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Production of Fish Protein Concentrate

Rabat, Morocco, 8-12 December 1969

NUTRITIONAL VALUE, UTILIZATION AND QUALITY CONTROL OF FISH PROTEIN CONCENTRATES 1/

Prepared by the Food and Agricultural Organization

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SUMMARY

NUTRITIONAL VALUE, UTILIZATION AND QUALITY CONTROL OF FPC [1]

prepared by the Food and Agricultural Organization

From the time the menace of the protein gap began to focus attention, fish protein concentrates attracted far more funds for research and development than [illegible] all other protein sources collectively taken over the last two decades. [illegible] nutritive value and in particular the high lysine content, when properly [illegible] made FPC a very important source for enriching low protein and lysine [illegible] values. Its digestibility is high and no toxic effects have been reported [illegible] feeding trials with animals and humans when FPC was processed under conditions [illegible] in the paper.

The functional characteristics of FPC, in particular those regarding the [illegible] of FPC in food formulation are discussed. The odour, flavour, inert [illegible] and the grittiness of most FPC could be modified by further processing but [illegible] - sometimes not negligible - cost.

[illegible] FAO have drawn up the first processing and quality control [illegible], which were further [illegible] by the FAO International Congress on Fish [illegible] in 1961. Upon the new experience obtained from the work of government [illegible] private institutions, FAO has been reconsidering the original guidelines and [illegible] features are presented in this paper.

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Introduction

It is a paradox to observe that in countries where malnutrition and, in particular, protein deficiencies are prevalent huge fish catches are processed into fish meal and exported to developed countries for animal feeding. Equally discouraging is the fact that ample supplies of fresh fish from the surrounding sea cannot find their way to the diets of the people even a few kilometers from the seashore. The lack of adequate handling, storage and transport facilities for fresh fish account for this unsatisfactory situation in both cases. Food habits, taboos and low purchasing power play their role also. The lack of fishing fleets and landing facilities, because of scarcity of investment funds, limit the exploitation of fish resources for human feeding.

The idea of developing a stable, easily transported and readily stored, as well as a highly nutritive product from fresh fish certainly is not new. Drying, salting, curing and fermenting have been approaches applied through centuries. The concept of producing a product free of fish flavours and lipids and possessing the nutritive characteristics of fresh fish is definitely of more recent date.

Over the last two decades early studies by FAO and WHO drew attention to the threat of the "protein gap". Research and development of the

production of edible fish protein concentrates has been attracting perhaps more time, energy and funds than any similar work for the development and utilisation of edible proteins from semi-conventional and unconventional sources of protein.

This paper will not enter into the technological, engineering or economic aspects which are dealt with by other speakers, but it will refer to them only to the extent required for the clarity of the arguments presented.

A need for definitions of terms coined and largely accepted appears necessary as confusion is easily created when certain terms are translated into other languages. The term "fish flour" is translated into "farine de poisson" which, in French, means "fish meal". The term of Fish Protein Concentrate appears now to be accepted.

At the FAO Symposium on "The Significance of Fundamental Research on the Utilisation of Fish", Husum, May 1964, the following definition was introduced: "Fish protein concentrate (FPC) is understood to include any form of dried fish, including fish meal, intended for human consumption. Products which are not concentrated, such as autolysates, containing all the water of the original fish, are not considered, except as raw materials for further processing".

At the Hearing on U.S.A. Federal Government's Research Programme on Fish Protein Concentrate, Washington, D.C.. August 1964, the U.S. Bureau of Commercial Fisheries defined FPC "as any inexpensive, stable, wholesome fishery product of high nutritive quality, hygienically prepared from fresh fish in which the protein and other nutrient materials are more concentrated than they were in the original material. It was explained that "This definition includes FPC products of varying characteristics ranging from tasteless, odorless, light-colcured. flourlike materials through coarse meals having a fish taste and odour, to highly flavoured, dark-coloured pastes or powders resembling meat extracts".

In the U.S. Federal Register of 2 February 1967 (Title 21 - Food and Drugs, Part 121 - Food Additives) it is stated that the food additive whole fish protein concentrate "... is derived from wholesome hake and hake-like species of fish, handled expeditiously and under sanitary conditions in accordance with good manufacturing practices recognised as proper for fish that are used in other forms for human food".

At the Conference on Fish Protein Concentrate, Ottawa, Canada, October 1967, FPC was defined as "an inexpensive, stable, wholesome fishery product of high nutritive qualities, prepared for human consumption from whole edible fish by sanitary food processing methods".

In the U.S. Bureau of Commercial Fisheries draft specifications for fish protein concentrate (submitted in July 1967 for consideration by FAO/UNICEF/WHO PAG) the product was defined as...."a stable, wholesome protein concentrate of high nutritive quality, prepared in accordance with good commercial food handling practices by solvent extraction of water and lipids from food grade whole fish".

In general FPC can be defined as : " edible products prepared from whole edible species of fish or edible parts of them and processed under sanitary food processing practices to increase the protein content beyond the protein content level of the raw fish calculated on a dry weight basis". It is generally assumed that such a concentration is achieved by removal of the lipids and water through solvent extraction, or by combined prepressing and solvent extraction. Other processes using enzymatic treatment might be considered when reaching the industrial production scale.

Nutritive Value of FPC

The primary aim in processing raw fish into FPC is to retain at least the nutritive value of the fresh fish, while concentrating its protein content. It is obvious that solvent extraction will remove all fat-soluble vitamins along with the removal of the lipids. This loss is considered of secondary importance. The importance of FPC in its utilisation lies in its high protein content and high nutritional and supplementary value of its protein.

The determination of nutritional effectiveness of FPC, as for any other protein source, is done by animal feeding studies as well as by clinical studies in humans. In animal feeding studies, values such as the Protein Efficiency Ratio (PER), Net Protein Utilization (NPU) and Biologival Value (BV) are the main indices for assessing the nutritional effectiveness of the protein. In human feeding, in particular with growing children, nitrogen balance studies and body weight/and height determinations are the standard methods accepted; serum albumin, plasma amino acid and enzyme levels have been proposed as useful criteria . (1)

When FAO, as early as 1953, started exploring the nutritional value of fish flours (the term FPC had not yet been introduced) a wide fluctuation of NPU and BV values were observed as shown in Table I. These wide discrepancies accounted for the different sources of raw material, but mostly for the processing methods which were still at a stage of development and gradual perfection. These determinations were conducted for FAO at the Bovril Ltd. Laboratories by Dr. A. E. Bender. It should be noted that the lower values correspond to fish meals and flours tested at the early stage of the programme. These values were communicated to the interested manufacturers who were accordingly improving their techniques so that by 1958 the samples of FPC from sources the same as before displayed digestibility at about 95%, NPU ranges between 64 to 78, and BV between 67 to 80. (2).

The available lysine, because of its importance in supplementing the proteins of the lysine-deficient cereals, such as wheat and maize, and the relative easiness for its determination by chemical procedures, is in practice a very suitable index for assessing the nutritive value of FPC. Actually it correlates very satisfactorily with the PER and NPU values. The available lysine of carefully processed FPC is, as a rule, very high. (Table II). The values obtained from sardine FPC (3) appear to be higher than those obtained from hake FPC, but both are high above the value — 6.5 g/16 g N — set as a minimum by the FAO/WHO/UNICEF Protein Advisory Group in 1957 and amended in 1961.

The FPC supplementary value to the protein of lysine-deficient diets has been demonstrated by many investigators. Metta (4) reported that the

PER values of most of the East-Indian type cereal diets were significantly improved at 3% fish flour supplementation. The Central Food Technological Research Institute (CFTRI) of Mysore, India (5) compared the supplementary value of fish flour-fortified with calcium and vitamins - to poor Indian diets based on different cereals and millets at the level of 3% with that of supplementation by skim milk powder at 7.5% providing the same amount of protein. The results showed that in diets based on rice, wheat, jowar (sorghum vulgare) and ragi (Elensine covacana) fish flour promoted slightly better growth than skim milk powder. Sreenivasan (6) found a good supplementary value in cereal diets with fish flours, produced from oil-sardines at 2-3% level of supplementation. Kik (9) has indicated that FPC added to milled white rice at the 3% level increases its NPU from 64.1 to 85.9. Similar are the findings of Bressani (8) with lime-treated corn. At 3% level the maximum PER was reached. Although the higher levels of FPC did not significantly improve the quality of the protein, the rats gained more weight because of the higher protein level in the diet.

In 1957 UNICEF in consultation with FAO arranged and financed a study undertaken by the Food Technology Department of MIT . The purpose of this was to assess the effects of processing variables upon the composition, quality of protein and organoleptic characteristics of the final FPC. This investigation covered the processing methods available at that time. This study was the percursor of the work undertaken later by the U.S. Bureau of Commercial Fisheries and which resulted in developing the isopropanol extraction process.

At the present time the available processes, e.g. the Isopropanol process of the Bureau of Commercial Fisheries, the modified Viobin process adopted by the Alpine Marine Industries, the Astra process, the SONAFAP process and the Halifax process, while utilizing varying sources of fish, are able to produce products displaying very satisfactory nutritional values, although with differing organoleptic characteristics.

The FPC was evaluated in the treatment of infantile malnutrition by various investigators. Graham et al (9) bottle fed a group of under-nourished infants with and without kwashiokor with a liquid preparation

of wheat flour enriched with 10% de-odourised fish flour (Viobin). This test was compared with bottle feedings of a modified cow's milk preparation, and with a vegetable mixture of high biological value. Similar weight gains and nitrogen retentions suggested that this preparation might well be a good substitute for milk in the diet of infants and children. Contrary to this, Srikantia and Gopalan (10) found that the same fish flour (Viobin) administered to children suffering from kwashiorkor met with poor acceptability and the intake of the FPC was unsatisfactory in 15 out of 33 children. The reason might be found in the fact that Graham used modified cow's milk to initiate recovery, to stabilize body composition and to obtain a steady gain in weight. In the latter case, the children were put on the FPC diet straight away without any preparation.

The SONAFAP FPC was tested in infant diets in a series of feeding trials carried out by F. Tavill and A. Gonik at the Casablanca MCH Center of the "Oeuvre de Secours aux Enfants" (11). The trials were conducted over a period of six months (August 1966 - January 1967) on a test group of 50 weaning infants (5 - 7 months of age), to determine to what extent FPC could contribute to basic cereal and vegetable diets in meeting the total protein requirements of this age group. A total daily quantity of just over 10 g. of FPC** divided into two meals served daily in the center was the maximum acceptable amount in respect to mother's attitude, the limiting factor in determining acceptance. The daily protein intake was brought, by a daily quantity of 10 grams of skim milk, in line with that of the control group. This was based on the allowance laid down by the U. S. National Research Council. No statistically significant differences were found between the two groups in respect of length and weight growth, blood urea levels and morbidity pattern. This experience indicated that FPC can make a significant contribution to the prevention of protein deficiency in weaning infants.

FPC made of oil-sardines, processed in a pilot plant at the Central Food Technological Research Institute, Mysore, India was tested in vegetable mixtures (25% FPC) on boys of 6 - 12 years of age belonging to low income population groups for a period of six months. (12). A highly significant increase in height, weight, red blood cell count and haemoglobin level was observed as compared with the control group.

** See Table II SONAFAP (4).

Wholesomeness

The nutritive value of FPC, as of any other food, depends to a great extent on its wholesomeness. The raw material used, the handling practices before, during and after processing, the residues of solvents and other processing aids used, the possible interaction of the fish flesh with the solvents might influence adversely the nutritive value and also might jeopardize its safety in use.

In the definition of FPC the certitude of edible fish or its edible parts is stressed. It has been reported (14) that there are several large groups of fish in which the flesh is poisonous when eaten. It is quite unlikely, however, that industrial production of FPC would have recourse to resources of poisonous fish. For sheer economic reasons fish catches for FPC cannot but depend on abundant schooling fish which definitely cannot be mixed with poisonous fish since the latter live and thrive in entirely different ecologic environment.

An inconvenience which might influence at least the colour of FPC produced from whole sardines - like in Morocco - is the varying type of content of the intestinal tract. The sardine canneries, for example, refuse to accept sardines caught during the day as their intestines are heavily loaded with dark green plangton. These sardines are routed to the fish meal plants. The difference in colour observed in the FPC of SONAFAP extracted by ethanol and isopropanol might well be attributed to the difference of the raw material as well as to the different extracting characteristics of the two solvents.

The handling practices before extraction can definitely influence the quality of the final product. Obviously refrigeration is indicated from the time of the catch until delivery to the FPC plant. Long delays at the landing and in the plant would favour bacterial action on the proteins as well as enzymatic oxidation of the unsaturated fatty acids. Samples of oil from sardine-FPC examined on thin-layer chromatography were found to be in a state comparable to that of frying oil heated for several hours .(15). This indicates that the oil had been at some stage severely oxidized. This could have occurred before, during or after the extraction. Furthermore,

samples of the same FPC on gas-liquid chromatography produced several peaks attributed to amines or mercaptans. This clearly suggested that the raw fish — before extraction — had been subjected to bacterial action. Apparently flavour reversion is apt to appear and, in fact, it did. Perhaps the best approach to prevent this type of trouble is to immerse the fresh fish upon landing or upon arrival at the plant in the solvent used for extraction.

The selection of the type and origin of the solvent might influence the wholesomeness of FPC. As a rule the use of chlorinated hydrocarbons is avoided in the extraction of food or feed products. Ethylene dichloride (1,2-dichlorothane) exceptionally appears not to react substantially with the constituents of the fish flesh. Actually, the Food and Drug Administration of the U.S.A. is permitting the use of ethylene dichloride as a solvent for FPC, provided that the extraction is completed with supplementary washings of the FPC with isopropanol. However, the MIT investigation mentioned earlier detected that methionine was heavily reduced and Morrison (16) found that both methionine and histidine were probably affected. Later Munro and Morrison (17) reported that they had isolated chlorocholine chloride, a reasonably toxic substance (LD_{50} of 500 mg/Kg) from FPC treated with ethylene dichloride. The subsequent washings with isopropanol apparently remove the chlorocholine chloride from the FPC.

The residues of solvents are of particular importance for the wholesomeness of FPC. So far, tolerances have been established for ethylene dichloride and for isopropanol. However, other solvents such as n-hexane are used for the extraction of lipids from foods including FPC for which no tolerances are as yet established. Another facet of the solvents concerns their purity. Impurities which are non-volatile or have boiling points high above that of the solvents could constitute a potential hazard. FAO and WHO are now looking into this problem. In the context of its work the Joint FAO/WHO Expert Committee on Food Additives is planning to deal with the problem during its next session in June 1970. The Committee will elaborate specifications for identity and purity and will proceed to the toxicological evaluation of the solvents used in the extraction of lipids from foods. Ultimately, it is expected to arrive at acceptable daily intakes which are essential in establishing acceptable residue tolerances.

The flavour reversion, often experienced with most FPC, is a deterring factor in their ultimate utilization in human feeding. It is claimed that FPC from isopropanol extracted red hake (lean fish) did not display any flavour reversion, but FPC of menhaden (fatty fish) over a period of time reverts in spite of the fact that the level of the residual lipids was the same in both FPCs (18). Preliminary investigations suggest that this effect may be due to a problem of oxidation of lipids whose omposition might differ in the two species and not necessarily to one of residual amines.

The use of hot solvents, such as isopropanol and even n-hexane combined with the steam-stripping with super-heated steam renders at the outlet of the extraction vessel a product practically free of microbiological load. Samples of FPC, withdrawn asseptically from the extraction vessel of the Agadir FPC plant during its early trial runs displayed a total plate count of less than 10 per gram. It is after this point during the transportation, grinding, sieving and packing that microbial contamination might occur. Sanitary conveyors, milling, sieving and packing equipment and materials as well as sanitary maintenance are essential in preventing microbial contamination and securing wholesomeness of the FPC.

Particular attention has been given during recent years to the fluorine content of FPC. Fluorine is a physiologically active element and in small quantities - 1 ppm in drinking water - has found worldwide application in the prevention of dental caries in children. However, in regions where the drinking water had a high fluorine content at the level of 8ppm persons between fifteen and sixty-years of age showed high incidence of mottled enamel of the teeth and of osteosclerosis(19). The Twenty-Second World Health Assembly, based on the report of the Director-General of WHO (20) requested that "continuing research be encouraged into the etiology of dental caries, the fluoride content of diets, the mechanism of action of fluoride at optimal concentrations in drinking water and into the effects of greatly excessive intake of fluoride from natural sources....".

Fish Protein Concentrates show differing degrees of fluorine content. In Table II it is shown that sardine-FPC from Agadir had fluorine content of 200 ppm and in one case 70 ppm. The difference cannot be explained easily and therefore further investigations are essential. If the tolerance established by the Food and Drug Administration at the level of 100 ppm (21) has to be accepted then the FPC of SONAPAP runs into great troubles. Of course, with efficient separation of the bones the fluorine content might be considerably reduced.

Utilisation of FPC in human feeding

Among the various factors which influence the extent of the utilisation of FPC the most important ones appear to be the texture, the organoleptic characteristics and the cost.

In general solvent extracted FPCs display a gritty texture that is detectable in the mouth even after fine grinding. In terms of functional characteristics, FPC is quite neutral with no binding and very low dispersibility qualities. Increased pH improves the dispersibility and promotes its solubility which becomes practically complete at pH12. Work conducted at MIT on behalf of the Bureau of Commercial Fisheries displayed the improved characteristics of such a modified FPC. A texturized product in admixture with soy protein isolate was produced with smooth consistency and good tensile strength. Such a treatment, however, might increase the cost of FPC high above the cost of normal FPC. However, such modified FPC could be used in milk-like products for large consumer groups probably at comparable or even lower cost than similar products now being introduced in the Western but also in other markets (Hongkong, Brasil, Singapore).

The lack of binding qualities, unless some binding addition is used, limits the usefulness of introducing FPC in pasta products. FAO has conducted some work with the Morocco FPC at the Braibanti Technical Laboratory in Parma, Italy. Spaghetti and other pasta products, where the water after boiling is discarded, lost some 20-30% of the FPC added to the wheat flour. By modifying the cooking method we were able to bring this loss down to 5%, but instructing the consumer to change his food preparation habits is not an easy or gratifying task.

Holme (22) reported that "at 5% and more FPC the quality of bread, as we know it, is decreased. Colour, taste, volume and structure are detrimentally affected". The observation qualified by the statement "as we know it" might be undeniable. However, the bread as known in North American countries has little in common with the bread as it is made in countries where bread is the staple food. I refer to the flat breads as baladi in U.A.R., Samoon in Iraq, chapatis in India and all the thin flat breads which essentially consist of wheat flour, salt and water with little or no yeast at all. Texture, colour and volume in these breads are hardly affected. And here FPC might find easy application if the problems of flavour and cost do not constitute insuperable hurdles. From the experience we had in Morocco with the leavened local bread, the addition of 5% of partly deodourised and partly defatted (1.5% lipids) FPC was practically acceptable by the consumers as the fishy flavour was hardly noticeable. The drawback however remained that of the added cost. In most developing countries and even in countries in advanced stage of development where bread is an essential part of the diet, the price of bread is a matter of serious economic, social and also of political concern. The policy of governments tends to absord any added cost by subsidies or otherwise rather than to increase the price of bread. Even at 5% level of addition to bread, at the price of 4? U.S. cents per pound, the price of bread might increase as much as 15-25%. Such an increase, if applied, would have serious social and political repercussions. On the other hand governments appear very reluctant to increase the burden of subsidies.

Disregarding the cost factor, FPC can find its way into staple foods and national diets in developing countries with, as repeatedly emphasised, spectacular nutritional results. Odour and taste can easily be masked either by synthetic or natural flavourings and spices which consist part of the nutritional pattern in developing or developed countries. The introduction of FPC into family foods or in protein food mixtures for infants and young children poses a number of problems (23). The ideal method of use is for the housewife or the mother to mix the FPC with the traditional constituent of the family diet or the infant food preparation. This might be feasible in sophisticated societies, but the experience with FPC in U.S.A., where FPC can be sold only in 1 lb. packages shows the impracticability of the approach. In developing countries a long and difficult education campaign is necessary to teach

mothers in low-income population groups to do it. Instruction is necessary concerning both the nutritional value of the FPC and the preparation of a mixture according to a formula. The use of too much or too little FPC will defeat the purpose of the supplementation.

The preparation of baby food in maternal and child health (MCH) centers or in hospitals does not pose problems if those who are responsible for running them understand the value of FPC. As a matter of fact, the centers offer useful opportunities for teaching mothers the importance of protein supplementation of the traditional staple weaning food.

Experience to date has whown that ready-mixed infant food, in small packages containing enough for 1 to 3 days, will be readily accepted by mothers. Price is, of course, a critical factor. The success of an introductory campaign will depend primarily on adjusting the price as closely as possible to the purchasing power of the sector of the population in need of this food. Hospitals and MCH centers can make use of infant food mixtures packed in large containers which substantially reduces the cost of the product.

The introduction of FPC into institutional feeding programmes (i.e. organized feeding of groups such as in schools, industrial canteens, MCH centers, hospitals, orphanages, prisons, public works programmes, army) presents one main problem: to convince the people who are responsible of its nutritive value and of the economic importance of its use. The development of recipes is a minor problem that can be easily solved with some imagination on the part of the nutritionist in charge of the preparation of the menus .

Quality Control of FPC

At the outset of the protein food programme of FAO, WHO and UNICEF and the creation of their Protein Advisory Group, the necessity for establishing carefully prepared guidelines concerning the selection of raw materials, processing techniques, chemical composition, safety in use, nutritive value and wholesomeness of the various protein concentrates became quite obvious. The first "Tentative Specifications for Solvent Extracted Fish Flour - Defatted and De-Odourized" were prepared by FAO and reviewed by the PAG in 1957. These were revised by a working group during the FAO International Conference on Fish in Nutrition, held in Washington, D.C. in 1961, and appeared as "Tentative Specifications for Fish Protein Concentrate". PAG, at its 1962 meeting in Rome agreed that these specifications (Annex A) could be applied tentatively with the amendment that the fat content of Product A be revised to 2.5%, as at that time the available processes were not able to reduce the "solvent extraction" below 2.5% and consequently no FPC completely de-odourized and defatted was available.

Upon the development of the FPC from hake by the Bureau of Commercial Fisheries the U.S.A. Food and Drug Administration issued a "food additive regulation to prescribe the safe use of a fish protein concentrate" (21). This regulation, however, is restricted to FPC from hake and hake-like species. Nevertheless, it covers quite well the aspects of adequate quality control and it introduces elements not covered by the PAG tentative specifications, such as: residues of solvents, fluoride content and minimum radiation for heat treatment.

In view of the development of a number of FPC processing methods using various solvents, various species of fish and consequently producing final products of various characteristics, PAG has requested FAO to prepare "Tentative Guidelines for Fish Protein Concentrates for Human Consumption". The first draft, considered by the PAG during its 1969 meeting is attached as Annex B. to this paper. Comments and suggestions for completing and amending these guidelines are welcome to FAO. The deliberations of this meeting, I hope, will be instrumental in completing this draft.

TABLE I. NUTRITIVE FISH MEALS AND FPC **

Raw material	Crude Protein (%)	Minerals (%)	Lipids (%)	N.P.U.	Digestibility	B.V
Lean fish	70.2	24.8	0.3	49	93	53
Cod	74.0	22.6	0.1	65	95	69
Cod fillets	89.1	4.4	0.2	64	95	67
Herring	87.0	3.1	0.3	74	93	79
Lean fish	75.2	13.5	0.3	73	93	78
Lean fish	64.7	24.8	1.2	77	94	82
Lean fish	71.3	24.8	1.2	77	96	80
Fatty fish	72.7	21.2	0.1	29	81	36
Fatty fish	73.4	20.5	0.1	31	68	46
Fatty fish	66.6	20.0	0.1	42	71	59
Semi-lean fish	79.4	19.4	0.1	67	94	71
Semi-lean fish	74.7	19.4	0.2	55	96	58
Herring	83.0	10.4	0.6	56	94	60
Sardines	81.8	9.6	0.5	70	95	74
Gutted haddock	73.6	19.0	0.2	69	95	73
Whole cod	75.7	21.6	0.2	67	95	71
Coi	78.7	14.9	0.3	64	95	67

** See ref. 2

TABLE II

CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF SELECTED FISH PROTEIN CONCENTRATES

	FAO 250B 1/	FAO 251B 1/	FAO 260 2/	FAO 262 3/	SONAPAP 4/	SPI-5 5/	FPC (BCF) 6/
Moisture	7.9	9.0	6.54	4.63	6.5	4.4	4.5
Crude Protein (N x 6.25)	80.9	80.9	87.98	84.51	88.0	77.7	85.0
Lipids	1.7	1.8	0.54	0.42	0.5	0.22	0.1
Ash	11.0	13.0	7.64	12.52	5.0	17.4	10.97
Ca	-	-	-	-	-	4.8	2.95
P	-	-	-	-	-	2.9	1.79
Lysine Available (g/16g N)	9.41	9.03	9.29	8.71	9.3	7.35	8.18
P.E.R. (Casein 2.50)	-	-	-	-	2.53	2.47	2.74
N.P.U.	73	72	-	-	-	-	-
Fluorine	200 ppm.	200 ppm.	-	-	-	70.2	-

1/ See Ref. 3 - FPC from beheaded and eviscerated sardines, Safi, Morocco (TNO)

2/ Beheaded and eviscerated sardines, Agadir, Morocco (BCF)

3/ Whole sardines, Agadir, Morocco (BCF)

4/ See Ref.12 - FPC from beheaded and eviscerated sardines, Agadir, Morocco (BCF)

5/ See Ref.13 - Whole sardines from Morocco, processed to FPC by the BCF

6/ See Ref.13 - FPC from hake, average value for 10 samples processed by the BCF.

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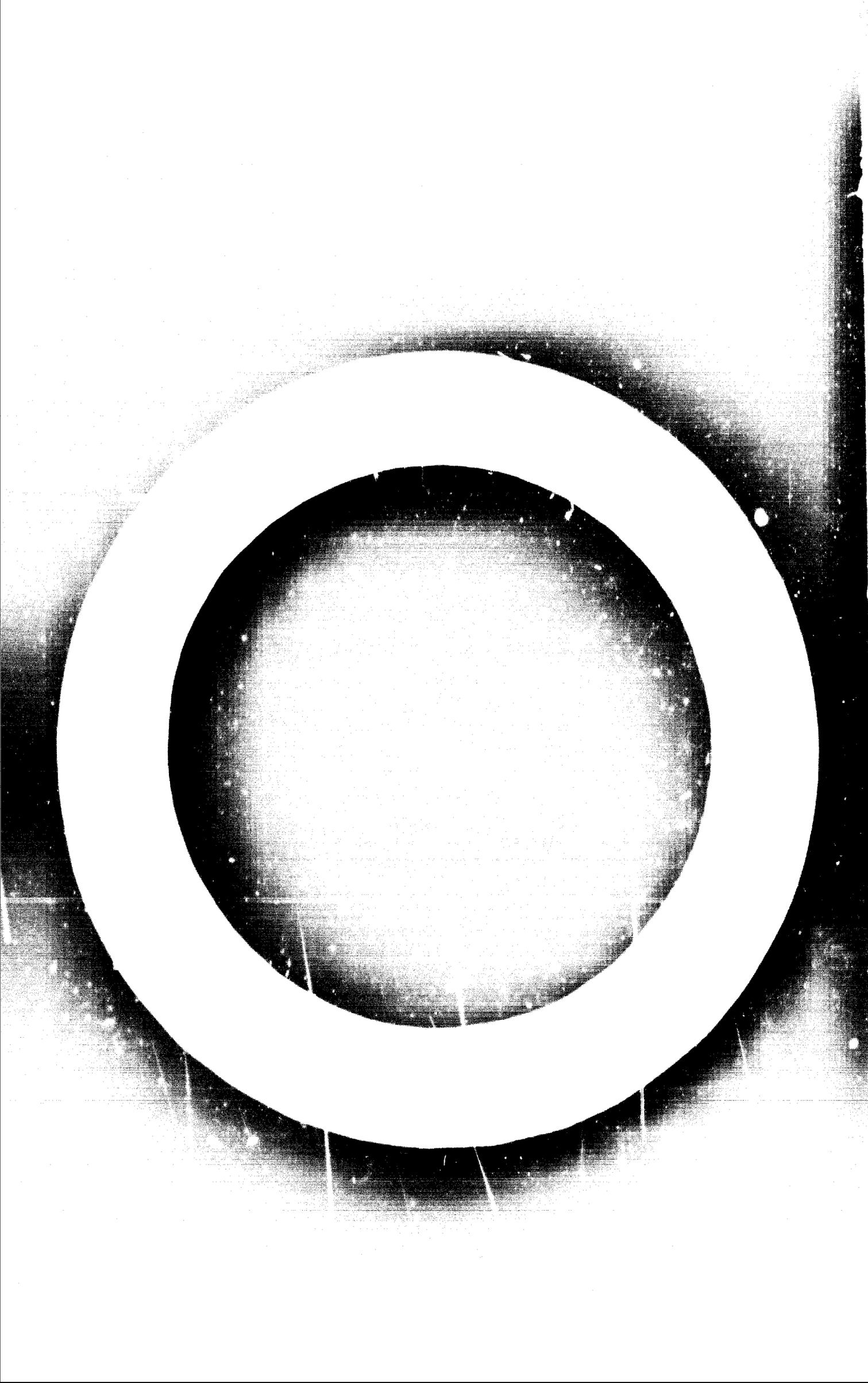

ANNEX A

Tentative Specifications for Fish Protein Concentrate

A Working Party was set up by Committee B of the International Meeting on Fish Meal to consider further the specifications and methods of analysis for fish protein concentrate. Defatted, deodorized products (A) were considered separately from non-defatted, non-deodorized products (B).

The Working Party considered these items from the following standpoints: 1) raw material; 2) processing; 3) product specifications and 4) analytical methods.

1. Raw Materials: Both types of fish protein concentrate (A and B) may be prepared from the same material. The Working Party felt that this material need not be confined to fish flesh, but could include whole fish, deheaded and degutted fish, or filleting waste of suitable type. In all cases, it should be in a condition fit for human consumption.

2. Processing: The Working Party felt it undesirable to specify in detail the processing methods which could be used for either A or B. However, sanitary precautions ordinarily applied in preparing human food must be observed in the handling of the fish from catch to end of processing.

3. Product Specifications: The Working Party considered the following criteria as important to specifications for fish protein concentrate and present these suggestions for possible incorporation into any specifications eventually drawn up.

		Product A	Product B
a) Protein (N x 6.25)			
Protein content		minimum 75 %	minimum 65 %
Pepsin digestibility		minimum 92 %	minimum 92 %
Available lysine		minimum 6.5 % of the protein	minimum 6.5 % of the protein
b) Moisture		maximum 6 %	maximum 10 %
c) Solvent extractives	*	maximum 0.1 % extracted by ethanol or chloroform: methanol	maximum 10 % extracted by hexane
d) Chloride		maximum 1.5 %	maximum 2 %

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* The WHO/FAO/UNICEF Protein Advisory Group re-considered the tentative specifications at their meeting in June 1971, and decided that this point should read as follows:

	Product A
c) Fat Content	maximum 2.5 % extracted by ethanol or chloroform: methanol

	Product A	Product B
e) **Silica**	maximum 0.5 %	maximum 0.5 %

f) Colour: Product A should be no darker than light or grey tan and ordinary bread baked with one part of it and 11 parts of ordinary flour should not show appreciable darkening.

Product B will show a wide range of colour according to raw material and, provided the pigment is natural, it is unobjectionable. Darkening due to overheating will give a product with lower digestibility and available lysine leading to automatic projection. Hence it is not necessary to specify colour.

g) Odor and Taste: Product A should have no more than a faint fish odor and taste and when baked in bread as described above should have no detectable odor or taste.

No specification can be made for Product B since it will show a wide range of odors and flavours.

h) Storage Stability: Product A, after 6 months storage at temperature prevailing in the area of intended use, but not exceeding 120° F (38°C), and when packed in metal containers or in polyethylene bags, should show no spoilage as judged by the development of off-flavours, mould growth, production of toxic amines (histaminem tyramine), or by deterioration in protein quality as shown by digestibility and available lysine values below the specific minima.

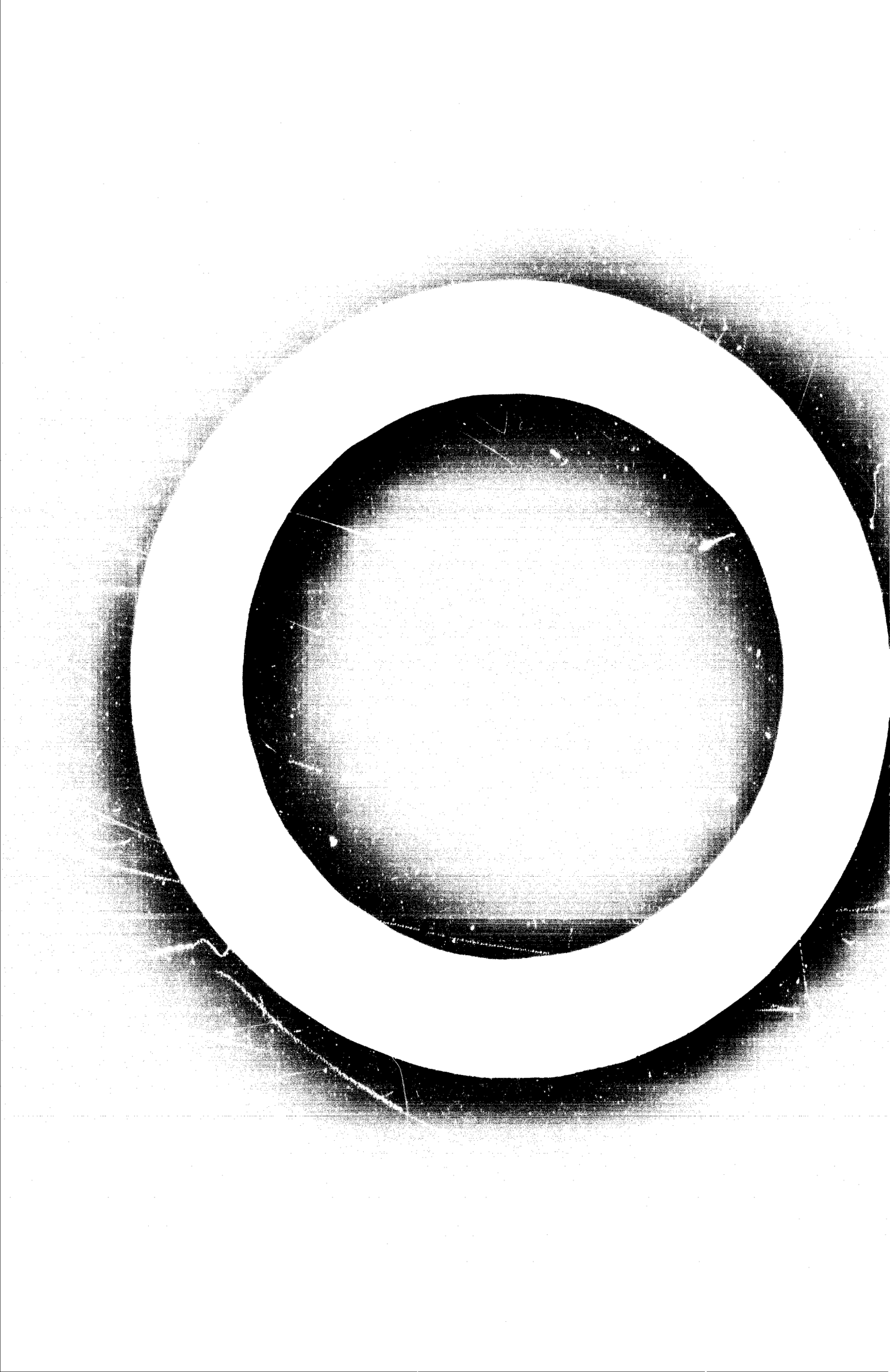
In Product B, the requirements are the same except that no specification is possible for the development of off-flavour.

i) Bacteriology: Product A should be free of E.coli, salmonella, and pathogenic anaerobes, and have a total bacterial plate count of not more than 2000 per gramme.

For Product B, the same requirements should also apply for E.coli, Salmonella, and pathogenic anaerobes. The Working Party were unable to agree on a desirable upper limit for total bacterial plate count, but felt that by proper attention to processing it could be kept considerably below that normally found in fish meal for animal feeding stuffs.

j) Safety: No additives, preservatives or solvent residues should be present in Product A. Safety tests on at least one species of animal should be done according to the requirements of the appropriate official agency of the country where the product is to be used.

Product B should contain no solvent residues and no substances such as anti-oxidants, colouring matters or falvourings should be added unless permitted by the consuming country. Safety tests with animals are required as with Product A.



ANNEX B

TENTATIVE GUIDELINES FOR FISH PROTEIN CONCENTRATE FOR HUMAN CONSUMPTION

I. Product Description

1. Definition

Fish protein concentrate (FPC) are products prepared from whole fish or parts thereof which have been processed using sanitary food processing practices to increase the protein content beyond the normal level of the raw fish, declared on a dry-weight basis.

2. Types of fish protein concentrates

a) Type A - an inodorless, tasteless and odorless product, white to light yellow or light grey in colour.

b) Type B - a bland, partially defatted and partly deodourised product yellow or greyish in colour.

II. Guidelines for Processing in Storage

1. Raw material - FPC may be produced from any fish species or parts thereof fit for human consumption. The quality of the raw material and the handling practices should be equivalent to those used for fresh fish for human consumption.[1/]

Before processing the fish may be preserved whole or in ground form by means of temperature, chilling, freezing or by immersion in the solvent used for extraction. Fish for processing into FPC should contain no toxic material.

2. Processing - FPC may be prepared by extracting water and lipids from the fish material in a continuous, semi-continuous or batch operation and carried out under sanitary food processing practices proposed by the Joint Committee on Food Hygiene.[2/]

3. Packaging - Any food packaging materials which guarantee protection of the raw FPC against the effects of air, moisture and light as well as against insect damage can be used.

4. Storage - The storage conditions should be such that direct effect of heat is avoided and controls are adequate to prevent infestation, rodent attack and contamination of the product.

1/ "The Code of Practice for Fresh Fish" FAO Fishery Report No. 74, Rome, 1969 could be used for guidance.

2/ Joint FAO/WHO Food Standards Programme - General Principles of Food Hygiene, CAC/LCP 1 - Rome, 1969.

III. Quality Guidelines for finished products

1. Proximate Composition:

	Type A	Type B	Method of Analysis
Moisture	not more than [illegible] %	not more than 10 %	AOAC, 10 ed. - 18.006
Lipids	not more than [illegible] %	not more than 5 %	AOAC, 10 ed. - 22.037
Protein	not less than 75 %	not less than 75 %	AOAC, 10 ed. - 2.04
Total ash	not more than 15 %	not more than 15 %	AOAC, 10 ed. - 18.008
Ash (acid insoluble)	not more than [illegible] %	not more than 3.5 %	AOAC, 10 ed. - 12.007
Fluorine (as F)	not more than [illegible] ppm	not more than 100 ppm	AOAC, 10 ed. - 24.029
2. Available lysine	not less than 4.5 % of protein		K.J. Carpenter (1960) Biochem. J. 77.604

3. Solvent residues

		Method of Analysis
Isopropyl alcohol	not more than 250 ppm	to be determined
Ethylene dichloride	not more than 5 ppm	to be determined
Ethanol	to be determined	to be determined
Hexane	to be determined	to be determined
Others	to be determined	to be determined

4. Organoleptic characteristics

a) Type A shall not have more than a faint odour and taste when moistened with boiling water in a closed container;

b) Type B - no specification can be established for Type B since these products will have a wide range of odours and flavours.

5. Stability

a) Type A - shall show no spoilage or adverse changes as judged by the development of flavours and odours or by deterioration in protein quality when stored in a moisture vapour proof packaging material for 6 months at 40°C (104°F).

b) Type B shall show no deterioration of the protein quality when stored in a moisture vapour proof packaging material for 6 months at 40°C (104°F).

6. Microbiological examination

The following tentative requirements are used by the Central Institute for Nutrition and Food Research, TNO, in examining the protein food mixture developed under the Joint FAO/UNESCO/UNICEF Protein Food Programme:

Groups of organisms	Tolerances	Literature
Total aerobic count (including spores)	less than 10^3/g	B. Ribbinder et al. (1953) Amer. J. Publ. Health 43, 26)
Total anaerobic count	less than 10^4/g	Mossel and Peerons (1965) Ann. Inst. Pasteur Lille, 16,147
Mould spores	less than 10/g	Mossel et al. (1962) Labor. Pract., 11,109
Yeasts	less than 10/g	Idem
Differential enterobacteriogramme		
Enterobacteriaceae	absent in 10 g	Mossel et al. (1963) J. Appl. Bacteriol., 26, 444
E. coli	absent in 10 g	MacKenzie et al. (1948) J. Gen. Microbiol., 2, 197
Salmonella	absent in 20 g	Hobbs (1963) Ann. Inst. Pasteur 104, 621
Sulphite-reducing Clostridia	less than 10^2/g	To be decided
Clostridium perfringens	less than 10^2/g	To be decided
Lancefield group D streptococci	less than 10^2/g	To be decided
Staphylococcus aureus	absent in 10 g	Giolitti and Cantoni (1966) J. Appl. Bacteriol., 29, 399
Bacillus cereus	less than 10^2/g	To be decided

7. Safety

No food additives other than those cleared by the Joint FAO/WHO Expert Committee on Food Additives should be used.

No solvents except those listed above (item 2) should be used and their residues should be within the limits established.

Toxicological aspects should ... to the PAG Document...