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POTENTIAL FOOD PRODUCTS FROM INDUSTRIAL FISH

by

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POTENTIAL FOOD PRODUCTS

FROM

INDUSTRIAL FISH

FOREWORD

About one-third of the world catch of fish is not used for direct human consumption but for the production of fishery by-products. As the present world catch is about 70 million tonnes, about 25 million tonnes of fish annually are handled and processed in ways other than fresh, frozen, smoked, canned and fermented products which are eaten. The large majority of these fishery by-products are in the form of fish meal and oil.

It should not be assumed that the production of fish meal and oil is a waste of fish resources. The fish oil produced is almost entirely used in the production of margarines and other forms of edible fats. The fish meal is used as an animal feed for the production of pig and chicken meat. It has been calculated that 30-40% of the fish protein is converted to pig or chicken meat protein available for direct human consumption. The best yield from whole fish in the form of fillets is only about 50% edible protein. The remainder, the frame, head, etc. is almost as high in protein content as the fillet but is not normally eaten. Pelagic fish left unharvested in the oceans contribute nothing to the protein available to mankind (and in certain circumstances they can have a detrimental effect on the ecology) or, at best, very little by the indirect routes of the fish food chain or the production of sea-bird guano.

Undoubtedly, powdered fish protein concentrate production from whole pelagic fish is the most efficient means to utilise the protein. However, the idea of defatted fish protein concentrate was developed over 30 years ago and in spite of considerable sums of money spent on research and development in a number of countries of the world, no significant market for this product has been established. The cost of production, relative to intended use, by methods developed to date, prevent it from being competitive with other available products.

The Manufacturers of fish meal and oil are aware, however, that in the future various pressures will be placed on the industry to maximise the efficient utilisation of the fish protein for humanitarian purposes. Two such pressures are already evident. These are:

(a) the increasing population in the world demanding efficient use of the world's food resources

(b) the increasing use of cheap animal feed substitutes in diets for pigs and poultry, forcing the industry to look

for more lucrative markets where fish products will be sold on the basis of the attractive and beneficial properties of fish as a part of the human diet and not merely on the basis of a unit of protein to be compared with soya.

In response to these pressures, the International Association of Fish Meal Manufacturers (IAFMM) together with representatives of the Fisheries Department of FAO, have formed a committee to consider the manufacture of foods from industrial species of fish under the Chairmanship of Mr. A.W. Haynie of the U.S.A. This committee combines some of the leading scientific minds in Fisheries Research, together with some of the world leaders in the fishery by-products industry. It is hoped that this combination of commercial and scientific knowledge will lead to the establishment of a number of economically viable products for human food prepared from industrial species of fish.

This paper entitled "Potential Food Products from Industrial Fish" was commissioned by the IAFMM Committee drawing on the expertise of two of the leading scientists in this field. Based on the content of this paper and the deliberations of members of the IAFMM, the Association has defined the following priorities for investigation :

(a) raw mince
(b) cooked and pressed products - frozen or salted
(c) surimi-type products.

The reader of this paper will be made aware of the practical considerations which led to the adoption of the above priorities.

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SUMMARY

This Paper is prepared at the request of the IAFMM/FAO Committee for Manufacture of Foods from Industrial Species of Fish. In doing so, it is assumed that all fish that can be brought in fresh and processed economically into human foods, along conventional lines, would be so processed to the maximum possible extent.

The main problems in processing pelagic fish in bulk for human consumption are their small size, their reactive oils, and dark flesh colour. These problems can greatly increase production costs and/or restrict the versatility and usability of products made therefrom.

The production of salted and dried whole fish would probably only find a market at very low prices in developing areas.

Suggestions are made for the bulk removal of gut contents and the production of mince and paste, which could be distributed in the frozen state to food manufacturing industries in industrial areas, and in the form of salted and dried products to developing areas.

It is suggested that priority be given to the production of mince and paste that is washed, cooked, and pressed, and then frozen or salted. These commodities would appear to offer several technical and economic advantages for fish meal manufacturers over the production of other forms of comminuted fish.

Further work is required in the laboratory, in co-operation with experts on Surimi and Kamoboko-type products, to try to adapt the above commodities for use in the production of similar eastern foods and with producers of fish cakes, sticks, hot dogs, etc., for western consumption.

The utilization of by-catches for the production of human food should be considered in relation to the above options and procedures.

ZUSAMMENFASSUNG

Diese Ausarbeitung erfolgte auf Veranlassung durch den IAFMM/FAO Ausschuss für die Produktion von Lebensmitteln aus industriell genutzten Fischarten. Dabei wird angenommen, dass alle Fische, die in frischem Zustand angelandet und wirtschaftlich zu Lebensmitteln verarbeitet werden können, in grösstmöglichem Umfang auf diese Weise genutzt werden.

Die Hauptprobleme bei der Verarbeitung von pelagischen Fischen im Bulk zu Lebensmitteln sind ihre geringe Grösse, das reaktionsfähige Öl und die dunkle Farbe des Fleisches. Diese Probleme können zu einer starken Erhöhung der Produktionskosten führen und/oder die Verwendbarkeit und Brauchbarkeit der daraus hergestellten Produkte einschränken.

Die Herstellung von gesalzenen und getrockneten ganzen Fischen würde wahrscheinlich nur zu sehr niedrigen Preisen einen Markt in den Entwicklungsgebieten finden.

Es werden Vorschläge gemacht für die Entfernung des Darminhalts sowie für die Herstellung von Hack und Paste, die in gefrorenem Zustand an die Lebensmittelindustrie in Industrieländern und in Form von gesalzenen und getrockneten Produkten in Entwicklungsgebiete geliefert werden könnten.

Es wird vorgeschlagen, die Priorität der Herstellung von Hack und Paste zu geben, die gewaschen, gekocht, gepresst und dann gesalzen oder getrocknet werden. Es scheint, dass diese Erzeugnisse den Fischmehlherstellern mehrere technische und wirtschaftliche Vorteile durch die Erzeugung anderer Formen von fein zerkleinertem Fisch bieten könnten.

Gefordert werden weitere Entwicklungsarbeiten in Zusammenarbeit mit Fachleuten für SURUMI- und KAMOBOKO- ähnliche Produkte, um zu versuchen, die obigen Erzeugnisse der Verwendung bei der Herstellung ähnlicher östlicher Lebensmittel anzupassen sowie mit den Herstellern von Fischgebäck, Fischstäbchen, Fischfrikadellen usw. für den Verbrauch in westlichen Ländern.

Die Nutzung von Beifang für die Herstellung von Lebensmitteln sollte unter Berücksichtigung der obigen Vorschläge und Verfahren durchdacht werden.

RESUMEN

Este trabajo ha sido preparado a solicitud del comite IAFMM/FAO para la elaboracion de productos alimenticios a partir de especies industriales de pescado. Al hacerlo asi, se ha asumido que todo pescado que pueda conseguirse en estado fresco y ser procesado economicamente en alimentos para consumo humano, segun lineas tradicionales, seria procesado asi en un grado maximo posible.

Los principales problemas en el procesamiento a granel de peces pelagicos para consumo humano son sus tamaños pequeños, sus aceites reactivos y el color oscuro de su carne. Estos problemas pueden incrementar sustancialmente los costos de produccion y/o restringir la versatilidad y utilidad de sus sub-productos.

La produccion de pescado entero salado y deshidratado probablemente solo encontraria un mercado a precios bastante reducidos en las areas en desarrollo.

Se dan sugerencias para la eliminacion a granel del contenido estomacal y para la produccion de desmenuzado y pasta de pescado, que podria distribuirse en estado congelado a las industrias de fabricacion de alimentos en las areas industriales, y en la forma de productos salados y deshidratados en las areas en desarrollo.

Se recomienda dar prioridad a la produccion de desmenuzado y pasta de pescado que es lavado, cocido y prensado para luego ser congelado o saldo. Estos productos aparentemente ofrecerian diversas ventajas tecnicas y economicas para los fabricantes de harina de pescado sobre la produccion de otras formas de pescado molido.

Es necesario un mayor trabajo de laboratorio, en cooperacion con expertos en productos tipo surimi y kamoboko, con el fin de tratar de adaptar estos productos orientales en la elaboracion de alimentos similares, y con productores de queques, palillos, salchichas, etc. de pescado, para el consumo occidental.

La utilizacion de la pesca de acompañamiento para la produccion de alimentos para consumo humano debera ser considerada con relacion a las opciones y los procedimientos antes indicados.

1. BACKGROUND

The literature is replete with details of a large number of different food products that can be made from pelagic fish. The literature references attached to this Paper comprise only some of the publications.

There seems to be little point, at this stage, in elaborating upon food products which still need considerable laboratory research effort before they can be produced successfully or economically.

It seems unwise for the industry, at any rate initially, to consider the manufacture of sophisticated, ready-food commodities and to compete with the highly skilled food processing industry. It may be better at this stage to manufacture commodities for use by the food industries and to co-operate in developing finished products with that industry.

It also seems that chemically and enzymatically produced substances (functional derivatives, isolates) are still either in the experimental stage (including storage properties) or are too expensive to compete with existing products such as soya isolates, soldium caseinate, eggalbumen, etc. The number of operations required for some of these products - for example, deboning, washing, enzymatic action, acid treatment, extraction, neutralization and spray drying - render these products complex and expensive to produce. There is little published information on the biochemistry and microbiology of the fermentation procedures involved in such products. Considerable laboratory research is still required before the production of silage for human consumption could be considered by industry.

There are really only few options which seem worth considering at present, namely:

(1) salted and dried whole fishes for developing areas
(2) raw mince or ground paste
(3) cooked and pressed mince or paste, and
(4) surimi or kamboko-type products.

2. INTRODUCTION

The present Paper has been prepared at the request of the IAFMM/FAO Committee for Manufacture of Foods from Industrial

Species of Fish. It concerns the possible production of food products from industrial fish on a practical basis.

Many traditional products (canned, frozen, salted, dried) and non traditional products (powdered, minced, chemically or enzymically treated) can be made in the laboratory, or are indeed produced from certain pelagic fishes, industrially.

Although canned foods still form an important method of preserving and distributing perishable commodities, the volume has decreased appreciably as a result of increasing worldwide transport and storage capabilities for fresh and frozen products, as well as the cost of canning. In so far as fatty fish is concerned, however, canning remains attractive due to the perfect protection of the oil from rancidity.

It is assumed that members who have industrial fishes that are suitable for canning, if properly preserved aboard the fishing boats and ashore, will do so to the maximum extent possible; and that the same is the case for fish that are amenable to freezing, salting, drying, etc., along well-known and well-tried conventional lines, on an economic basis.

The present Paper deals with those few food products which seem to be the best, from an economic and practical standpoint, for industry and its scientists to concentrate on initially, if traditional processing of the species is uneconomic.

Ideally such products should involve, as much as possible, the existing techniques and equipment of the fish reduction industry, such as bulk handling, cooking, pressing, drying, certrifuging, multiple effect evaporation, packaging and storage.

In this respect the production of FPC type B could be considered as a natural entry into the food field, by industries having suitable fish for this purpose. Such fish should have an acceptable or neutral flavour, and should contain oil that does not quickly turn unacceptably rancid on exposure to air.

The process of manufacture is well known, and if the main problem of marketing can be solved, such industries would in this way become familiar with the hygienic preservation and processing of fresh fish for human food.

2.1 Industrial Fishes

Generally speaking, industrial fishes are relatively small and oily. They vary in size from tiny lantern fishes, anchovies, capelin, pilchards, anchovetta and horsemackerel to menhaden and

many more. The term "industrial fish" is, therefore, a family name. There is no clear definition of industrial species. While some species have an attractive flavour, others have not. It is, therefore, for individual members to decide what treatment their fishes need, either to wash out unattractive flavours or to mask them, or to use methods that are best adapted to their species. Even unpalatable fishes can be treated to become attractive-comminuted products.

There are, however, common features for all industrial species. They are, for instance, all subject to rapid bacterial and enzymatic spoilage and to rapid oxidation and rancidity - and thus present expensive problems.

All have to be handled hygienically and have to be kept chilled and away from oxygen, e.g. under water, to avoid rancidity from the time of catch until processing.

All have to be degutted, or at any rate have the gut contents removed, and all have to be deboned for the preparation of mince or paste, and all final products must be packed or treated to protect them from oxygen and consequent rancidity.

2.2 Preservation Aboard and Ashore

The fish must be chilled rapidly, and the recommended procedure is to use containers containing broken ice. When fishing starts, sea water (1:2) is added to the ice, and the fish is emptied into the containers. The ice-slush and fish mixture should be agitated either with compressed air or recirculation of water to provide uniform and rapid cooling.

If recirculation of water is used for agitation, this should be upwards through the fish, not only to keep the fish covered and reduce rancidity but also to facilitate uniform circulation, especially with small fish that tend to pack tightly.

Chilling is far more rapid with an ice-slush mixture than with chilled sea or fresh water alone, due to the high-latent heat of the ice. The fish should be kept under chilled water and ice at the factories while awaiting processing. It should be stressed that even when kept under an ice-water slush, many fatty fishes will remain in food standard condition for no more than a few days.

3. MAIN PROBLEMS

The main problems in processing pelagic fish are:

(1) their small size and the high cost of cleaning and degutting

(2) the content of reactive oil, necessitating special precautions all along the line to avoid rancidity

(3) the dark colour of the flesh, which necessitates additional cost to separate white from brown flesh to lighten it for certain products. The fish cannot be bleached to whiteness without damaging its food values and especially its protein quality.

These are the main reasons also for the general low consumption of these species.

3.1 Degutting

Degutting of small fishes would be too expensive with ordinary degutting machines.

The gut contents may be easier to remove from fish which is destined for mince or paste than from fish which is to be prepared in any other way. For instance, it seems worth trying to do this by chopping the fish or feeding it through a deboner and then washing away the contents of the broken gut. The coarsely minced flesh would then be suitable for use as gut-content free or it could be deboned further to form a finer mince or paste, free from gut contents. The guts themselves (pyloric cacae) are thought to add to the flavour of salted products. Deboners have wide ranging capacities, up to 6 tons per hour or more, and can be set for performations ranging from 1 to 10 mm. They are made in Japan, USA, West Germany and other countries.

3.2 Reactive Oil

It is essential for acceptable, food-quality products to keep the fish at all stages of processing and preservation under water, or out of contact with air, to avoid rancidity. Approved antioxidants can help to minimize rancidity during unavoidable exposure.

3.3 Dark Flesh

A certain amount of lightening in colour of bulk-minced fish results from washing with excess water, and further lightening

of the flesh could be obtained by treatment with a buffer solution (pH 4 to 5) containing a very small amount of hydrogen peroxide. However, it is generally better to avoid peroxide due to the danger of injuring protein quality, and possible public health concern.

4. NEW PROJECT OPTIONS

4.1 Whole Fish

The simplest and least expensive entry into human food would be in the form of whole, salted and partially or fully-dried commodities. Salted and dried fish are consumed on a considerable scale e.g. by workers in sugar-producing areas and in other regions such as Senegal, Liberia, Egypt, Sudan, Mali, Philippines, Sri Lanka etc. In many such regions some rancidity is tolerated and even liked. It is suggested that if industry considers making salted and dried fishes for these markets, it is left to the consumers to remove the head and gut when they eat the product.

In some areas salted and smoked-dried fish are preferred, while in others again, dried but unsalted fish are desired.

4.2 Comminuted Fish

The most promising food that can be made from industrial fish is based on minced or finely milled products. These can be converted into many products that are suitable for fish cakes, stews, fish crispies, chowders, fish bites, soups, sausages etc. and for meat and fish extenders (about 15% of meat can be replaced by fish in hot dogs and hamburgers), spiced or smoked pastes, pizza and other sauces, meat and fish balls, loaves etc. Tests have shown that 5.0% of oily fish can be added to frankfurters, viennas, meat loaves, pork sausages, etc. without detection, and up to 15% in lean beef products. In sausage - making, about 12% of fat is used and this, to some extent, protects fish oil from oxidation.

"Beefish" patties have been made in the USA, of which one-third consisted of fish and flavour was pleasant, though fish flavour was discernable. A type of wiener is made from lean fish with spices, soy, smoke flavouring, sodium tripolyphosphate and salt. Similar products could no doubt be made with added raw or cooked and pressed minces described in this Paper. These products are all well washed, bleached and bland.

Finally, the Japanese have produced a variety of sausages, polonies and other meat products from fish and it seems that

many of these could incorporate oily fish mince or paste, which is well washed and bleached.

The comminuted products can be dried, salted or frozen; they can be spiced, smoked or used in the natural state. They can be reformed into steaks, prawn shapes or any other required shape. It should be borne in mind that minced and milled fish break down more rapidly than the fish from which they are made.

Spiced mince is used on a considerable scale in Malaysia.

Dried, salted, or salted and dried mince would be suitable for developing regions, especially in the tropics or subtropics, or in poorer industrial areas. Rancidity should be eliminated or reduced by oxygen-free packaging or oxygen-resistant packaging and the addition of antioxidants.

Frozen mince and pasta are suitable for industrial areas and should find increasing uses.

Minced and milled fish are thus suitable for industrialized areas as well as for developing regions. Marketing of new products from fish would seem to be the main problem, and co-operation with existing food industries, and the supply of partly-processed ingredients to it, would seem to be the best approach, at any rate initially. It is suggested that contact be made and co-operation be sought with producers of fish and meat cakes, chowders, stews and other appropriate western food products, and with makers of fish sausages, salami and Surimi and Kamoboko products, rather than to try to develop new finished products independently and in competition with existing food industries. Co-operation should also be sought with large food marketing organizations and with such potential users as hospitals, railways, military etc. The industry and its scientists could, and should, render assistance to the food industries in developing new recipes for the use of fish mince and paste. The literature contains many such recipes.

4.2.1. Preparation of mince

The fresh fish is washed and passed through a coarse deboner or mincer and thence to a continuous counter current washer to wash away the gut contents. If the degutted fish from this operation is relatively free from bone, it can be converted to mince by further counter current washing, for reducing volatile and soluble odour and flavour substances, and to lighten the colour of the flesh. If the mince is made from a species of fish in which fine bones remain in the flesh after deboning, an alternative

is to convert such fish into cooked and pressed mince (see 4.3 below).

As leeching losses are considerable, the washing should be done by means of counter-current flow. In this way the spent wash-water is thick enough in solubles to justify the cost of centrifuging for oil and concentrating the solubles to a valuable by-product for feed or fertilizer.

The mince may then be treated with 2.0% or more of salt, 0.5% of sodium tripolyphosphate and MSG, sugar, curry, soy, or seasonings and antioxidant.

Alternatively, it can be smoked, or liquid smoke can be added to it, depending upon the requirements of the food processing industry. Fatty fish is suitable for smoking and cold smoking will not destroy the functional properties of the tissues. Phenols and other constituents in the smoke are antioxidants.

The addition of 3.0% salt, 0.5% of sodium tripolyphosphate (TPP), and 0.15% of sugar, results in a blander product and improves the water-holding capacity. The texture of pelagic fish can also be improved by adding calcium phosphate.

The use of polyphosphates minimizes the loss of functional properties of the fish flesh (oil and water holding capacity, emulsion capacity, elasticity) which occurs during freezing.

Flavourings that have been found to mask fish taste in the laboratory are curry, mustard, vanilla and cinnamon in such small quantities that they are hardly detectable.

For sophisticated regions, the mince should be frozen in blocks and glazed e.g. with chilled gelatine solution, as an oxygen barrier, or packaged in sealed plastic bags. The cost of preventing oil oxidation adds considerably to the cost of production. Unless this is done, the products are doomed to failure, at any rate in industrial areas.

A mince that is suitable for fish cakes can also be prepared by salting and transport under brine or in sealed packages, or by salting and partial drying (and smoking, if required) and transport in sealed oxygen-tight packages.

Uniform salting of mince can be achieved by adding the

requisite amounts of mince and salt (2:1) to a ribbon blender. After blending, the mixture is left for some time e.g. several hours or a day in water-tight bins. Thereafter, excess moisture can be removed and the bulk reduced by pressing to form cakes which are then packaged in air-tight containers.

Desalting for subsequent use is rapid and easy, due to the relatively fine subdivision of the fish. For making fish cakes it is sufficient to add water to the mince bringing it to the boil and discarding the salty water. The potato, egg, onion, parsley, seasoning etc. is then added.

Although fish cakes made from oily fish are inferior to those made from white fish, especially in colour, they are nevertheless tasty and of good texture.

4.2.2 Preparation of Paste

The deboned product is returned to a deboner with finer orifices. By using fine orifices in the flesh separator, a smooth paste is produced and deboning is more complete than with coarse deboning. The capacity of the deboner is appreciably reduced; but it can nevertheless handle tons per hour. The paste is then washed by a counter-current technique (the effluent water being centrifuged for oil and the protein fluids being concentrated to solubles) and treated with salt, TPP, etc. as for mince.

This product can be frozen in blocks and packaged for dispatch to sophisticated food processors. Salted, salted and dried, and smoked products could go to developing areas or used in industrialized areas.

Paste has been drum dried (20 second contact time) after adding 0.5% salt and 2.0% TPP by the National Marine Fisheries Service of the USA and is reported to reconstitute well. The paste could also be drum dried by adding more than 10% of wheat or maize flour, without the addition of TPP. The work was done with Pacific hake; it seems worth trying similar experiments with industrial fishes. Similar work has been conducted in Denmark and other countries.

4.3. Cooked and Pressed Mince (or paste)

This is the product with the greatest chance of industrial success. The mince is suitable for making fish cakes, stews, casseroles, soups, precooked sausages, and many other dishes, both in sophisticated regions and in developing areas. The salted

product keeps well for years, due to the low moisture and oil contents, and it does not turn brown or become hard like ordinary salt fish during prolonged storage. In one experiment, even after two years' storage in hermetically sealed cans, the colour, flavour and texture of fish cakes made from it were similar to those for fish cakes made from fresh pilchards. Because the product is cooked, it does not have the functional properties such as elasticity, water-holding and full gelling capacity etc. of raw mince, but neither is it gritty and devoid of functional properties as is fish powder.

It would probably be unsuitable, however, for making fish sticks or fingers without adding a binder, due to denaturation of the protein. Nor could it, like raw mince, be used for making surimi-type products for the same reason.

In this connection, however, it should be borne in mind that many industrial fishes have poor elasticity anyway.

Fish sticks and kamaboko are used on such a large scale that considerable effort should be made to try and develop suitable material from industrial fish for use in the manufacture of similar commodities, even in small proportions.

Nevertheless, the cooked and pressed product has many advantages and should be given priority in planning. It can be produced as frozen, as salted, salted and partially dried, smoked, spiced or dried products. The salted products are very readily reconstituted. Another significant advantage of producing cooked presscake mince is that the oil is recovered as in present fish meal production for separate sale, as are the solubles. Concentrated wash water and bones are also recovered.

Moreover, only little salt is required for stabilization e.g. about one-third of that required for salting of ordinary fish. This does not only result in a saving of salt, but it means that the product can be added to other foods in far larger quantities without oversalting the food.

It can be added to food to the extent of about 10% (i.e. 20% fish flesh) without other added salt, resulting in a product of about 1.5% salt content, which is just right for flavour. For incorporation of larger amounts, the product is very easily and rapidly desalted.

There is a saving of about 50% in packaging, due to the removal of moisture, and storage and transport costs would be about half of those for ordinary frozen mince.

The fat content is no higher than for FPC type B (less than 10%).

The manufacture of cooked and pressed mince and paste requires, in part, machinery found in fishmeal plants e.g. rotary cookers, press, mills, centrifuges for recovery of oil from stickwater, and stickwater evaporators and blenders.

4.3.1. Preparation

The following steps are taken in its preparation:

(1) Pass the fish through a coarse deboner or chopper

(2) Wash the flesh in a counter-current (inclined rotary) washer, recover the outlet wash water and concentrate it for feed or fertiliser, and recover oil, if present.

(3) Cook the flesh in a rotary cooker, just sufficiently for maximum oil removal by subsequent pressing.

(4) Press the cooked flesh in the screw press (if necessary fitted with screens containing smaller than normal perforations e.g. 1 mm) and recover the oil and stickwater. The latter is concentrated for feed. By far the least expensive method of removing oil and water is mechanically.

(5) Mill the flesh presscake to the desired consistency (mince or paste) by means of a deboner.

(6) If desired, or required for the species, any small ones remaining in the flesh should be softened by adequate heat processing and/or the mince should be rewashed by means of a counter-current continuous washer, using hot or cold water as required. Again recover the outlet wash water and concentrate it for feed or fertilizer.

On the other hand, fish flesh with good flavour should be washed only to the extent necessary to remove gut contents.

(7) If the fish flesh is rewashed as indicated above, then it should be centrifuged or pressed again to remove as much water as possible.

Operations (6) and (7) will not be necessary under most circumstances.

(8) Add about 15% of salt, uniformly distributed e.g. in a ribbon blender. This is about 8.0% salt, based on the original fish. Package hermetically, and store and transport at atmospheric temperature. Alternatively:

(a) add about 5.0% salt to a ribbon blender and partially dry to about 20% moisture content in the rotary drier, and pack hermetically for storage and transport at atmospheric temperatures

(b) Dry the material to about 10% moisture content in the rotary driers, as for ordinary press cake.

(9) Alternatively, the flesh can be packaged hermetically without salting, and frozen for storage and transport. The products can be smoked or spiced or mixed with cereals, and can be used as a meat extender in cooked wares such as loaves, hamburgers etc.

4.4 Surimi Type Products

Surimi is a fish emulsion from which dozens of kinds of kamoboko (fish cakes) and other commodities are made. Kamoboko is made by boiling, broiling or frying in deep fat.

Cooked and pressed mince might well find use in kamoboko-type products. In the making of kamoboko, vegetables and cereals may be added, as well as colouring agents.

There are apparently two main types of surimi; namely (a) Kaen surimi, having 2.5% of salt and 10% sugar, and (b) Muen surimi with 0.2% of TPP and 5.0% to 8.0% of sugar or glucose. Starch is added to these products for thickening and monosodium-glutamate (MSG) for flavour.

They are usually frozen in 10 kg blocks and are packaged in polythene bags, and stored at -20°C. Low-grade eating fish can be used for making surimi, but it should be white (the whiter the better) and non-oily, and it must have good gelling properties. Thus, the best surimi is made from young fish, before spawning, that is processed before rigor mortis. The elastic and gel-forming properties vary from species to species. Alaska pollock is a good fish for surimi. Oily industrial fish would make inferior surimi by Japanese standards, as these species have very poor elasticity. Also, the dark colour is undesirable.

In the making of surimi, the fish flesh which must be absolutely fresh, is minced and washed several times in 15 to 50 times its weight of water. It is then strained or pressed to remove excess water. Then the sugar, salt, sorbitol etc. are added and

mixed in. About 50 kg of mince yields about 20-30 kg of surimi, but the price of surimi is nearly three times that of minced fish. Considerable research remains to be done before industrial fishes generally, and especially the dark-fleshed oily types, can be considered for the making of surimi. Such research is in fact in progress in Japan.

Initially, it would seem more promising to direct effort to making a kamaboko-type product, which resembles a sausage or elastic fish cake. The milled product could perhaps be used in mixtures with more suitable fish and/or a suitable binder having the desired functional properties could be added.

Summarising, industry should try to interest kamoboko manufacturers in utilizing cooked, pressed, washed and treated mince or paste in their smoked and coloured products and to interest surimi makers in the raw mince or paste that has been thoroughly washed and bleached for admixture e.g. with white fish of good functional properties. As industrial fish fails in important qualities for surimi, such as whiteness of flesh, good gelling properties and low oil content, it may be wise to avoid the term surimi, when making such products from industrial fish, and to refer to the latter as processed fish emulsion.

4.5. By-catch

The by-catch from shrimping operations is very large (4:1) in relation to the main catch, but unfortunately it is discarded or landed in relatively small amounts at many different points, and is a mixed bag of different species. The installation of expensive machinery for manufacturing stable food products or for the manufacture of fish meal might be uneconomic in most cases. The making of simple products with inexpensive equipment should thus be considered first, at any rate for the time being. The manufacture of salted and semi-dried or fully-dried whole fish, mince or paste seem worth considering. The installation of deboning equipment would open the way to the production of raw mince and paste along the lines described above. Depending upon the product(s) envisaged, appropriate preservation should be commenced on board.

Alternatively, the reject fish could, in many cases, be semi-preserved with some acid, after coarse mincing, for transport to centrally located reduction plants. If there is a farming area within about 40 miles, the reject fish could be converted to silage for farm feed, requiring inexpensive equipment. Transport of liquid silage over greater distances would generally be too expensive.

5. CONCLUSION

Four options are suggested for further consideration for producing food products of intermediate materials for processed foods from industrial fish. Further research is urgently needed in the laboratory, followed by pilot-plant and cost studies. Samples of the products could be used in discussions with appropriate food industries, or for developing recipes for final-finished products and packages for direct wholesale distribution. It is suggested that the fish reduction industry restrict itself initially only to the production of samples of semi-processed or processed ingredients for the sophisticated food industries or for food distribution agencies in developing areas.

In the long term, the prospects of such materials and finished products will depend upon their uniformity and quality, and strict standards and independent inspection are indicated. Uniformity of good quality is more important than good average quality, with fluctuations ranging from excellent to poor.

Marketing will probably be the most difficult and expensive aspect of this enterprise. It will be important initially to introduce the above products into local recipes, in co-operation with existing food processing and distribution industries, and conform to local food habits - in sophisticated areas, poorer areas, and in developing regions.

6. OVERALL RECOMMENDATIONS

a. As a first step the industry and its scientists should acquaint themselves with accepted codes of practice and specifications concerning the production of fish products for human consumption, and particularly of minced fish. Subjects such as freshness of raw material, hygienic handling, moisture and protein contents, freedom from rancidity, bone material and other impurities should receive close study, with the view to ensuring compliance when new products are produced.

b. Samples of intended products should be prepared by scientists of the industry for conducting both accelerated and long-term storage trials in appropriate packaging. Suitable provisional standards of quality and working procedures should be initiated by industry at this early stage. These could be modified if and when considered advisable, but "any plan in this direction is better than no plan".

c. Preliminary cost estimates of possible industrial procedures should be made and the economics of production and marketing should be assessed, as accurately as possible.

d. Samples made in the laboratory should be used for early negotiations with food producing and marketing organizations. Many food-marketing organizations and individuals are very conservative, and it may be necessary to approach a number of experts in this field before real interest in a new product is awakened.

e. Pilot scale production should be considered only after definite interest is evident and full scale production should be considered only after contracts have been confirmed at pre-arranged prices and specifications.

f. Minced, cooked presscake fits more closely into existing fish-reduction procedures than any of the other options considered. It has the greatest chance of economic success, particularly as the oil and concentrated stickwater are recovered for separate sale to existing markets. They are of more value than if left in the new product, and their removal is, moreover, advantageous to the new product from stability and acceptance viewpoints.

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