canada
James, B. N.	A. E. Staley Mfg. Company	Decatur, IL
Johnson, C. E.	McCallum-Legaz Fish Co., Inc.	Seattle, WA
Juhl, R.	Nat'l. Marine Fisheries Serv.	Pascagoula, MS
Kaplan, A.	Sau-Sea Foods, Inc.	Yonkers, NY
Kaplan, H.	University of Rhode Island	Kingston, RI
Kaylor, J. D.	Nat'l. Marine Fisheries Serv.	Gloucester, MA
Keay, J. N.	Ministry of Agriculture Fisheries & Food	Aberdeen, Scotland
Kemp, D. W.	Trident Seafoods	Marion, MA
Kershaw, R.	The Gorton Corporation	Gloucester, MA
Kidd, N.	Dolphin Seafoods	Strongsville, OH
King, D.	King-Bartolotta Inc.	Erie, MI
King, F.	Nat'l. Marine Fisheries Serv.	Gloucester, MA
Kleckner, B.	Griffith Laboratories	Chicago, IL
Koo, T.	University of Maryland	Solomons, MD
Krasemann, A.	National Sea Products, Ltd.	Lunenburg, N.S.
Lane, J. P.	Nat'l. Marine Fisheries Serv.	Gloucester, MA
Larson, H. W.	Castle & Cooke, Inc.	San Francisco, CA
Learson, R. J.	Nat'l. Marine Fisheries Serv.	Gloucester, MA
Lewis, B.	Coastal Fisheries	Portland, ME

Licciardello, J. J.	The Gorton Corporation	Gloucester, MA
Liles, A. W.	Exxon Enterprises	New York, NY
Linehan, J. F.	Nat'l. Marine Fisheries Serv.	New Bedford, MA
Linton, O.	Environment Canada	Ottawa, Canada
Lopp, T. G.	U.S. Tariff Commission	Washington, D.C.
Lovell, R. T.	Auburn University	Auburn, AL
Lusk, G.	The Gorton Corporation	Gloucester, MA
Luther, H.	Frionor Kitchens, Inc.	New Bedford, MA
McCallum, J.	McCallum-Legaz Fish Company	Seattle, WA
McKay, P.	Nat'l. Marine Fisheries Serv.	Gloucester, MA
Maceikonis, V.	Nestle	Ringoes, NJ
Malone, J. R.	Booth Fisheries	Chicago, IL
Madakia, H.	P. Janes & Sons Ltd.	Trinity Bay, NFLD.
Matthews, R.	Bumble Bee Seafoods	Astoria, OR
Meier, W. R.	Walter Meier, Inc.	Milwaukee, WI
Mendelsohn, J. M.	Nat'l. Marine Fisheries Serv.	Gloucester, MA
Metzak, J. M.	Golden Dipt Company	Plainview, NY
Miller, J. T.	Blue Channel Company	Belhaven, NC
Miyauchi, D.	Nat'l. Marine Fisheries Serv.	Seattle, WA
Moss, P.	Freshwater Fish Marketing Corp.	Winnipeg, Canada
Mozlin, P.	Mrs. Paul's Kitchens, Inc.	Philadelphia, PA
Nierenberg, H.	Vita Food Products, Inc.	New York, NY
O'Brien, D. V.	Brilliant Seafood Inc.	Boston, MA
Oliver, K.	National Sea Products Inc.	Rockland, ME
Olson, M.	Carpole, Inc.	Garfield, MN

Omstead, L.	Omstead Foods Ltd.	Wheatley, Canada
Orr, C.	O'Donnell-Usen Fisheries	Gloucester, MA
Pace, J.	Pace Fish Company	Brownsville, TX
Patashnik, M.	Nat'l. Marine Fisheries Serv.	Seattle, WA
Perry, A.	Gulf Coast Research Lab	Ocean Springs, MS
Peters, J.	Nat'l. Marine Fisheries Serv.	Gloucester, MA
Pettinato, E.	Modern Maid Food Products	Garden City, NY
Phillips, S.	Beehive Machinery	Sandy, UT
Piver, E. L.	Merck & Company	Rahway, NJ
Quinn, T. M.	Food & Drug Administration	Washington, D.C.
Raynes, G.	Dept. of Industry & Trade	Ontario, Canada
Reif, H. V.	Fishery Products, Inc.	Gloucester, MA
Reynolds, A. E.	Michigan State University	East Lansing, MI
Rice, R.	The Gorton Corporation	Gloucester, MA
Richards, G. P.	Rockland Shrimp Corporation	Rockland, ME
Richards, J.	Nat'l. Marine Fisheries Serv.	Seattle, WA
Ronsivalli, L.	Nat'l. Marine Fisheries Serv.	Gloucester, MA
Roskey, C. T.	Framingham State College	Framingham, MA
Roy, B. J.	Pearce & Company	Danvers, MA
Rutter, J.	Research & Productivity Council	Fredericton, N.B.
Ryan, J. J.	Nat'l. Marine Fisheries Serv.	Gloucester, MA
Sander, E. H.	Food Service Innovators	Minneapolis, MN
Schwarzschild, L.	South African Rock Lobster Service Corp.	New York, NY
Seagran, H.	Nat'l. Marine Fisheries Serv.	College Park, MD
Sidwell, V.	Nat'l. Marine Fisheries Serv.	College Park, MD

Silvestro, R.	Channel Fish Company, Inc.	Boston, MA
Slavin, J.	Nat'l. Marine Fisheries Serv.	Washington, D.C.
Smith, H. M.	Fish Expo	Boston, MA
Smith, J.	Sort-Rite Sales	Harlingen, TX
Sortwell, D. R.	Nat'l. Marine Fisheries Serv.	Seattle, WA
Steffens, K.	Ralston Purina Company	St. Louis, MO
Steinberg, M.	Nat'l. Marine Fisheries Serv.	Seattle, WA
Stephenson, R. A.	Vita Food Products, Inc.	Bronx, NY
Stone, T.	King-Bartolotta	LaSalle, MI
Szymczak, E. J.	U.S. Customs Service	Boston, MA
Taylor, G. H.	Maine Dept. of Marine Resources	Augusta, ME
Taylor, R.	Beehive Machinery	Sandy, UT
Tupman, W. H.	Seamark Corporation	Boston, MA
Turner, I.	Iceland Products, Inc.	Camp Hill, PA
Turover, A. S.	Castle & Cooke	San Jose, CA
Tuttman, H.	Summit Provisions, Inc.	Swampscott, MA
Tuttman, S.	Summit Provisions, Inc.	Swampscott, MA
Van De Kamp, T. J.	Dunham & Marcus	New York, NY
Vaughn, M. J.	A & P Tea Company	Boston, MA
Vedie, G.	Robert Reiser & Company	Boston, MA
Ventola, R.	Shamrock Fisheries, Inc.	Boston, MA
Verchinski, A.	Golden Dipt Company	Millstadt, IL
Washburn, H. G.	Ralcon Foods	Chicago, IL
Waters, M. E.	Nat'l. Marine Fisheries Serv.	Pascagoula, MS
Waugh, J. J.	Quincy Market Cold Storage	Gloucester, MA

Whitaker, D.	Nat'l. Marine Fisheries Serv.	Washington, D.C.
Willmer, J. S.	Environment Canada	Hull, P.Q.
Wilson, W. C.	Booth Fisheries	Portsmough, NH
Winter, F.	Pine State By Products	South Portland, ME
Worthington, J.	Bay Trading Company	Gloucester, MA
Yamamoto, M.	Fisheries & Marine Service	Vancouver, B.C.