FISH PROTEIN CONCENTRATE

Sucheta sahoo

Introduction

This note describes what fish protein concentrate is, how it can be made, and the principal technical problems encountered in making it. The manufacture and use of fish protein concentrate raise a number of economic and social questions and these also are briefly discussed in the note.The term fish protein concentrate is often shortened to FPC, and this abbreviation is used frequently in this note.

The idea of producing a fish protein concentrate is by no means new. A vase found in the ruins of Pompeii bore an inscription claiming that the best liquamen in the world was made in the factories of Umbricus Agathopus, and liquamen is a kind of FPC. In more recent times the Norwegians exhibited biscuits containing fish flour at an international exhibition in 1876.

However, it is only in the last twenty-five years that extensive endeavours have been made to produce fish protein concentrate, and only in the last few years that most of the technical problems of making FPC on a large scale have been solved.

What is fish protein concentrate?

Fish protein concentrate is any stable fish preparation, intended for human consumption, in which the protein is more concentrated than in the original fish.

What are the principal types of FPC?

The Food and Agriculture Organization of the United Nations defines three types:

- Type A:virtually odourless and tasteless powder having a maximum total fat content of 0·75 per cent.
- Type B:powder having no specific limits as to odour or flavour, but definitely having a fishy flavour and a maximum fat content of 3 per cent.
- Type C:normal fish meal produced under satisfactorily hygienic conditions.

These three types, all of which in a sense resemble fish meal, are the subject of this note, but there are other fish protein concentrates which are totally unlike fish meal. These are typically made by hydrolysing fish protein by means of enzymes or other chemicals and then concentrating the product into a paste or extract. Hydrolysed products have received much less technological attention than the variants of fish meal, and they are not discussed further here.

The fat content is specified when defining types of FPC because fat when oxidised can produce a strong, often rancid, taste in the product. The protein content of FPC depends on the raw material used and the extent to which water has been removed, but the products normally contain at least 65 per cent protein and, in type A, up to 80 per cent.

How does FPC differ from fish meal?

Fish meal as produced throughout the world is a very cheap potential FPC, but it is not intended for human consumption; it is used for making pig and poultry feeds for farming. Ordinary fish meal is unsuitable for human consumption for three main reasons:

1. It is not normally made under sufficiently hygienic conditions to rule out the risk of occasional contamination by disease-causing bacteria.

2. It usually contains rancid fat which destroys certain vitamins and may lower the nutritive value of the protein; a fish meal diet might precipitate vitamin deficiency in poorly nourished people. Moreover the flavour of the rancid fat is unacceptable in many societies, though not in all.

3. There is a slight risk that the rancid fat may have a cumulative toxic effect if consumed over a long period.The first of these reasons is the most important; thus fish meal made under hygienic conditions is called FPC type C.

Is FPC the same as fish flour?

Fish flour is not a precise term, and causes confusion in some languages, but is the name sometimes given to a product such as FPC type A which, when ground to a fine powder, can be used as an unobtrusive additive to prepared foods.

What raw material is used to make FPC?

The raw material can be fresh fish of almost any kind or size, or fish meal. The care taken of the fish on the fishing vessel should at least equal that given to fish for ordinary consumption; it should normally be stored in ice immediately after capture, and the factory should start processing it within at the most 48 hours and preferably within 12 hours of landing. Storage of the raw fish in ice for up to 8 days after capture does not affect the nutritive value of the FPC.

In some areas of the world's oceans there are large stocks of unexploited fish, and these might well be used to make FPC. In any large-scale operation, FPC would be in direct competition with the fish meal industry for its raw material. Biologists estimate that the annual world harvest of marine fish could be doubled or tripled; much of the additional catch would consist of species not normally eaten but which could be used to make FPC.

How is FPC made?

The manufacture of types A and B is described here, since type C is simply hygienically prepared fish meal.

Water and fat together constitute about 80 per cent of the whole fish, with the fat itself in some species accounting for up to about 20 per cent at times. The manufacture of FPC involves removal of most of the water and some or all of the fat. Methods developed so far are based mainly on the use of chemical solvents to remove the water, fat and fishy-tasting components, either from raw fish or from fish meal. The solvents most successfully used to make FPC type A are the alcohols, for example ethanol or propanol; ethylene dichloride is also used. The choice between ethanol and propanol is based on cost, but since propanol is usually free of excise tax it has tended to replace ethanol. Normally the solvent is recovered and used again and again.

The manufacturing process is quite complicated, but an outline of a typical process is shown in the figure. The sequence of operations is:

Diagram of an FPC production plant

1. Fresh whole fish are rinsed with fresh water soon after landing, weighed and fed to a mincer by conveyor.

2. First extraction: the minced fish are fed to extractor 1 which dehydrates the fish; it is an unheated vessel in which the mince is agitated for about 50 minutes together with the liquid recovered from extractor 2, which contains some isopropanol.

3. Centrifuging: the contents of extractor 1 are fed to a continuous centrifuge, where the slurry separates into a solid known as wet cake, and a liquid. The wet cake is conveyed to extractor 2, and the liquid to a still for recovery of solvent and fat.

4. Second extraction: extractor 2 is jacketed, and the temperature is about 75°C. Here the liquid recovered from extractor 3 is added to the wet cake from extractor 1 and the mixture is agitated for 90 minutes. At the beginning of this stage the cake is almost completely dehydrated, but has a fat content of about 5 per cent, which is reduced to about 1 per cent during the extraction.

5. Centrifuging: the contents of extractor 2 are centrifuged, the wet cake is conveyed to extractor 3, and the liquid is returned to extractor 1 for the next batch of raw material.

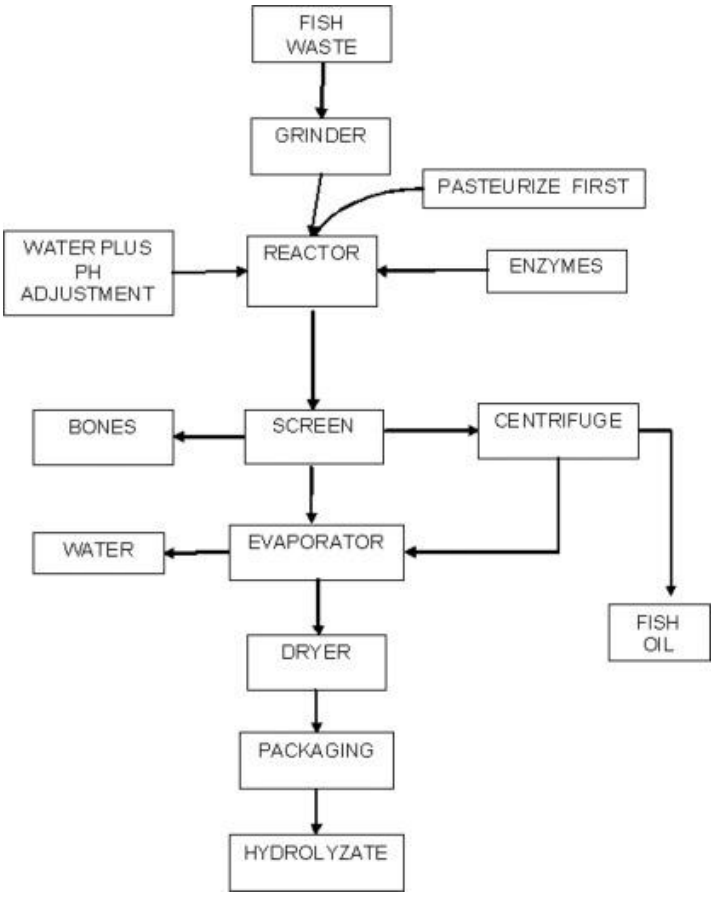
6. Third extraction: extractor 3 is jacketed, and the temperature is again about 75°C. Fresh isopropanol is added to the wet cake and agitated for about 70 minutes. During this stage the fat content is reduced to about 0·3 per cent.

7. Centrifuging: the contents of extractor 3 are centrifuged and the wet cake is washed with pure isopropanol for about 50 minutes. The liquid is returned to extractor 2 for the next batch.

8. Solvent removal: the wet cake is heated in a rotating vacuum dryer to evaporate the solvent; the vapours are drawn off, condensed and used again.

9. Grinding and packing: the dried material is conveyed to a hammer mill, where it is ground to a fine powder and sieved. The FPC is typically packed in 50-lb fibreboard containers and sent to store ready for shipment.

The important point to note is that the solid FPC material and the solvent move through the extractors in opposite directions. Thus the solvent becomes more contaminated with water and fat as it moves from extractor 3 to extractor 1, while the FPC loses water and fat as it moves the other way. The fat can be recovered from the solvent, and the solvent can be used again; solvent losses are said to be only about 1 per cent of the amount used for a batch



What are the remaining technological problems with FPC?

The problems of manufacture and storage depend on the type of FPC. For FPC type A, with a low fat content, the main problem is that of flavour reversion; that is the product may develop a fishy, or fish mealy, flavour during storage. Complete removal of the solvent is also sometimes difficult with this product. It is worth noting that the flavour components of the fish are removed along with the fat, so that the finished product has a bland taste; a process that removed the fat but left the fresh fish flavour would offer a considerable advantage, in that the product would be more acceptable to many consumers.

The main problem with fatty FPC is the prevention of rancidity; oxidised fat is nutritionally undesirable and frequently unacceptable because of its flavour.

There have been minor processing problems in the recovery of both solvent and fat, but these have largely been solved.

Finally it is worth noting that FPC has a somewhat chalky texture. To remove this characteristic is a rather daunting technical problem, but there is little doubt that such a change would increase the acceptance of FPC as a foodstuff

Why is FPC a good protein source?

First, of course, because it is concentrated; untreated and unprocessed foods do not generally contain more than about 20 percent protein, whereas FPC contains about 80 per cent. Secondly, the quality of the protein is high; by this is meant that the amino acids which make up the protein are present in just the right balance for human nutrition. Other foods such as cereals may contain useful amounts of protein but are frequently deficient in one or more of the amino acids that are essential for growth.

How is FPC used?

Fish protein concentrate type A is an odourless, tasteless powder which is unattractive to eat by itself; there is therefore a real problem in finding ways to make most use of it. It has to be incorporated in other foods such as bread, biscuits, soups and stews at a level that does not affect their normal properties. Good results have been obtained with macaroni products, a milk shake drink, spaghetti sauce, infant foods, dietetic foods and breakfast cereals.

There is less of a problem with other FPC products which have some flavour. A fishy flavour, even if a rancid one, is acceptable in food in some societies; thus the FPC can be eaten more or less as it is, or used as a flavouring in soups or stews.

However, it is true to say that this highly nutritious, concentrated, stable foodstuff is now available without as yet any clear demands appearing for its use.

How long does FPC keep?

Fish protein concentrate is described in its definition as stable; the term stable here has been tentatively defined as showing no significant deterioration in 6 months at 27°C when packed in a hermetically sealed container. Some FPC now being made can certainly reach this standard of stability.