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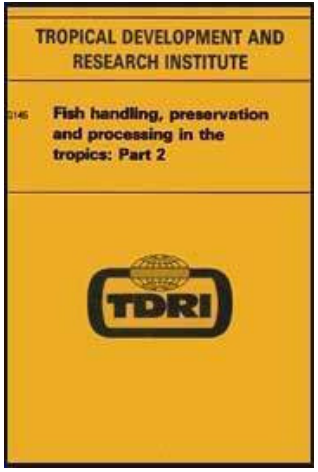


Fish Handling, Preservation and Processing in the Tropics: Part 2 (NRI)

Organoleptic (sensory) measurement of spoilage

Quality assessment methods

The food manufacturer has to produce a product at a quality which will satisfy:

(a) the customer
and
(b) statutory food legislation.

Much has been written on the analytical techniques developed to establish the nutritional and chemical composition of foods to ensure their compliance with food law, and it is not proposed to explore this area in this lecture.

In many ways, the quality requirements of the customer are more difficult to satisfy since the customer assesses the quality of a product entirely by subjective means, i.e. by sensory evaluation of a food's

appearance, colour, odour, taste and texture, plus the visual appeal of its packaging and presentation.

Hence, it is the responsibility of the manufacturer to develop methods which can, as accurately as possible, evaluate the sensory properties of a food which the customer finds important. This will often mean using subjective methods of testing such as sensory (taste panel) methods or, in some cases, it may be possible to use objective methods.

However, it must be remembered that objective measurements of food quality are preferable only if the objective tests can provide a precise measure of the subjective quality being considered.

Sensory methods

A sensory method is one in which subjective measurements are made by individuals. Numerical scoring systems may be developed for such methods, or methods of ranking, or results may be expressed simply in attribute form, e.g. pass/fail, acceptable/defective.

Objective methods

An objective method uses a calibrated scientific instrument to measure a specific quality parameter usually on a numerical scale.

Problems of assessing fish quality

1. Many hundreds of species are sold throughout the world, all with distinct physical, chemical and sensory characteristics.

2. Fish, alone among the major items of food, are susceptible to virtually no control before harvesting or slaughtering. In addition, they are one of the most perishable items of food eaten.

3. Fish freshness/spoilage may be investigated objectively by assessment based on, for example:

(a) Physical changes, e.g., measurement of conductivity using the Torrymeter.

(b) Chemical and biochemical tests, e.g.

- tests dependent on bacterial action such as estimation of trimethylamine (TMA);
- tests dependent on autolytic action such as enzymic assays of

nucleotide breakdown products, e.g., hypoxanthine;
- tests dependent on fat oxidation, such as peroxide value estimation.

(c) Bacteriological changes, e.g., counting and identification of various micro organisms.

However, none of these methods produces results which may be regarded as providing a precise measure of consumer acceptability. Therefore, any system adopted to measure the quality of fish must, at some stage, be related to consumer acceptance. This must involve sensory ('taste') panels and consumer research. in the following sections, it is planned to consider the problems and methods of establishing a taste panel and assessment of results.

Classification of sensory characteristics

Sensory appreciation of food quality may be divided into the following categories:

1. Appearance and colour;
2. Odour and taste;
3. Texture.

The above three categories cannot be treated in isolation since sensory evaluation is often a combination of several overlapping factors, e.g., 'flavour' includes elements of odour, taste, texture and even the psychological effect of colour.

Taste panels

Aims

Taste panel techniques may be used in many different ways:

1. To characterise sensory changes in foodstuffs, e.g., changes that occur during spoilage or changes brought about by processing methods such as freezing or dehydration.

2. To distinguish (often with the hope of failure) between batches or samples of a particular foodstuff.

3. To ascertain whether 'qualify' can be represented by a simple numerical index or whether it is multidimensional.

4. To help establish standards, in some defined area, of raw or unprocessed food products.

5. To grade products according to some agreed quality classification system.

6. To help establish a usable relation between sensory data and consumer acceptability.

Methods to achieve the above aims roughly divide into two categories:

(a) Product rating
Grading on some agreed numerical or descriptive/hedonic scale is carried out by a small panel of well-trained judges.

(b) Difference testing
Usually done by a panel of sensitive judges, without any great expertise or elaborate training.

Panel selection and training

Prospective taste panel members must be in sound health, self-motivated and of even temperament. They should first be screened for primary taste sensitivity and reliability. Members should be consistently able to detect and recognise the following levels of the

four primary taste components:

Sweetness	- 1.5 per cent sucrose
Saltiness	- 0.15 per cent sodium chloride
Sourness	- 0.06 per cent citric acid
Bitterness	- 0.005 per cent quinine sulphate

Many individuals will be able to detect levels considerably lower than these values. It is also important to remember that initial detection of a component (say differentiation from water) is likely to occur at a lower concentration than recognition of the primary taste concerned.

If evaluation of odour is a major part of the sensory test then prospective judges must also be able to demonstrate a good 'odour memory'. On a general level, it is wise to find out how well the candidates will perform on an odour recognition test carried out with stoppered bottles of some of the commoner chemical smells such as acetic acid, ammonia, amyl acetate, aniseed, benzaldehyde, linseed oil, menthol, peppermint, vanillin etc.

Finally, prospective members should be able to display discriminatory skill with different qualities of the foodstuff under test. Discriminatory

skill need not be general, e.g. a good wine taster may not be a good judge of teas or fish.

Having chosen members for the 'taste panel', a preliminary training period should be carried out, designed to acquaint the tasters with the quality factors involved in the fish product under test. The group should be asked to evaluate a selection of fish of the same type, at different stages in deterioration, from fresh to wholly unacceptable.

Tasting room

Control of environmental factors is universally recognised as being of value in sensory work with foods. Thus, a special 'taste panel' room where as many variables as possible can be controlled is highly recommended.

For maximum privacy and concentration, the use of screened tasting booths is recommended.
Although natural or white fluorescent lighting should be used where possible, a coloured light facility should be made available to disguise any minor colour differences between samples that may occur on occasion and which would otherwise distract the taster.

All possible sources of extraneous odour should be excluded, e.g. samples should be prepared in a separate room to eliminate cooking odours. Beware also of odours from detergents, floor polishes and other cleaning compounds.

Preparation of samples

The cooking method selected should not add any extraneous flavour to the food, e.g. frying is a poor method, but all sample flavour should be retained where possible, e.g. for fish, steaming "casserole) is recommended.

All samples should be presented at the same temperature.

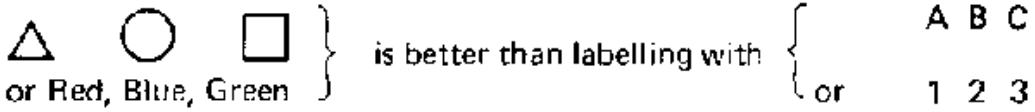
In 'difference testing', the difficulty of presenting a 'standard reference sample' is acknowledged since: (a) any standard will deteriorate with time and (b) any standard will be quickly used.

Many workers use a standard control taken from a frozen stock of acceptable material.

Bias

In order to neutralise errors associated with the order of presentation of samples, the order in which items are presented should be balanced between the possible alternatives, e.g. in a triangular test:

AAB	ABA	BAA
ABB	BAB	BBA



Samples should also be labelled in such a way as to eliminate any subconscious bias in the taster. For example, labelling samples with

Fatigue

The maximum number of samples which can be reasonably assessed in one session will vary depending on the nature of the product. In general, fewer strongly tasting foods may be tested in one session than more bland products.

In order to avoid transfer ('carry-over') of flavour from one sample to the next, a warm water rinse between samples is recommended.

(Some authors also recommend the use of white bread, unsalted biscuits, apple, lemon juice etc.).

Some commonly used test designs
(a) Methods of product rating

The sensory panel should consist of 4 to 6 individuals, who have undergone a period of intensive training both with the product under test and with the procedures being used.

Ranking

Ranking tests require that judges arrange a series of two or more samples in an ascending or descending order of intensity of a specific characteristic. Samples may be ranked in order of degree of acceptability, or in order of general quality, or by specific attributes of colour, texture or flavour intensity.

Grading

The panel is asked to grade samples according to some agreed numerical or descriptive hedonic scale.

Numerical scoring systems: Freshness, or degree of spoilage, may be assessed in a raw fish from:

(i) the general appearance of the fish including that of the eyes, surface slime, and texture of the flesh and
(ii) the odour of the gills and belly cavity.

In addition, marks may also be awarded for cooked fish odour, texture and flavour.

Various numerical scoring systems have been devised to cover some or all of the above sensory parameters. The most intensive investigation of this type of sensory evaluation has been that of Shewan and co-workers, who have devised detailed descriptive schemes in which numerical scores are given to:

(i) Raw fish - appearance, odour and texture;
(ii) Cooked fish - flavour, odour and texture.

Such schemes have been devised for cod, haddock, whiting and redfish, and similar schemes have been developed for various other species.

Generally speaking, the full Shewan's scheme is probably too complex for regular commercial use although abbreviated versions may prove useful for routine quality grading.

Hedonic seales: For example,

Excellent	Good	Average	Poor	Bad
Like	Like	Neither like	Dislike	Dislike
definitely	slightly	nor dislike	slightly	definitely

For a scoring or grading system to be effective certain prerequisites must be met:

1. With numerical scoring systems, quality factors must be properly 'weighted' to reflect their relative importance.

2. The scale should be such that a difference in score reflects a reproducible variation in the quality factor being scored, i.e. scale not too large with too many elements.

3. Agreement is necessary between judges as to quality relating to specific scores given.

4. Whenever possible, physical and chemical analysis of the commodity should be carried out to supplement sensory evaluation.

(b) Methods of difference testing

The panel should consist of 10 to 20 individuals with, ideally, 3 or 4 replications per judge per 'difference test'.

The panel do not require any intensive training as long as members are reasonably motivated and have passed the sensitivity requirements.

The three most commonly used test designs are the pair comparison, duo-trio test and the triangular test.

Pair comparison involves simultaneous presentation of one coded sample each of material A and B with the question: -

'Which is the……er of the two?' or
'Which is the regular sample?'

In the Duo-trio test, three samples, two of A with one of B, or one of A with two of B, are presented. One of the duplicates is coded, say, S

and the other samples are coded, say, 1 and 2 and the question asked is 'either 1 or 2 is identical with S; which is it?'

In the Triangular test, three coded samples are presented, of which two are identical and one is different but, this time, the question is 'which one is the odd sample?'

Statistical calculations can be carried out to establish whether the number of 'correct' answers obtained is sufficient to demonstrate a significant difference in the flavour of the 'odd' sample.

Conclusions

The introduction of sensory panel evaluation of fish quality requires research, good organisation and proper training.

An established visual and organoleptic scale is probably one of the easiest and least expensive ways of evaluating fish spoilage. It has the advantage of meaning something to the fisherman, the fish seller and the consumer. Its main disadvantage is that it is often open to discussion and disagreement.

Each country should develop its own standards under its own

conditions. Consumer acceptability must always be the criterion on which to base methods. If fish products are for export, retraining of taste panel personnel and review of quality methods may be necessary to meet new market requirements.

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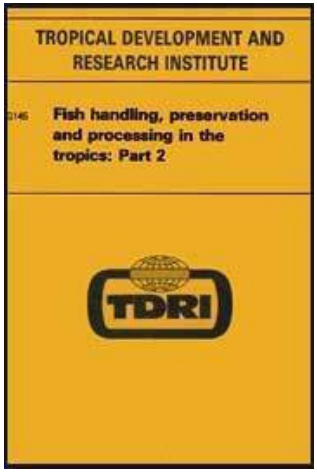

- Drying of fish: basic principles
- Drying of fish: methods
- Smoking of fish
- Marinades
- Fermented fish products: a review
- Boiled fish products
- Fish canning: theory and practice
- Freeze drying
- Irradiation
- Miscellaneous products: crustaceans
- Miscellaneous aquatic products used as food
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- New and delicatessen products
- Fish meal
- Fish silage

- Chemical and physical methods of quality assessment
- Organoleptic (sensory) measurement of

Microbiology of spoilage

Morphology, structure and growth of bacteria

Morphology

With a few exceptions, bacteria come in two types: cocci, which are spherical, and rods, which are cylindrical. Cocci are 0.5 - 1µ in

diameter; rods are 0.3 - 1 μ in diameter and 1 - 10μ in length. 1 μ is 1/1000 mm. The size of cells can be measured directly by microscopic observation or by the ability of cells to pass through a filter with pores of known size.

The normal method of reproduction in bacteria is binary fission in which a single cell divides into two identical daughter cells. It is often found that the cells do not separate after division and the mass of cells that results adopt characteristic patterns. If the planes of division are random the pattern will resemble a bunch of grapes and is called staphylococci; divisions in the same plane will result in a chain called streptococci.

Rod shaped cells can be regular cylinders or cigar shaped. They are sometimes found in chains but are more often as single units. Some cells contain a resistant spore which can be seen under the microscope; this will be discussed in more detail later.

When bacteria are cultured on a solid nutrient, the colony which is formed by the growing mass of cells is often of use in identifying the bacterium; the addition of reagents and indicators can modify the appearance of the colony and provide further information.

Structure

Microscopic examination of cells shows very little unless special staining techniques are used. This is because the cell contents have a refractive index which is similar to that of water which is the suspending medium. In order to make a stained preparation, the cells must be spread thinly on a glass slide and then fixed by gentle heating. Special dyes are then applied to the smear and, after a suitable time, the excess is washed away leaving a stained film of bacteria against a clear background. The dyes which are used differ according to the chemical nature of the structure under study.

The nucleus contains the deoxyribonucleic acid (DNA) of the cell and it is this which dictates the nature of the cell. In many cells, the nucleus is a diffuse structure and can only be seen clearly during cell division when it becomes thicker.

The ribosomes are the parts of the cell that translate the coded information in the DNA into proteins, which are used to build the cell, and enzymes, which control the biochemical processes which occur in the ceil.

The nucleus and the ribosomes are contained in the cytoplasm which

is bounded by the cytoplasmic membrane. The shape of the cell is governed by the presence of a rigid cell wall, which may be protected by a slime layer.

Some cells are motile and they achieve this by means of a whip-like flagellum. The flagellum arises from a basal granule in the cytoplasm and protrudes through the cell wall. The position of the flagellum, or the arrangement if there are more than one, is sometimes of use in identifying bacteria.

The resistant spores referred to earlier are produced as a means of surviving extremes in the environment. The spore is formed from only part of the cell but always includes the nucleus with its DNA. When conditions are once again favourable for growth the spore germinates and a new generation of cells is produced. The spore which is dormant is protected by a tough spore coat and by the fact that it has a very low water content. The position and size of a spore within the cell is often of diagnostic use.

The chemical composition of the cell determines the way in which it reacts to staining. In practice, the majority of cells fall into one of two types. The first worker to discover this was a Dane, Gram, and this effect is now called the Gram reaction in memory of him. He

discovered that, using a combination of dyes and decolourising solutions, cells would either stain blue or red. We now know that this effect is determined by the chemistry of the cell wall. The Gram reaction has proved to be a most valuable diagnostic tool.

Growth

When we talk about growth in bacterial terms, we usually refer to the increase in numbers of cells and not the enlargement of individual cells. It is a fairly simple procedure to count the numbers of cells in a liquid nutrient medium and, from this data, we can produce a growth curve for the population.

In most spoilage situations, there is a limited supply of nutrients and the growth curve under these conditions usually takes the form shown in Figure 15. For reasons that need not concern us here, the numbers of cells is plotted as the logarithm of the actual number counted against time.

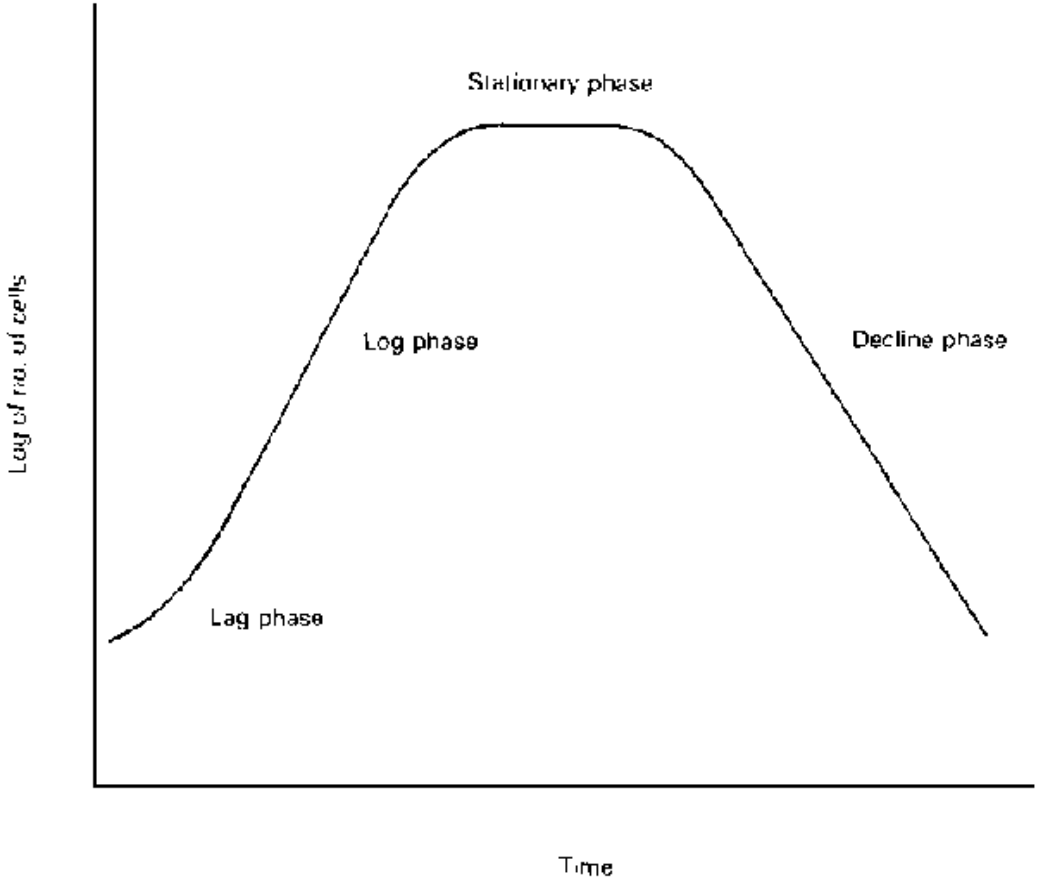

Figure 15 - Typical growth curve

At the start of the curve, the cells are adapting to the new environment and the rate of division is so slow that it does not keep pace with the number of cells which are dying. This tends to give a straight horizontal line or a slight downward curve. This is called the lag phase,

At the end of the lag phase, the cells begin to divide more rapidly and the total number of cells in the culture rises. At best, the cells will reproduce logarithmically which on our graph is shown by a straight line, the slope of which is a measure of the rate of growth. This is called the log phase.

After a time, the nutrients become exhausted and there may be a build up of toxic waste products. These and other factors lead to a reduction in the rate of cell division and a consequent flattening of the growth curve. At this point cell division and death are equal and this is called the stationary phase.

Following the stationary phase, the rate of division falls even more and there is an increase in cell death which leads to a logarithmic decline phase. Introduction of fresh nutrients, or the transfer of some cells to a new source of nutrient, will result in a repeat of the cycle.

From experiments of this type, it is possible to calculate the time taken for a newly formed cell to mature and reproduce itself: this is called the generation time. Different bacteria, and even the same bacteria under different conditions, have different generation times. Many preservation techniques control spoilage by inducing a prolongation of the generation time.

Microbial classification

Bacteria, like most living things, have been sorted into groups which have similarities. The distinguishing features are normally biochemical and morphological. The system as a whole need not concern us except to point out that in referring to a particular organism use is made of both the generic and specific names. Thus Staphylococcus aureus is usually abbreviated to S. aureus.

Yeasts and moulds

Yeasts are usually ellipsoidal and are about 6µ by 3µ in size. They reproduce by budding although some do divide in a manner similar to bacteria. Moulds consist of cylindrical filaments called hyphae which form a mass known as the mycelium. The hyphae may or may not have crosswalls. Moulds reproduce both sexually and asexually, in

both cases a spore (or spores) is formed which can germinate to form a new mycelium. Fragments of hyphae will also produce a new mycelium if the environment is suitable.

Yeasts are not important as far as seafoods are concerned but moulds, due to their ability to grow where water is limited, can be a problem on smoked or dried fish. Where water is abundant, the bacteria grow so much more rapidly that moulds are only of secondary importance.

Culturing bacteria

In order to study bacteria, or for that matter moulds, they must be separated from the sample and grown on an artificial food source. The composition of the growth medium must be optimal for the particular organism and this means that the exact requirements of each organism must be known. Fortunately, most of this work has been done for the commonly isolated organisms and we have only to prepare the medium as laid down in the standard texts on the subject.

The temperature at which the medium is incubated must suit the organism and there are three groups: psychrotrophs which grow at 0 - 5°C but have higher optimum temperatures; mesophiles which

favour temperatures between 10 and 45°C; and thermophiles which grow at 80°C. At chill temperatures, the psychrotrophs are important spoilage organisms whereas organisms of public health significance are almost always mesophiles.

When an organism is growing on a suitable medium, it becomes easy to test its various biochemical properties and study the shape and size of the colonies. The ability to ferment certain sugars or utilise unusual carbon or nitrogen sources can be determined and is useful in identifying unknown cultures.

Bacteria may be grown in tubes of liquid media, or on slopes or plates of media solidified with agar. Cotton wool plugs are the traditional method of sealing tubes and bottles of media but screw caps have the advantage that there is a reduction in evaporation which means that media have a longer shelf life.


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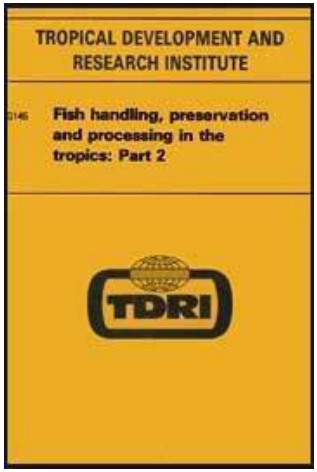

Microbiology of fish spoilage

Post-mortem bacterial growth

As soon as a fish dies, a series of changes starts to take place which is collectively known as spoilage. The degradation of the tissue is brought about both by indigenous fish enzymes and by micro-organisms which are present on the surface of the skin, on the gills and in the intestines. The chemical and autolytic changes that take place are the subject of another lecture and will not be dealt with here.

Where do bacteria come from?

It is a fact that newly caught healthy fish have sterile tissues and that bacteria can only be found on the skin, gills and in the intestines. Whilst still alive, the fish and the bacteria exist in a state of equilibrium and it is only after death that the bacteria can invade the tissues and spoil the fish. Invasion of the muscle from the gut is, of course, made easier by the autolysis brought about by the gut enzymes. The numbers of bacteria in the gut are highest when the fish has recently been feeding. It is reasonable to assume that fish caught in polluted waters will be more heavily contaminated than fish from

clean areas, and the literature on the subject bears this out. The situation changes when we consider the fate of the fish once it is caught: it will be contaminated to some extent by all the materials with which it comes into contact, e.g., ice, fish boxes, the boat itself and even the crew.

What do they do?

The bacteria grow using the fish as a food source and producing various waste products which accumulate and produce off-odours and bad flavours. It is well known that trimethylamine oxide can be reduced by bacteria to give trimethylamine which imparts an off-odour to the fish. Other bacterial by-products are ammonia and hydrogen sulphide, both of which have objectionable smells. In the quest for nutrients, bacteria make use of the simplest compounds first and intact proteins may only be used when they have been broken down by autolytic enzymes.

The result of the activities of bacteria, coupled with the autolytic changes, is fish which are organoleptically, and often visually, spoiled. In some cases, the production of bacterial waste products may be such that fish become inedible before the tissue is visibly damaged.

Methods of controlling spoilage

The lecture on the fundamentals of microbiology has provided us with some hints as to the methods to be used for controlling spoilage. The technology of preservation will be dealt with elsewhere and we will only by considering how the techniques affect the bacteria themselves. Even under ideal conditions, fish will only keep for a defined period with the possible exception of canned fish; the purpose of preservation is to make the storage life of the product suitably long whilst not adding too much to the selling price.

You will recall that we have discussed generation times of bacteria in the first lecture on microbiology. An increase in the generation time will mean that the time scale of the typical growth curve will be lengthened. This can be achieved in a number of ways, the first of which is to lower the temperature of the environment. It is of little consequence to the cells how the cooling is effected: it is the temperature which is important assuming that there are no other factors at work such as dehydration (often found in refrigerators).

The lowering of the temperature means that the enzymes in the cell cannot function at their optima and, since the metabolism of the whole cell relies on enzymes, the cells are slow to grow and divide.

The effectiveness of a particular temperature in preserving a food will depend on a number of factors as follows:

(a) What proportion of the flora is psychrotrophic (i.e., able to grow at low temperatures).
(b) The growth rate of the organisms at the given temperature.
(c) The previous treatment given to the food.

The last factor requires a little explanation. If a food is heated to a temperature which is sufficient to kill all vegetative cells but not the resistant spores of Bacillus spp. or Clostridium spp., then storage in the refrigerator can be quite lengthy since the spores will not germinate unless the temperature rises into the normal mesophilic range. It is difficult to be precise about this since the conditions, as well as the particular organism, will influence the temperature at which germination takes place.

If the temperature is taken to below freezing, the situation is a little different. In most cases, growth is completely stopped and the change in state of the water may well kill a large proportion of the cells. Death can be attributed to many factors including mechanical damage, dehydration, concentration in cellular solution, cold shock and metabolic injury. The fact that the last mentioned of these factors

does occur is demonstrated by the exacting nutritional needs of cells recovered from frozen foods.

For some time, it has been known that fish from tropical waters can be stored for longer in ice than fish from temperate waters. This is due, in some measure, to the tropical flora being unable to adjust rapidly to the large drop in temperature upon the addition of ice: a drop of the order of 30°C. In temperate waters, the corresponding drop may be only a few degrees Centigrade.

The growth of bacteria can also be arrested by shifting the pH of the environment so that the cells' enzymes are again not able to function at their optima. This is what occurs in pickles and marinades. Many spoilage organisms find the low pH so hostile that they die during storage. Spoilage of pickled foods is usually the result of mould growth, the mycelium being visible on the surface of the liquid. The growth of mould may bring about a rise in the pH of the pickle and this will enable yeasts and perhaps specialised bacteria to grow. The following table shows the pH minima and maxima of a few common organisms:

Organism	Minimum pH	Maximum pH
Escherichia coli	4.4	9.0

Escherichia coli	4.4	9.0
Salmonella typhi	4.5	8.0
Streptococcus lactis	4.3 - 4.8	-
Lactobacillus spp.	3.8 - 4.4	7.2
Moulds	1.5 - 2.0	11.0
Yeasts	2.5	8.0 - 8.5

It will be obvious that since the pH of fish tissue will be 5.6 or more, almost any micro-organism can grow on and spoil it. Some bacteria, particularly Lactobacillus spp., have the ability to reduce the pH to a level where the normal spoilage flora is inhibited, the usual mechanism being the production of lactic acid from the carbohydrate in the substrate or food. Many of the traditional fermented foods of South East Asia owe their long shelf life to such a mechanism as this. Unfortunately, there is not much information on the exact nature of these products or the organisms which are responsible for the preservative effect.

All the reactions which take place in the cell require an aqueous environment for their proper functioning. Thus, reducing the amount of available water in the foodstuff will bring about a slowing, or complete cessation, of bacterial growth. Water content is usually

recorded as percentage moisture but, in bacterial terms, it is the free water which is important. Microbiologists measure water content as water activity (aw), which is derived from the following formula:

Equilibrium relative humidity = 100 aw

Here is a table showing the minimum aw at which different groups of microorganisms can grow:

Organisms	**aw**
Most spoilage bacteria	0.91
Most spoilage yeasts	0.88
Most spoilage moulds	0.80
Halophilic bacteria	0.75
Xerophilic moulds	0.65
Osmophilic moulds	0.60

The water activity of a food can be lowered by removal of water or the addition of a solute which makes the water no longer available to the cells. Sodium chloride is such a solute; the aw obtained for different concentrations of salt are given in the table below:

Per cent salt w/v	aw
0.9	0.995
1.7	0.99
3.5	0.98
7.0	0.96
10.0	0.94
13.0	0.92
16.0	0.90
19.0	0.88
22.0	0.86

It is obvious that although a 22 per cent salt solution is too salty for the average palate, it still does not give complete control of spoilage organisms, especially moulds and halophilic bacteria. In order to provide the best protection to the food, it is usual to remove some of the water and add salt. The removal of water can be by the direct application of heat but a more interesting technique is the smoking of foods.

Tests for assessing microbial spoilage

All the operations involved in these tests must be carried out in such a way that there is no contamination of the sample by the technician; this is known as aseptic technique. The sample is weighed out into a sterile bottle from which it is transferred to a blender and homogenised with 450 cm³ of sterile diluent. The resulting suspension is returned to the bottle. One cm³ of this suspension is pipetted into each of two petri dishes and 1 cm³ is transferred to a bottle containing 9 cm³ of diluent. Two more petri dishes are inoculated in a similar fashion from this bottle; this process is repeated until a suitable dilution has been reached. About 20 cm³ of nutrient agar, cooled to 45°C, is poured into each dish and after mixing with the sample the agar is allowed to set. The prepared plates are placed in an incubator for a defined period at a set temperature. After incubation, the plates are examined; those for the dilution which has between 30 and 300 colonies growing are counted. By multiplying by the dilution factor, the actual count for the sample can be calculated.


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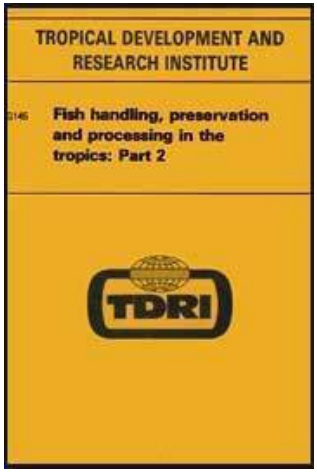

- Food by-products
- Non-food by-products
- New and delicatessen products
- Fish meal
- Fish silage
- Chemical and physical methods of quality assessment
- Organoleptic (sensory) measurement of spoilage
- Microbiology of spoilage
- Microbiology of fish spoilage
- Public health microbiology
- International standards for fisheries products
- Large-scale fish landing facilities
- Small-scale landing facilities: design and operation
- Retail sale facilities
- Fisheries extension services: their role in rural development

Training in the field Appendix

Public health microbiology

Organisms which cause infection in man

The field of microbes and their activities is a vast one including everything from the useful to the downright dangerous. These notes are intended to provide basic information on those organisms which cause intoxication and infection in man and are either water or food borne.

Staphylococcus aureus

Staphylococcus aureus is a spherical shaped cell which tends to occur in clusters resembling bunches of grapes. It can cause infections in man and is often found in the nose, throat, skin, and in septic lesions. Symptomless carriers are often found. The most important factor of this organism is its ability to produce a heat-stable enterotoxin which, when ingested, gives rise to nausea, cramps and diarrhoea. The incubation period between ingestion and illness is usually 2 - 4 hours. The organism is normally transmitted to the food from the hands of

food handlers and, if the food is kept warm for some time, growth occurs and toxin is produced. The addition of preservatives or low temperature storage will prevent growth, as will adverse pH or lowered water content. Once the toxin has been formed, it is very difficult to destroy and often survives treatments which kill the causative organism.

Salmonella spp.

Salmonella spp. form a large group of cylindrical shaped organisms which is commonly associated with the intestinal tracts of warm-blooded animals. Although this is their principal habitat, they are capable of prolific growth on a wide variety of foodstuffs. As with Staphylococcus aureus, symptomless carriers do occur but at much lower rates. The organisms are passed in the faeces and are transmitted thence to the food. Salmonella produces infections in man and there is no toxin production in food; this means that sufficient cells (the minimum infective dose) must be ingested in a living state to cause disease. Following contamination of a food there must, therefore, be a period during which growth can occur followed by ingestion; if there is any form of cooking, then the Salmonella will probably be killed and the food will be rendered safe. The heat-

resistance of Salmonella is, except for a few strains, low and pasteurisation is normally adequate to eliminate them. The symptoms of salmonellosis are fever, abdominal pain, diarrhoea, prostration and frequent vomiting. The symptoms usually occur between 12 and 24 hours after ingestion but can occur between 6 and 48 hours. The illness may last for & days or even longer. During the period of the illness, and for some time afterwards, the patient will be passing Salmonella in the faeces and for this reason should not be allowed to handle food until he is fully recovered. Control of this organism in the factory is effected by the exclusion of carriers and an insistence that all staff wash their hands before entering a food handling area.

Clostridium perfringens (welchii)

This organism is widely distributed in nature, it is a commonly found inhabitant of the bowels of man and many other animals, and its spores can persist in soil, dust and water for considerable periods. The cells are cylindrical and may contain a resistant spore. This organism is anaerobic and grows most rapidly when oxygen is absent or in low concentrations. When food is cooked, oxygen is driven off and, thus, if cooked food is kept warm for any length of time, the spores which may well have survived the cooking process will

germinate and growth will occur. if food in which C. perfringens has proliferated is eaten, the illness which usually develops within 10 - 12 hours is thought to be due to the release of a toxin within the intestine. The symptoms are abdominal pain, diarrhoea and prostration and they may last for 12 - 24 hours. Due to widespread distribution of this organism, it is difficult to ensure its absence from foods although normal procedures for hand washing and plant sanitation will help. The principle method of control must be to ensure that all cooked foods are stored at temperatures outside the normal growth range for the organism. For most practical purposes, the safe temperatures are below 10 or above 60°C, and food should only be at temperatures in between whilst being actively heated or cooled. Foods in which a preservative is incorporated or some other physical condition is growth limiting may be exempt from this requirement.

Clostridium botulinum

This is an organism which is in many respects similar to C. perfringens but differs in that, during growth on suitable substrates, an extremely potent toxin is released. The toxin, when ingested, attacks the nervous system causing paralysis and frequently causes death. Fortunately, the toxin is sensitive to heat and foods can be

rendered safe by boiling for a few minutes.

Spores of C. botulinum are widely distributed in nature and it is not uncommon to find them on raw materials. If it is accepted that there is a high probability that raw materials will be contaminated, then control measures must centre on the prevention of growth and subsequent elaboration of toxin. Except in the case of canned seafoods, there is little hope of destroying the spores by heat treatment and it is necessary to control growth by physical or chemical means. Commonly used methods are: refrigeration/freezing, drying, pickling, salting, and curing with nitrite. If, despite such precautions, toxin is produced and the food is consumed without further cooking, then the symptoms mentioned above will occur after approximately 6 hours but may be delayed for up to 24 hours and sometimes even longer. Death, if it occurs, will follow at the earliest at 24 hours but sometimes as late as one week after ingestion of the toxin.

Vibrio parahaemolyticus

This is an organism which is frequently found in seafoods and in coastal waters. The organism grows on the food, and ingestion of the living cells gives rise to the symptoms which are as follows:

abdominal pain, nausea, vomiting and diarrhoea. Symptoms may start within 2 hours but may be delayed for up to 48 hours. The illness usually lasts for 1 - 2 days. This organism does not produce resistant spores and can be easily destroyed by heat. For this reason, it is only a problem where seafood is consumed raw, e.g., in Japan. There is still a great deal to be discovered about the pathogenicity of this organism and its significance in seafoods which will be cooked before consumption. After initially over-reacting to the presence of V. parahaemolyticus, many importing countries now accept shipments containing the organism provided that they are raw products.

Vibrio cholerae

This organism is traditionally regarded as waterborne but the use of polluted water in a seafood processing plant can lead to contamination of the product. Mild forms of the disease do occur and there is a danger that personnel with mild diarrhoea may in fact be excreting cholera vibrios, which might be transferred to the food. This in itself is sufficient reason to exclude anyone suffering from a gastro-intestinal disturbance from the processing plant. The symptoms are similar to many of the other types of food poisoning but the passing of rice water stools is peculiar to cholera. The illness starts 1 - 5 days

after ingesting the contaminated food and may cause death due to loss of fluid and electrolyte depletion. V. cholerae is not heat resistant so that, like V. parahaemolyticus, it is destroyed by normal cooking procedures.

Bacillus cereus

This is a rod shaped organism which can form heat-resistant spores. It is common in many foods and in soil and produces two fairly distinct types of illness. The first, or classical, form resembles C. welchii poisoning, with an incubation period of 10 - 13 hours. The second form is more acute and resembles staphylococcal intoxication and has an incubation period of 1 - 5 hours. This suggests that, in the first form, there is some type of infective process taking place, whilst in the second form the symptoms are indicative of a straightforward intoxication. In either case, illness only develops when the food contains extremely large numbers of the organism (usually in excess of 10 million per gram). This fact means that effective control of the growth of B. cereus by means of temperature control, drying, salting etc. will greatly reduce the possibility of illness. Foods are most susceptible when they are cooked and then held in a warm state for protracted periods. Under these conditions, the spores which survive

cooking grow very rapidly and large numbers will be produced in a matter of hours.

Indicator organisms

The tests needed to ascertain the presence of the principal intestinal pathogens are very elaborate and, particularly in the case of water samples, it has been found to be more expedient to look for organisms which indicate that contamination with faecal material has taken place. Organisms used in this way include C. perfringens, Escherichia cold type I and Streptococcus faecalis, al I of which can be isolated from human faeces. From time to time, these organisms can cause diseases in their own right but their principal importance is in assessing plant hygiene. This is true of the coliform group in general and particularly of E. cold I with its association with faecal matter from humans and other warm blooded animals. It should not be assumed that the presence of the indicators is always associated with the presence of pathogens and, indeed, on some occasions, organisms such as Salmonella can be found when there are no indicator bacteria. Nevertheless, tests for these organisms do provide a fair indication of the hygienic state of the production facilities and the personal hygiene of the staff working in them.

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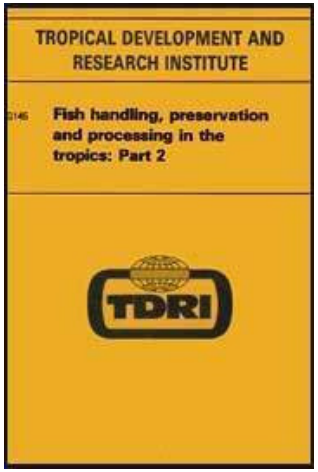

Fish Handling, Preservation and Processing in the Tropics: Part 2 (NRI)

International standards for fisheries products

Food laws

Food laws deal primarily with two areas of food quality:

1. SAFETY of food: the law protects the consumer's health, e.g., by ensuring that reasonable standards of hygiene are practised and that food additives and contaminants are controlled.

2. COMPOSITION of foods: the law protects the consumer against fraud, e.g., by preventing:

(a) the sale of adulterated, impure or low quality foods,
(b) the sale of food which is of short weight, and
(c) extravagant claims being made on labels or in advertisements.

The main concern of the law maker is, therefore, to produce laws for the safety, identification, compositional quality, labelling and advertising of foods, both to inform and protect the consumer and to sustain a fair basis for honest trading.

In addition to statutory food laws which are legally binding in the countries in which they are passed, various national and international standards and codes of practice exist which are predominantly voluntary or recommended.

An exporting company, therefore, needs to be aware of:

(a) The relevant national legislation of the consumer country to which the product is being exported.

(b) Any recommended international standards or codes of practice which may be applicable.

It must be emphasised that legislation is not usually simple and may vary significantly from one country to another. Legislation is never static: it is constantly being revised and updated in all countries of the world. It is, therefore, essential to obtain up-to-date information on any changes likely to affect product standards.

The objective of the following information is to be illustrative rather than comprehensive. Detailed regulations may be obtained from national Ministries and summaries are often compiled by relevant Food Research Associations.

Regarding international standards and codes of practice, most countries have a Codex Alimentarius Contact Point where information should be available.

International standards

The Codex Alimentarius Commission

The main international food standards organisation is the Codex Alimentarius Commission which was set up in 1962, under joint auspices of the two United Nations bodies:

(i) The Food and Agriculture Organization (FAO) and

(ii) The World Health Organization (WHO).

Membership of Codex is open to all countries who are members of either FAO or WHO but, in practice, only about 40 - 50 countries are

regularly represented at the Codex annual meetings.

Purpose of Codex

Its purpose is to develop international food standards which can be agreed and adopted on a world-wide, regional or group-of-countries basis. These food standards aim at protecting consumers' health and ensuring fair practices in the food trade. Their publication is intended to guide and promote the elaboration and establishment of definitions and requirements for foods, to assist in harmonisation of standards between countries and, in so doing, to facilitate international trade by removing technical barriers.

Scope of Codex

Ultimately, it is hoped to produce standards for all the principal foods, whether processed, semi-processed or raw. Codex documents also include provisions in respect of food hygiene, food additives, pesticide residues, contaminants, labelling and presentation, and methods of analysis and sampling.

The Commission has established various specialist committees to deal with separate areas. These are of two types:

1 Commodity committees	
e.g.	Fish and fish products (Norway)
	Fats and oils (United Kingdom)
	Meat and meat products (West Germany)
	Poultry and poultry meat (USA)
	etc.
2 General subject committees	
e.g.	Hygiene (USA)
	Labelling (Canada)
	Additives (Netherlands)
	Pesticide residues (Netherlands)
	Analysis and sampling (Hungary)
	General Principles (France)

The responsibility for running each committee and for piloting standards through the various stages is taken by the member government responsible for that particular committee (given in brackets above).

Codex procedure

Currently, many countries are collaborating in the drafting of comprehensive minimum standards for a wide range of fishery products. Almost all are for products meant for direct sale to the consumer. In order for a 'Recommended International Standard' to be agreed it must pass through a complicated 10-step procedure. Following various draft stages the final standard is eventually submitted to governments for their formal acceptance (step 9). The 'recommended standard' is then published as a Codex standard when the Commission determines that this is appropriate, in the light of the acceptances received (step 10). The assumption is that standards acceptable on a world-wide basis and published as Codex Alimentarius standards will be legally binding in those countries operating them. It has been possible to reach agreement on such matters as hygiene, contaminants and specifications for defects. However, there is still considerable disagreement on numerical methods for measuring staleness, chemical deterioration or microbiological contamination. Thus, for example, there are still no internationally agreed microbiological standards for fishery products.

Codex Recommended International Standards for Fishery Products

Recommended International Standards have been produced for, e.g.,
Canned shrimps or prawns
Canned Pacific salmon
Quick frozen gutted Pacific salmon
Quick frozen fillets of Ocean perch

A typical standard document will include the following:

1. Name of standard
Should be clear and concise, and should normally be the common name by which the commodity is known.

2. Scope
Should contain a clear statement as to the food or foods to which the standard is applicable.

3. Description
Should contain a definition of the product, with an indication of the raw materials, processing, types and styles, and form of pack.

4. Essential composition and quality factors
Should give detailed quality specifications of all controllable quality factors, with tolerances where appropriate, e.g., odour, flavour,

texture, size designation etc.

5. Food additives
Should give names of additives permitted and, where appropriate, maximum amounts permitted.

6. Contaminants
May highlight special problems. Should refer to WHO limits for contaminants.

7. Hygiene
The product should be prepared in accordance with the appropriate sections of the General Principles of Food Hygiene as recommended by the Codex Committee on Food Hygiene.

8. Weights and Measures
Should give minimum total fill and minimum drained weight.

9. Labelling
Should be in accordance with the 'Recommenced International General Standard for the Labelling of Prepackaged Foods'.

10. Methods of analysis and sampling

All methods should be endorsed by the Codex Committee on Analyses and Sampling.
Sampling is usually in accordance with the document 'The Sampling Plans for Prepackaged Foods (1969)'.

FAO Codes of Practice

In addition to the Codex Alimentarius Recommended International Standards for fishery products, a comprehensive and widely used set of Codes of Practice has been compiled by the Fisheries Products and Marketing branch of the FAO Department of Fisheries, advised by an ad hoc Consultation of international experts.

These voluntary codes are meant to provide technical guidance to manufacturers wishing to make products which meet Codex Alimentarius Standards.

Codes have been prepared for:

(i) Fresh fish (FAO Fisheries Circular 318)
(ii) Frozen fish (FAO Fisheries Circular 145)
(iii) Smoked fish (FAO Fisheries Circular 321)
(iv) Canned fishery products (FAO Fisheries Circular 315)

(v) Salted fish (FAO Fisheries Circular 336)

A typical code-of-practice document contains sections on:

(i) scope
(ii) definitions
(iii) raw material and ingredient requirements
(iv) handling and processing requirements at sea and on shore
(v) end-product specifications.

National standards

Governments of all countries recognise that they must assume ultimate responsibility for health. Thus, public health problems arising from the consumption of fish products are embraced by the national or local food laws; these are usually enforced by a team of official inspectors whose responsibilities, in addition to hygiene surveillance, may include ensuring absence of parasites, certain chemicals or pathogens in fish products.

Most governments also assume responsibility for ensuring the operation of fair trading practices which affect the fish industry, e.g., correct descriptions, labelling, weights and measures, etc.

There is still disagreement on use of certain additives in fish products, e.g.

- Traditional preservatives such as salt, vinegar and smoke compounds are usually permitted, but antibiotics such as tetracyclines may be banned.

- Colouring matters (from a permitted list) are often not permitted in raw or unprocessed fish but may be allowed in certain processed fish products. Different countries have different permitted lists.

- Use of polyphosphates is controlled by many countries and maximum limits are set.

- Use of permitted antioxidants in fatty fish may be allowed.

Canada

Canada probably has the most highly developed and extensive system of official inspection for fish products of any nation. On arrival at port, all types of fresh fish are graded into three freshness grades. A somewhat similar compulsory system is in operation for the canned salmon industry using a relevant grading scheme. Canada also has a

comprehensive set of mandatory standards for most commercial fish products. These are very detailed, usually with two acceptable grades, and are drawn up by the Fisheries and Marine Service (Department of the Environment).

USA

The Food and Drug Administration (FDA) is engaged in the formulation of processing standards, in the inspection of imported products and in the public health surveillance of processing establishments. USA product 'grade standards', using a three-grade system, have been drawn up for most of the 15 or so major frozen products sold by the National Marine Fisheries Service in conjunction with industry and other interested parties.

Japan

Mandatory inspection of chilled and frozen fish landed at Japanese ports from fishing vessels is carried out by highly trained officials employed by the Food Inspection Service. The aspects included are:

(i) checking for spoilage or contamination;
(ii) bacterial testing of raw shellfish;

(iii) ensuring that edible fish containing poisonous organs are identified and segregated;
(iv) ensuring that adequate sanitary conditions prevail.

Detailed mandatory standards issued by the Ministry of Agriculture are also in force in conjunction with compulsory inspection of exported canned and frozen products. The canned product standards are two-grade, while those for frozen products are minimum standards. Similar standards are used for products within the country.

Norway

Various regulations lay down the exact way in which the fish should be gutted, bled, washed, iced, stowed, dried, salted, frozen, cold stored and transported. In addition, compulsory standards of construction of vessels and premises, and of cleanliness, hygiene and sanitation are prescribed.

Detailed two-grade mandatory standards have been drawn up for approximately 15 canned products. They are used as the basis for inspection by the Quality Control Institute for Canned Fish Products.

European Community (EC) countries

(a) General

The arrangements for inspecting fish and fish products in the nine EC countries are very varied. Denmark probably has the most highly developed system of official inspection.

Inspection of chilled fish invariably occurs during laying out for auction at the main port markets. Inspection, carried out by public health or veterinary officials, is of three kinds:

(i) To ensure that fish unfit for human consumption is identified and discarded.

(ii) To ensure good general standards of preservation and sorting on fishing vessels and at point of first sale.

(iii) To supervise and control grading into defined categories of size and freshness.

A mandatory regulation controls the grading system at first sale of chilled fish. The fish must be sorted into three freshness grades and, depending on species, into several size grades. However, this scheme has still not been fully adopted at all ports and landing places.

Inspection for public health aspects of chilled, frozen or processed fish may also be carried out at ports of entry, in factories, at inland markets or at retail outlets.

The general aim of the Community is to harmonise legislation throughout the nine countries, so that legal barriers to the free movement of goods within the Community can be effectively removed. However, progress towards this ideal remains slow.

(b) United Kingdom

In the UK, the White Fish Authority and the Herring Industry Board have jointly published detailed minimum standards for a range of chilled and frozen products.

Various codes of practice have also been published jointly by the Ministry of Agriculture, Fisheries and Food and the Department of Health and Social Security relating to hygiene in the retail industry and in transport and handling of fish. These are complemented by the British Standards Institution's 'Recommendations on cleaning in the fish industry' (BS 4259/1968). The UK Association of Frozen Food Producers have also published a code giving recommendations for the handling, production, distribution and retailing of frozen food, much of which is relevant to the frozen fish industry.

UK legislation also covers minimum compositional standards for fish pastes, spreads and fish cake products, and controls the addition of colouring matters, preservatives and antioxidants.

The labelling of food regulations clearly define which species of fish can be used for a particular 'appropriate designation'.

Finally, the general provisions of the Food and Drugs Act offer general protection to the consumer concerning safety and composition of fish products while weights and measures is also thoroughly covered by legislation.

Conclusion

The increasing number of standards for fish products reflects a growing interest in, and movement towards, the standardisation of foods generally. If a company is to compete successfully in world markets it must increasingly be aware of national and international quality requirements.

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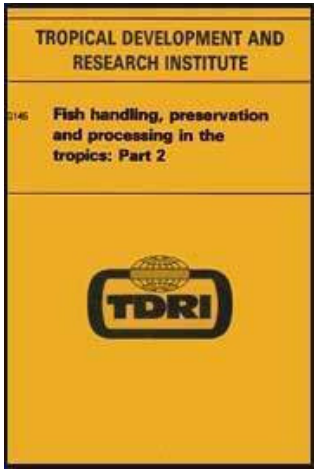


- Salting of fish: methods
- Drying of fish: basic principles
- Drying of fish: methods
- Smoking of fish
- Marinades
- Fermented fish products: a review
- Boiled fish products
- Fish canning: theory and practice
- Freeze drying
- Irradiation
- Miscellaneous products: crustaceans
- Miscellaneous aquatic products used as food
- Food by-products
- Non-food by-products
- New and delicatessen products

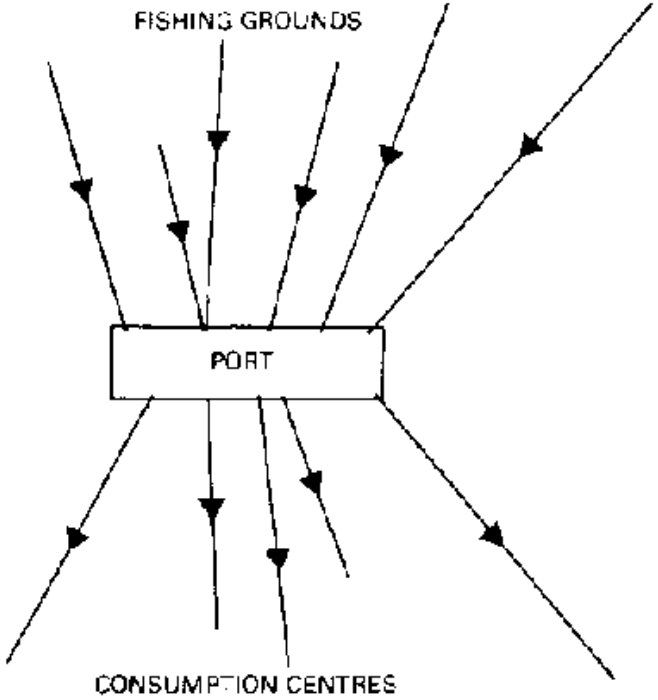
- Fish meal
- Fish silage
- Chemical and physical methods of quality assessment

Large-scale fish landing facilities

Suitability of site Unloading systems

Fish landings of all sizes tend to be by their very nature focal points of

the fishery industry. On the one hand, catching vessels from different fishing areas focus on the centre for landing their fish and for obtaining essential supplies and, on the other hand, traders, processors, marketeers etc. from different inland areas focus on the landing for their supplies of raw material (see Figures 16 and 17).



Source: Adapted from a drawing on page 76 of 'Fishing Ports and Markets'. Edited by G. Campleman, W. J. Guckian and P. J. Schjefte. Published by arrangement with the Food and Agriculture Organization of the United Nations (C) FAO (1970), by Fishing News (Books) Ltd., London.

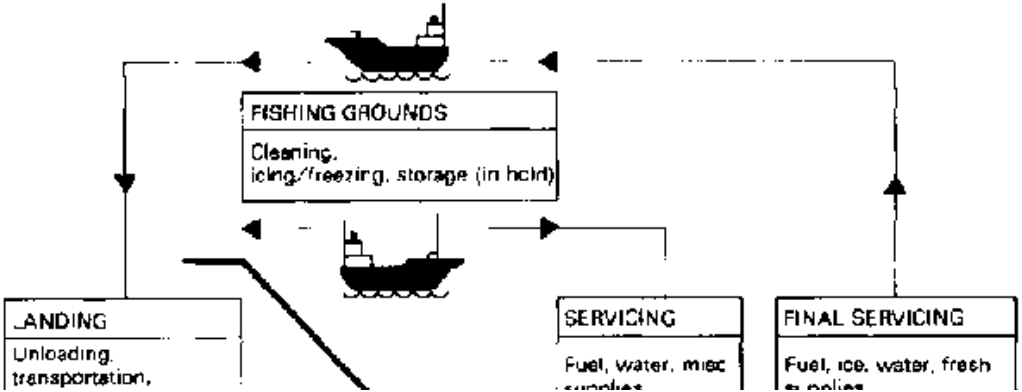
Figure 16 - Fishing grounds - consumption centres

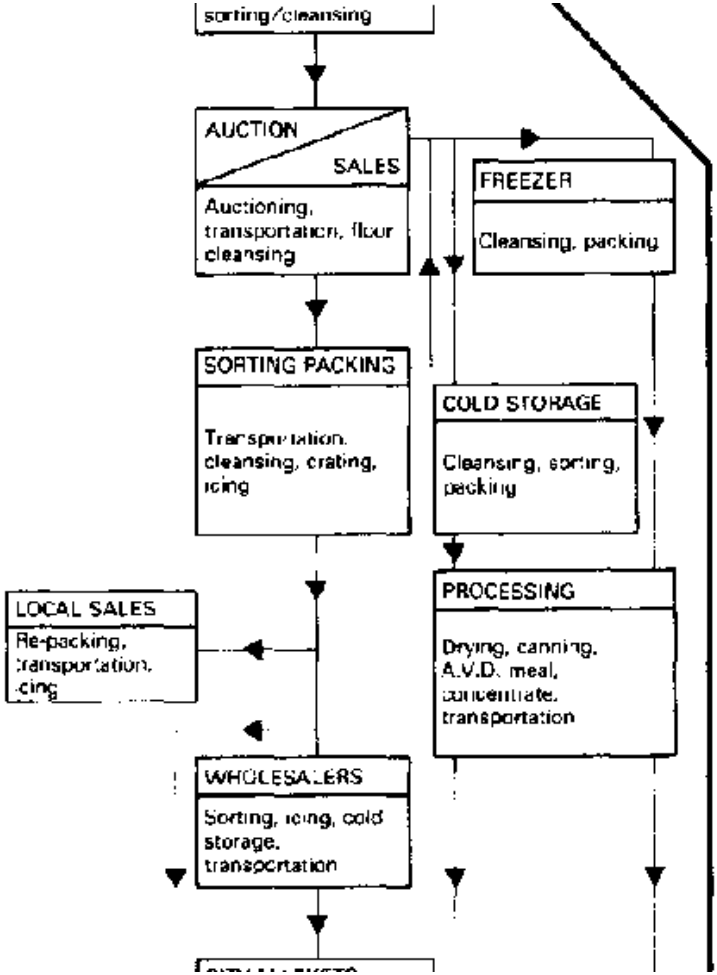
Suitability of site

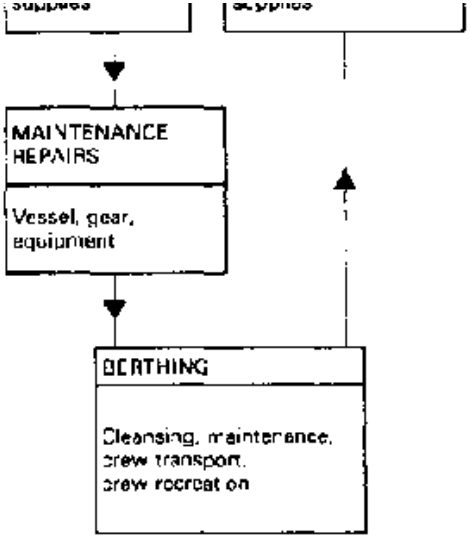
Due to the multiplicity of different functions that a fishing harbour, therefore, has to perform, it is extremely important that the site is selected with care. In many cases, the final decision as to the site for a new fishing harbour will be a political one but the technical requirements must be made clear at the planning stages. The following list of requirements gives some idea of the many factors which must be taken into account during the planning stages:

1. It must be at a convenient distance from the fishing grounds.

2. It must be in a convenient location with regard to existing or planned fish markets and must have good communication with such markets.

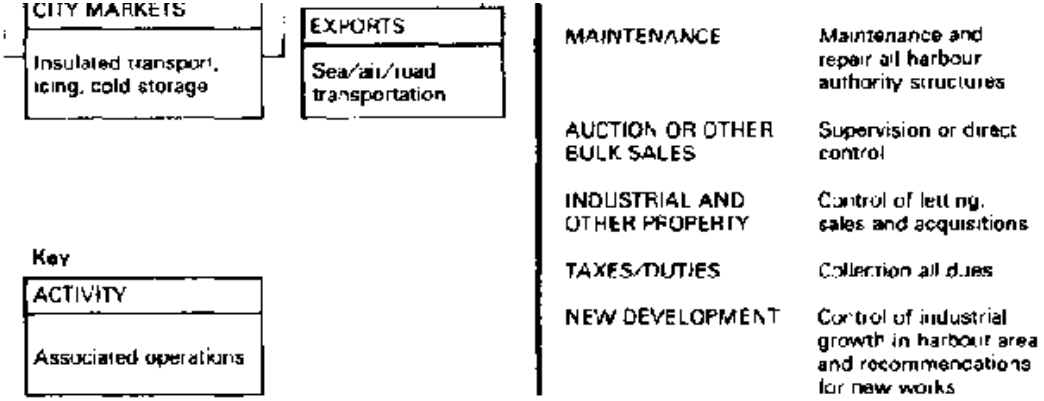






Harbour and fishery authorities activities

ACTIVITY	ASSOCIATED OPERATIONS
ADMINISTRATION	Control of operations
	Vessels and shore base
	Traffic control
	Sanitary supervision all harbour operations



Source: Redrawn from a drawing on page 41 of 'Fishing Ports and Markets'. Edited by G Campleman, W. J. Guckian and P. J. Schjelte. Published by arrangement with the Food and Agriculture Organization of the United Nations (C) FAO (1970), by Fishing News (Books) Ltd., London.

Figure 17 - The fishery harbour: chain of activities

3. There must be adequate and suitable space both on the sea and landward sides for development of an efficient fishing station. This should include areas for fish processing and auxiliary industries, shipbuilding and repair, offices, shops, space for the parking of lorries and cars etc.

4. It must be remembered that the fishing industry depends on people and there must be sufficient attractive residential accommodation for

fishermen, traders and workers in the fishing industry and their families.

5. There should be safe access from the open sea in all weathers and all states of tide.

6. The site should provide safe shelter for vessels likely to use it.

7. There must be adequate depth of water in the harbour and approaches for the sizes of vessel contemplated. This depth must be able to be obtained and maintained at reasonable cost.

8. There must be suitable ground conditions for building of harbour walls, quays, breakwaters etc., and for the land-based factories and infrastructure.

The suitability of a particular site depends on the type, size and number of fishing vessels; the type of fish to be caught and landed; the processing that may be done in the immediate vicinity of the harbour; the neighbouring communications network which may serve the site etc.

Once a site which meets the necessary requirements has been chosen,

then the actual facilities required must be detailed and the following points are worth considering:

(a) A safe and easily identified approach from the open sea with adequate depth at all tides should be marked.

(b) A safe well-defined entrance and approach channel of adequate depth at all tides should be constructed.

(c) There must be a sufficiently large, deep and protected basin to cater for all types of vessel. This must take into account turning and manoeuvring of vessels within the harbour area and anchorage of the vessels awaiting landing space. There should also be permanent anchorage for vessels unable to use the berthing quays, and also servicing facilities for dredgers and other maintenance vessels etc.

(d) There must be, within the complex, provision of all necessary navigational beacons and visual and electronic aids to assist vessels in the safe use of the port.

(e) Where necessary, protective breakwaters of adequate structural design and suitable layout should be provided to reduce wave or storm effects within the approach channel and port facilities.

(f) There must be adequate landing, servicing and provisioning, berthing and repair quays or jetties to cater for the number and types of vessels using, or likely to use, the facility in the foreseeable future. This particular point brings out the necessity for forward planning. A well-designed and adequate harbour facility will attract more fishing business. It is necessary to plan ahead to make sure that there are going to be adequate services for future expansion.

(9) All necessary utility services must be planned and provided: for instance, fuel oil loading points and storage; water, ice-making plants and ice storage for the supply of vessels and the shore-based activities; electricity supply for public, industrial and domestic use; surface water drainage and sewerage systems; fire precaution services for vessel and shore use.

(h) Consideration must be given to the buildings required for: display, auction and sales; sorting; agents' and wholesalers' activities; harbour and fishery administration offices; storage accommodation for containers, gear and equipment; workshops and maintenance stores; possibly, training centres and laboratories; wholesale and retail suppliers for ships supplies; sheds or other buildings for repair of nets and vessel maintenance at the berthing quays; storage for

repairing items such as ropes, nets, fish boxes, lobster pots; accommodation sheds for port transportation machines, for instance, fork-lift trucks, mobile cranes, tractors, waggons.

(i) There must be adequate space for the development of the necessary processing industries. It may be decided that public cold stores and freezing facilities are required from the start and these should be planned and built at the same time as the rest of the fishing harbour. If private industry is likely to need to build its own factories for fish processing, then there should be adequate areas made available for them at reasonable cost.

(j) If the harbour complex is not already on a main road or rail head, there should be connections made to the main trunk road or rail head for the movement of fish to and from the harbour area. These roads and rail connections should also include any connections that need to be made within the harbour area itself for taking provisions from one part to another.

(k) Provision of parking space for industrial and private vehicles must be made; adequate space around halls and industries, for loading and unloading vehicles, which does not upset the free flow of through traffic, must be provided.

(1) There must be provision of vessel, engine and gear repair facilities in the vicinity of the harbour, and the inclusion of a boatbuilding establishment where the fleet is rapidly expanding or replacing itself from local resources.

Unloading systems

One of the most important functions that a fishing port must perform is that of unloading fish from vessels returning from sea. The type of unloading system adopted obviously depends on a number of factors, for instance:

1. The type of fish being landed, e.g., fresh, frozen etc.

2. The use to which the fish are to be put, e.g., for human consumption or for industrial processing.

3. The types of vessel landing fish and the stowage methods used on the vessels themselves, e.g., box, bulked, shelved etc.

4. The tidal rise and fall in the harbour.

5. The number of vessels being unloaded.

6. The cost and availability of labour as opposed to the cost and availability of energy.

7. The ambient temperatures.

It must be remembered that, whichever system is chosen, it should be as efficient as possible, especially in terms of the time taken to get the fish from the hold of the vessel to cold storage, the auction floor or to transport because it is at this stage that unacceptable rises in temperature of cooled fish can occur. In addition, crews of vessels returning from long voyages may be anxious to return to their families for leave or to return to sea as soon as possible.

Unloading fresh fish

There are many ways of unloading fresh fish.

1. Bulked fish are often put into boxes on board the vessel and handed up on to the dockside.

Comments: This method is labour-intensive, it may be slow and can cause physical damage to the fish.

2. Bulked fish may be put into baskets which are swung on to the dockside using either the ships derrick or shore-based cranes.

Comments: This Is a reasonably fast method of unloading with experienced labour. Derricks can be powered and are, therefore, subject to failure; hand powered derricks are sometimes used. Fish are handled twice (i.e. into the baskets and then out again into a second container at the dockside); therefore, physical damage can be a problem.

3. Lifting boxes of fish directly from the hold to dock with a derrick. Comments: This means that there is minimal handling of the fish. Boxes can be used for further transportation of the fish. Any ice left will remain in the boxes, thereby helping to keep the fish cool.

4. Mechanical elevators and conveyors are used in some fisheries.

Comments: This method can be fast but it often separates the fish from the ice and, therefore, unacceptable rises in temperature can occur. It enables direct transport of fish to the auction hall along conveyors. Fish can be sorted and/or re-iced from the conveyors. If well-designed, these methods cause no physical damage to the fish.

Unloading frozen fish

1. When uniform blocks of frozen fish, for instance from freezer trawlers, are to be unloaded, a mechanical tailor-made system is often used.

2. Frozen bulk stowed fish, such as tuna, are often unloaded using swinging derricks, baskets, nets or boxes. These methods can cause physical damage to the fish.

Unloading industrial fish

Vessels catching pelagic fish, such as anchovy, menhaden, capelin, herring etc., for conversion into fish meal often catch large quantities of fish of fairly uniform size. The care needed in handling fish for the domestic market is not as necessary with these fish although they must be unloaded quickly. Industrial fish can obviously be unloaded in the same way as other fresh fish but, to speed up the operation and save on manpower, various pumps and mechanical unloading devices have been produced for this purpose.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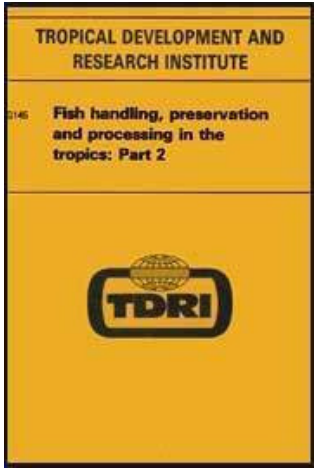

Acknowledgements

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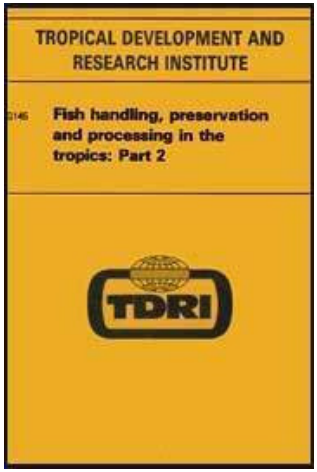
Fish Handling, Preservation and Processing in the Tropics: Part 2 (NRI)
(introduction...)
Summaries



Small-scale landing facilities: design and operation

Siting of fishing communities

Before considering what facilities are needed in a modern fishing village, it is interesting to speculate about the reasons for the siting of some existing small fishing centres. If we go back far enough, of course, we arrive at the situation in which families tended to group together in villages purely for protection. People farmed and fished only for home consumption. At a somewhat later stage, specialisation in farming or fishing and trade began. It was probably at this stage, when some people became full-time or almost full-time fishermen, that the majority of fishing centres which exist nowadays first became established.

The first essential would seem to be that the fishermen should live close to the place where they expect to fish: the village would be sited somewhere close to the fishing grounds. The reasons for this are obvious: the shorter the journey to and from the grounds, the greater the proportion of the time that can be spent fishing and the shorter the time the fishermen are at risk from the elements.

Sometimes different grounds may be fished, possibly for quite different fish and with quite different gear at different times of the year. The siting of the village might then be a compromise based on

ease of access to a number of different points at which fishing might take place.

A second and most important consideration as far as the fishing activity is concerned would be boat safety. The village must be sited where it is possible to ensure that the boats, which are the most expensive item owned by the fishermen, could be kept in safety when not in use. In many cases, this has meant that villages have been sited on river estuaries or in enclosed bays where the boats can be left afloat. In other cases, where suitable ports do not exist, the boats have been drawn up on beaches and this restricts the design and, more particularly, the size of the fishing vessels. In Europe, as we shall see later, quite large vessels, certainly some over 50 feet in length, have been operated from open beaches.

In some cases, the fact that suitable timber for boatbuilding was available close at hand seems to have influenced the siting of fishing centres. In other cases, however, this has had no influence at all. For example, in south Arabia, no boatbuilding materials are available and small fishing vessels, many of them less than 15 feet in length, have traditionally been imported from the Indian subcontinent. In some cases, siting appears to have been influenced by the need for suitable

land on which to build housing and grow a cereal crop. In other cases, neither seems to have been an important factor. For example, many of the villages of South East Asia are built in mangrove swamps where it is difficult to erect housing, no crops can be grown and there is no supply of drinking water. The mangrove forests do however provide another important element - a supply of fuel for cooking.

The villages of south Arabia lie along sandy beaches where water can only be obtained by driving a well down 80 or 100 feet, where there is no fuel for cooking, where boats have to be imported and where there is no possibility of growing food.

The fishermen of the African lakes often establish camps on papyrus islands floating in the middle of the lake where there are no facilities of any kind. In these latter two cases, it would seem that nearness to the fishing grounds is all-important.

It might be thought that proximity to a market in which the catch could be sold profitably would be an important point. Again, this is not necessarily so: in cases where there is a good supply of fish but no nearby market, the catch has traditionally been salted and dried or smoked and dried, often for sale in markets many hundreds of miles distant.

So, while it may be difficult to establish an order of priorities for the needs of a fishing community, it becomes obvious that proximity to the fishing grounds and safe harbourage for the fishing craft are all-important.

Facilities needed at modern fish landings

Assuming that the landing is sited so that it provides ease of access to nearby fishing grounds and a safe harbourage, the next most essential feature is surely ease of access. It is important that the catch can be moved from the village to the nearest market as expeditiously as possible. The fishermen and their families also need to travel, so a road which lorries can always use, and on which bus and taxi services can run, is of first importance.

Where no access road can be provided, access may be possible by water. Many fishing villages operate on the basis of a ferry service. The provision of roads is expensive and the ntervention of fisheries department headquarters may be needed before roads can be provided. The remainder of the points listed here should be within the compass of an extension service. One of the prime duties of an extension service is to see that facilities are provided for fishermen and their families.

Facilities which would be required at every landing include:

1. Bunkerage: Provision must be made for fuel; often both diesel and petrol will be required. Where possible, these should be made available alongside a point at which the boats can draw direct from a pump. Where there is a heavy duty on fuel, it may be possible to arrange nationally that fishermen draw duty-free fuel on the grounds that they are performing an essential public service in providing fish.

2. Repair of fishing vessels: Facilities must be made available for this; they may be of the simplest possible kind. Facilities should preferably be available for drawing the boats out on to hard ground; concrete standing makes for easier working and it is preferable that the vessels should be raised so that it is easier for men to work underneath them. At its simplest, this facility can be provided by means of a sled running on greased ways. More complicated systems include the use of wheeled trolleys on railway lines, even proper slipways. Winches, whether hand or power-operated, are also extremely useful.

3. Engine maintenance: This is a high priority. The more commonly needed spares should be kept to hand; trained mechanics should be available and a small simple workshop should be provided. At the small fish landings, there is no need to provide a workshop with

power tools. It goes without saying that the extension service should encourage the fishermen to restrict their purchase of engines to those for which spares are readily available within the country.

4. Fishing gear: Except at the very smallest fish landings, it is useful if the fishermen can buy some of their fishing gear requirements without travelling to a nearby town. The advantages of co-operative purchase are well-known and obvious.

5. Fishing gear repair: It is often found that even the simplest facilities for this are not available. All that is required is an open space with a clean, hard, dry floor and a roof to protect the gear and the men working on it from the weather. Where a village is strung out along a river, it may be impracticable to provide a central facility.

6. Food and water: Ordinary everyday living requires that these should both be available. The extension service should see that every village has a properly designed, hygienically operated market facility. Water is needed both ashore and at sea. Life for everyone becomes much easier when a piped supply becomes available, so that water is on tap instead of having to be carried from a well. In the earlier stages of development, stand pipes can be provided at intervals in a village street: later on, it may be possible to take the water into the

houses so that individual piped supplies are available.

7. Medical facilities and schooling: These should be available in all but the very smallest landings. Where these cannot be provided within the village itself, it may be possible for the extension service to assist with the organisation of transport to school, and to arrange visits by a travelling dispensary and provision of an ambulance for emergency cases.

8. Recreation: Although this is not necessarily the most important feature, some facilities should be provided if possible. These may include such things as badminton courts, tennis courts, football pitches and a small library. A Community Centre in which meetings can be held, films shown and lectures arranged is obviously useful. Where people cannot afford their own television set, it may be possible to provide a shared one for a community. Regrettably little use has been made of television for educational purposes in developing countries.

9. Fish handling, processing, preservation and marketing: These are the facilities with which we are primarily concerned. The type of facilities needed depends primarily on whether the fishery is based on selling fish fresh or frozen, or in some dried or smoked form. Often, of

course, the fishermen from a particular landing will sell their catch in a variety of forms.

Correct fish handling starts in the boat the moment the fish are caught. However, preparations for proper handling must begin before the craft puts to sea. If fish are to be landed in good condition, they must either be brought ashore within a few hours of death or they must be chilled to the temperature of melting ice as quickly as possible. An ever increasing number of vessels are carrying ice to sea; in Europe, and more particularly in the Arctic fisheries, the fish room or fish hold was often uninsulated. In the tropics, it would make no sense at all to carry ice to sea without very good insulation; ice is invariably expensive and everything possible should be done to avoid loss through melting. Often ice is seen being carried on open lorries; in these circumstances, money pours on to the road. Ice should be loaded into the fishing boat as quickly as possible; the ice-making plant or machine should always be as near as possible to the point at which the fishing boats berth. In most modern installations a flake ice machine is sited on a jetty so that ice can be shot straight into the fishing boats. Where this is impossible or where an existing plant, possibly a block ice plant, supplies the fishery, there should be a well-insulated (and possibly refrigerated) ice store close to the berthing

point of the vessels. Quite satisfactory arrangements can be made for storing ice very cheaply by packing it in sawdust under cover. If block ice is used, an ice crusher or breaker should be provided if possible; sometimes fishermen prefer to carry unbroken ice to sea because losses through melting are then less.

Often fishing boats are washed down with water from the river or harbour in which they are berthed. This defeats the object of washing since such water is invariably heavily laden with bacteria, often food poisoning bacteria, and the vessel may in effect be dirtier after washing than before. A piped water supply, the water containing free chlorine, should be provided wherever possible. If this cannot be done, the final cleaning down should be carried out in the open sea, as oceanic sea water should be tolerably clean.

The inside of the fish hold should be thoroughly scrubbed with water containing detergent and given a final rinse in water containing plenty of free chlorine. Boxes or tubs of some kind are needed for removing the fish from the boats. Aluminium and plastic containers have many advantages over wooden ones but cannot always be afforded. Whatever containers are provided, facilities should also be made available for properly cleaning these. A good scrub in detergent-

loaded water, followed by a soaking in water containing free chlorine, provides the best results.

Where quantities have to be moved, wheeled trolleys of some kind should be provided. These may be rubber tyred vehicles which can be moved over almost any surface; in some cases, railways are laid so that simple iron wheeled trucks can be used. They are often manipulated manually; they may equally well be drawn by winches or tractors and, in some cases, fork-lift trucks may be the best answer.

Nowadays, the advantages of boxing fish on board (ease of handling, ease of sorting and better condition on landing) are usually recognised. Unless the fish can always be moved expeditiously from the landing point, a refrigerated, or at least well-insulated, chill store should be provided. There may also often be a need for one or more packing sheds.

The larger landings should be provided with a fish market - a point at which fish can conveniently be auctioned.

At some landings, facilities will be needed for salting and drying fish and for the storage of the dried products.

All too often the catch is handled ashore by men who have to wade through surf or yards of muddy foreshore to the detriment of both the crew and the catch. Obviously, where possible, facilities should be provided so that boats can come alongside a jetty or wharf so that the catch can be handled ashore as quickly as possible. Either the boat's gear can be used to land boxes or tubs of fish, or small cranes can be provided on the jetty. Neither pumping nor the use of elevators is usually practicable at the smaller landings.

Once a jetty is available, of course, not only the handling of the fish but also the provision of other facilities becomes easy. Pipelines can be laid so that fuel and water are available at a number of points and fishing gear is easily loaded into the vessels or put ashore. The provision of good facilities for berthing alongside is one of the most important points in fishing village improvement.

Management of small fish landings

Almost all of the facilities so far described might be in private ownership (operated for the benefit and profit of a single owner); owned communally (operated for the joint benefit of a number of people as in a co-operative society); or they might be owned publicly. Publicly-owned facilities may be provided from taxes for the common

welfare and good, or they may be used by individuals on payment of a statutory fee.

Harbour dues are often lower for fishermen than for other users; in some places, fishermen pay no dues. Berthing fees are usually charged on overall length of the vessel, which seems fair since the longer vessel uses more quay than a shorter one. Again fishing vessels are often exempted. Where fish are auctioned, a statutory percentage of the value is often charged. Where fish are put in chill storage, there is usually a standard charge per day; where fish are frozen and held in cold storage, similar arrangements apply.

A common arrangement is for most of the communally used facilities to be publicly or commonly owned; for example, the jetty, quay or wharf and the auction point or market. Other facilities, however, such as the ice plant, packing sheds, factories, and repair and maintenance facilities are usually operated as private businesses. The advantages of co-operative society ownership and management are as well-known as the difficulties involved in establishing a co-operative society amongst fishermen.

Whatever arrangement is made for management of the landing's facilities, someone should be in a position of sufficient authority to

ensure that the common practices required for good hygiene are observed both to protect the consumer and to make certain that the fishermen get the best possible prices for their catches.

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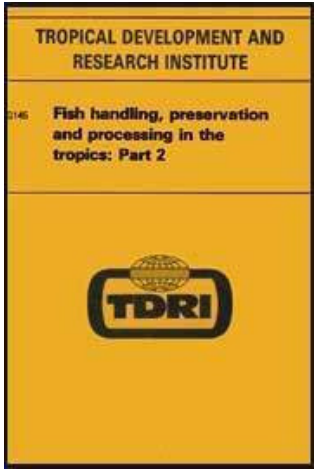

- Fermented fish products: a review
- Boiled fish products
- Fish canning: theory and practice
- Freeze drying
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- Microbiology of spoilage
- Microbiology of fish spoilage
- Public health microbiology

Retail sale facilities

Retail facilities may be provided in markets and this is common in South East Asia, where a number of stallholders rent facilities from a municipal or other authority and display their wares alongside one another. The advantages of this system are that wholesalers have to deliver only to one central point; housewives can easily compare prices and values offered by particular stallholders; retail markets for other goods can be nearby so that housewives can buy all their daily supplies at one point in the city; and waste disposal is a relatively simple matter. This does, however, have the disadvantage that housewives have to travel to the market.

In many other parts of the world, shops are provided near to where people live. In other cases, as in outlying country districts in England, mobile retail facilities are provided: a van carries fish into the villages and the fish are sold direct, from the back of the van. Pedal-driven facilities have also been used in some parts of the world.

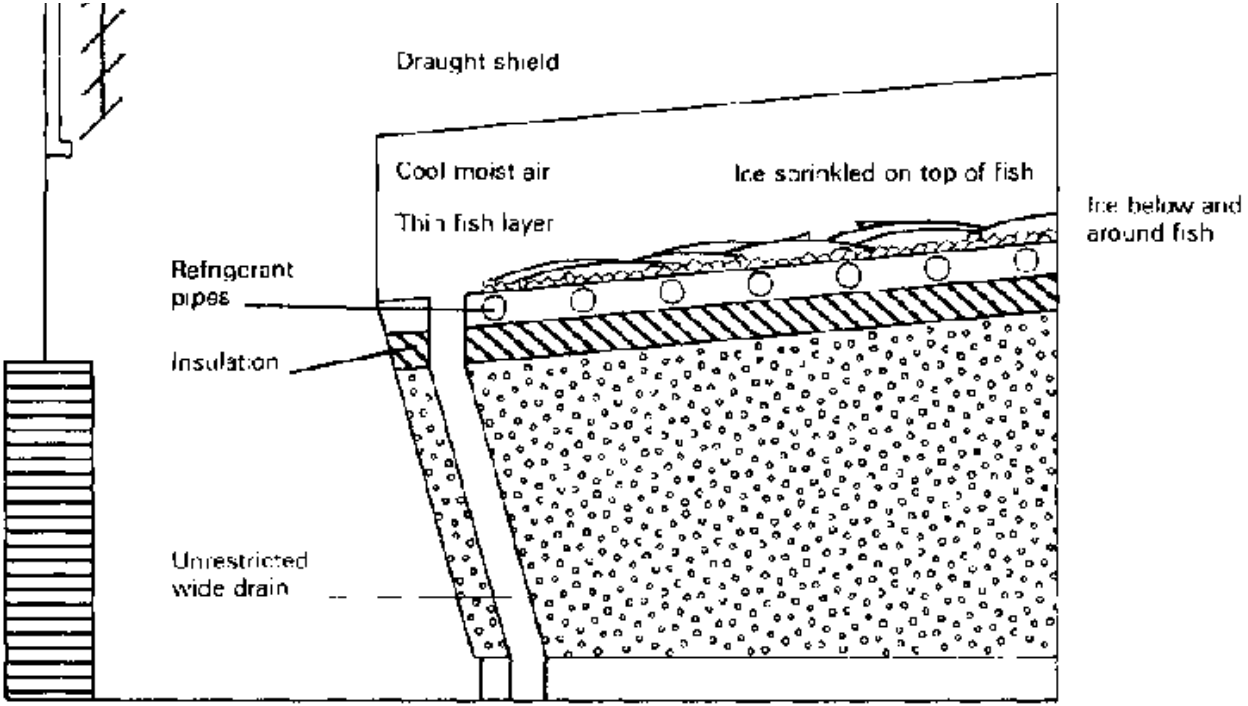
Whatever arrangement is decided upon, facilities should be provided for the retail sale of wet, smoked, dried and frozen fish. The requirements for each are quite different. In many cases, it is also necessary to provide facilities for the sale of live fish.

Sales of wet fish

Fish spoil mainly because of the activities of bacteria and the speed at which these grow on fish flesh depends largely upon the temperature. Fish taken straight out of the sea and kept at 0°C by placing them in crushed ice can remain fit to eat for almost 3 weeks. If kept at 6°C, they can keep for only about 6 days and, at 11°C, they will be inedible after 3 or 4 days.

The first essential in looking after wet fish is, therefore, to keep them as close to the temperature of melting ice as possible. The best way to do this is, of course, to keep them buried in melting ice. Obviously,

it is easiest for the fishmonger to keep his fish buried in melting ice by holding them in boxes with ice rather than attempting to display them on a bench. Some fish must, however, be displayed on the bench so that people can see what is for sale. Therefore, a sales bench must be provided; this is best made in the form of a slab which is sloped to provide drainage and for ease of cleaning. The slope should not be excessive or the fish and ice placed upon it will slide down. The slab should be covered with a bed of ice and the fish pushed into this; ice should be piled round them so that only the top surface of the fish is visible, which allows the fish type to be identified. Where possible, a glass cover should be provided so that fish are kept under a pool of cool moist air and are shielded from draughts. Figure 18 shows a suitable arrangement. The sales slab should be backed up by storage boxes or by a chill store.



Source: Redrawn from a drawing on page 56 of 'Food and Agriculture Organization of the United Nations. Rome (1968). FAO Fisheries Report (59)'.

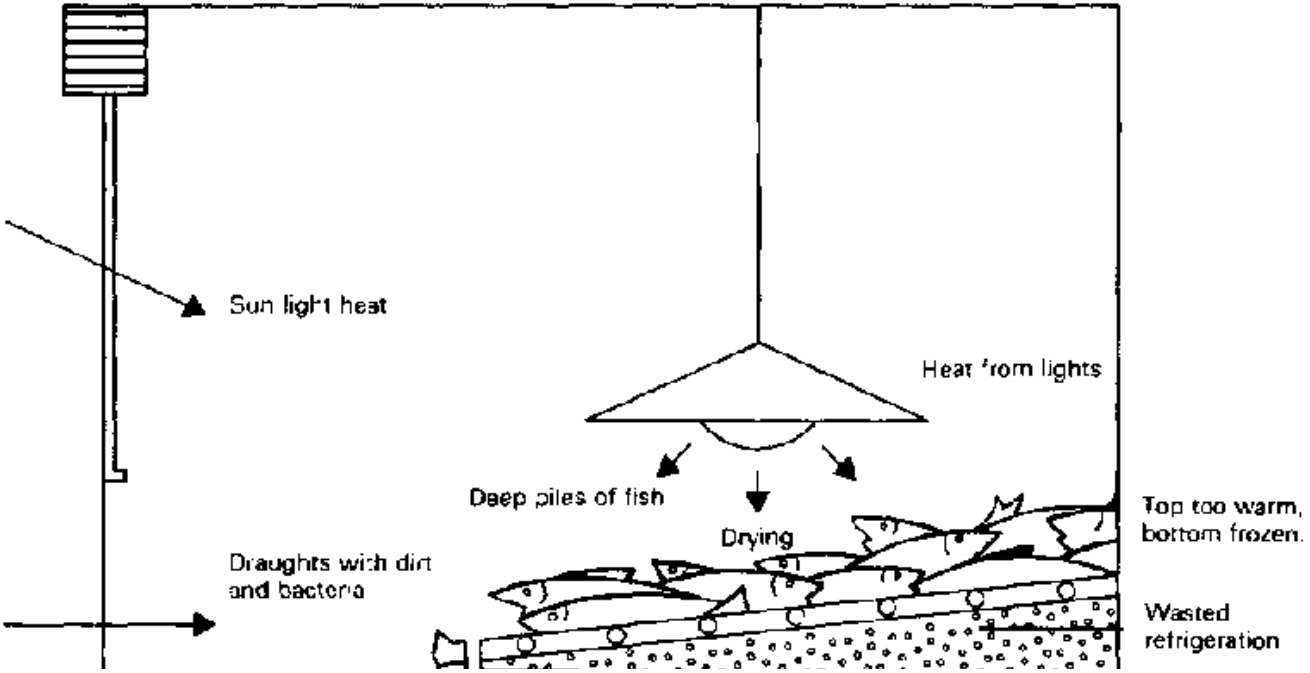
Figure 18 - Fresh fish ideally displayed on ice

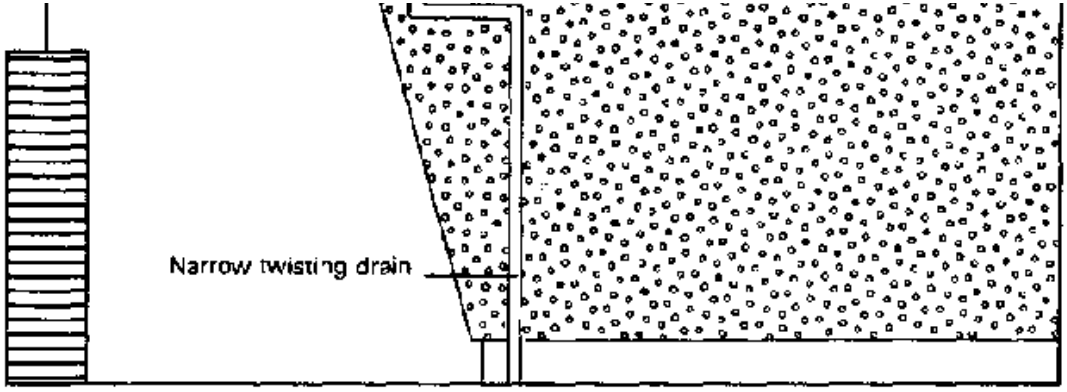
The use of chill stores alone for cooling fish is very bad practice: the

appearance of the fish will rapidly be spoiled by the drying of the surface and, if the room thermostat is not sufficiently accurate, it is possible to freeze the fish, which will give very poor results when they are finally eaten. The best way to store wet fish is to put them in boxes with plenty of ice and then to put the boxes in a refrigerated store which is set at about 2°C. There would then be no risk of freezing the fish. There should be at least one and preferably two thermometers in different parts of the store to make sure that it is not too cold. The thermometers should not be hung on or near the cooling grids but near the actual fish.

There are a number of practices which should be avoided in constructing a sales slab. There is really little point in attempting to refrigerate it except where fish are to be sold in a sophisticated store. Even there, the fish must be surrounded by ice, the refrigeration being used only to prevent excessive wastage of ice. The fish must not be piled deeply on the slab. They should not be subjected to an air current from a fan, even the coldest moving air will dry them out. Whilst it is obviously desirable to have a light over the fish so that they can be seen clearly, the light should not be too powerful or too close to the fish or it will cause an increase in their temperature. All draughts which are likely to bring in dirt and bacteria should be

avoided and, of course, the fish should not be displayed where the direct rays from the sun can warm them. A slab should be arranged so that it is sloping and can be easily cleaned. The drain should be as straight as possible and it must be large enough to take pieces of fish. Small narrow twisted drains can rapidly become blocked and useless. Figure 19 illustrates some points of bad practice.





Source: Redrawn from a drawing on page 56 of 'Food and Agriculture Organization of the United Nations. Rome (1968). FAO Fisheries Report (69)'.

Figure 19 - Bad practice in retail display

The floor in any retail facility should be made from material which is easily kept clean by scrubbing. Concrete provides a reasonable compromise between the ideal and that which is cheap enough in practice. The floors should slope to wide gullies which should in turn slope to a trap at which fat and fish waste are easily removed; the effluent should pass either to a sewer or to a septic tank.

The walls should also be easily cleansed. While tiling may be considered ideal, plastered concrete which can be scrubbed will have

to suffice in most cases.

The comers between the walls and the floors should be curved for ease of cleaning. A high roofed building is obviously more easily kept at an equable temperature than one with a very low roof but will be more expensive to construct. Adequate ventilation must be provided and this should be screened to keep birds out.
It should not be necessary to screen to keep flies out and, provided waste is disposed of properly, there should be no fly problem. Where flies do exist in large numbers, screening is usually ineffective because every time the door is opened flies enter. Every stallholder should have a covered bin in which he places waste which is discarded at the end of the day.

Fish should be cut on boards, not on the slab surface. The best fish cutting boards, which are made of plastic, are extremely expensive and the best substitute for these is a board made of edge grained hardwood. Knives and choppers should be kept sharp and facilities for sharpening should be available.

All the facilities so far discussed for the sale of wet fish should also be provided in a mobile fish shop. Usually this must be provided with a tank to hold chlorinated washing water, which is kept at a high level

so that it feeds by gravity to the points at which it is needed, and with a storage tank, at a low level, which can later be emptied into a sewerage system.

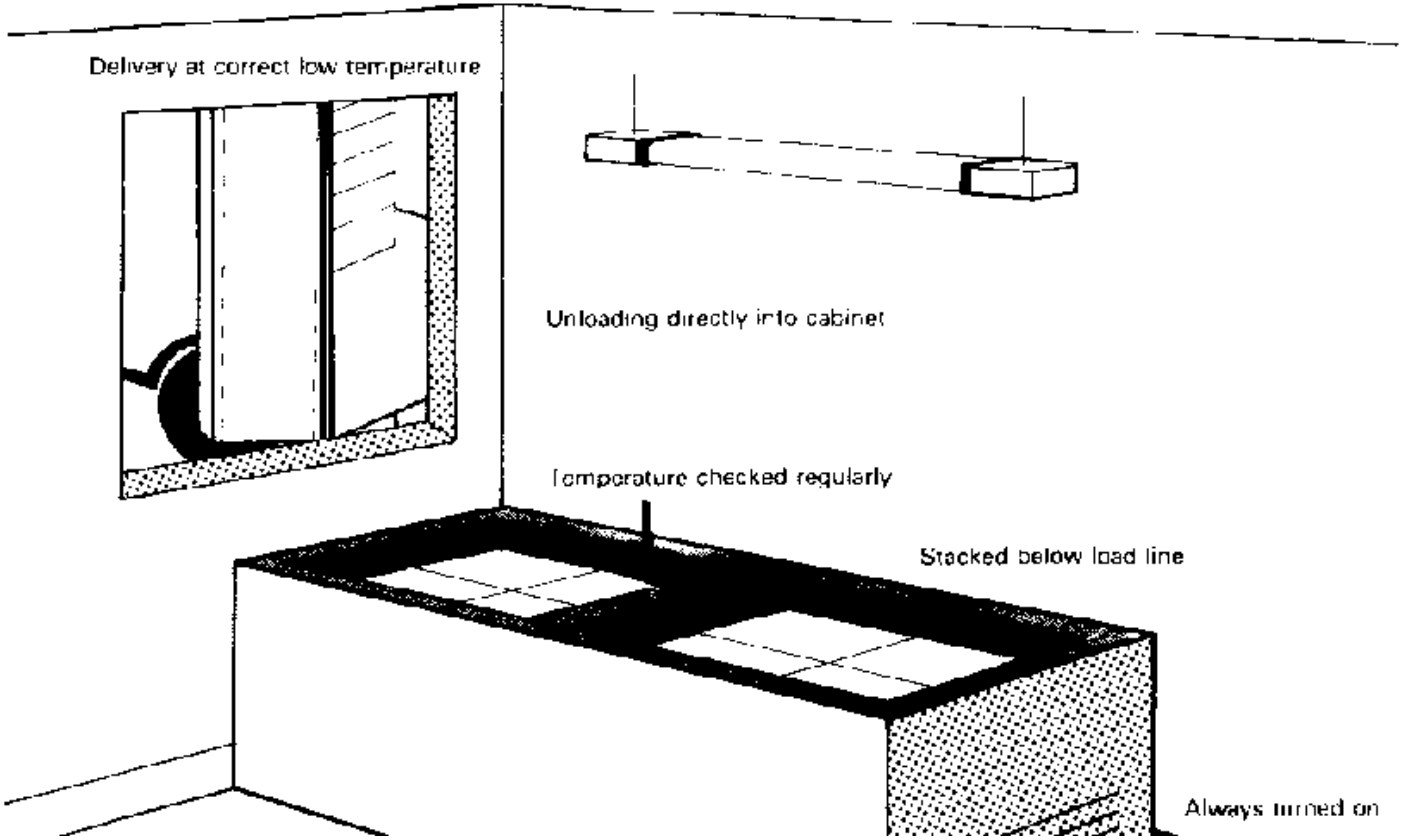
Both retail markets and fish shops should have some means of storing ice. In the larger markets, it is perfectly easy to manufacture ice and hold this for sale to stallholders. It is now possible to buy small ice-making machines which will manufacture 100 kg of ice a day which is adequate for many shops. Where possible, a flake ice machine should be used; some of the small machines manufacture ice in the form of pellets or small cubes which are not really suitable for use on fish.

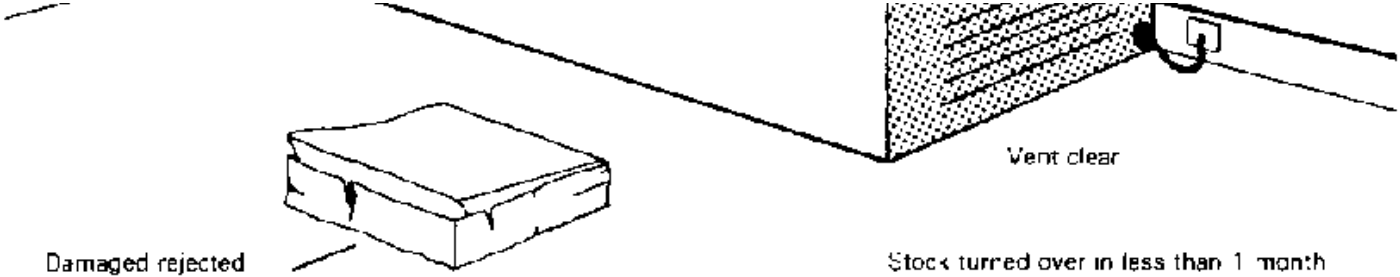
Sales of frozen fish

Frozen fish may arrive at the point of sale in a number of different forms; sometimes it arrives as whole fish which have not been wrapped, sometimes as fillets which have been wrapped, packaged and frozen; in other cases, it arrives as cooked frozen fish which only needs re-heating before serving.

If frozen fish are to be sold as frozen fish, they must be kept in refrigerated storage. Prior to delivery to the retail facility the frozen material should have been held at - 30°C. In practice, however, the

storage is likely to have been slightly warmer and, during carriage from the cold store to the retail shop, the fish may warm up further.

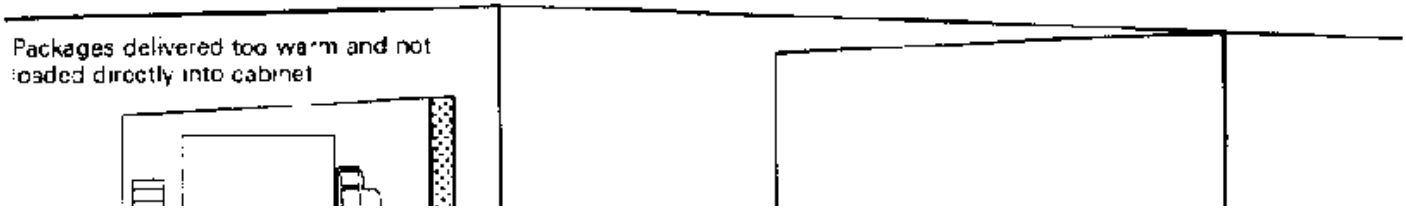


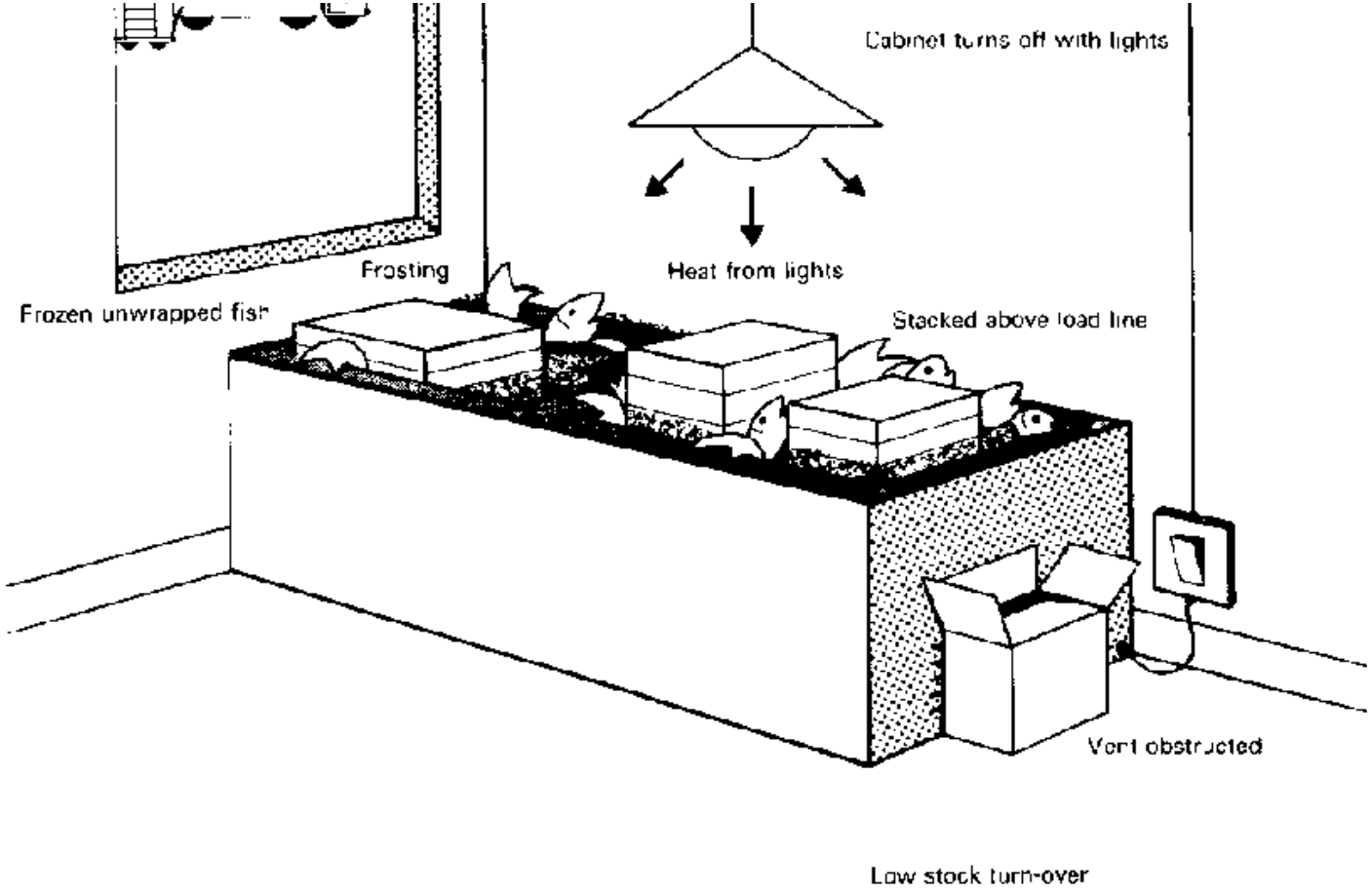


Source: From an idea derived from a drawing on page 7 of Torry Research Station Torry Advisory Note No 12 (Revised).

Figure 20 - Correct use of zero cabinet

Much of the frozen fish sold in Western countries is sold from what are called 'zero' cabinets because they are held at 0°F (this equates to - 18°C.). If fish are held for a month at this temperature, they will suffer little harm; however, if they are held for several months at this temperature, they will be of somewhat poor eating quality. It is important, therefore, that the retailer should hold as little frozen fish as possible.





Source: Adapted from a drawing on page 8 of Torry Research Station Torry Advisor Note No. 12 (Revised)

Source: Adapted from a drawing on page 8 of Torry Research Station Torry Advisory Note No 12 (Revised).

Figure 21 - Misuse of zero cabinet

Material which is kept in a zero cabinet should be treated like any other frozen fish in cold storage; it should be kept glazed and properly packaged to prevent dehydration. It is particularly important that the practice of 'first-in, first-out' should be followed so that material is held for as short a time as possible. This may mean that the retailer must personally date-mark the produce which he has for sale. If he does not wish the public to know how long he is holding material, he can devise a simple code.

There are a number of points to watch when handling frozen material. Good storage practice is illustrated in Figure 20; poor practice, in which a cabinet is misused, is illustrated in Figure 21.

Remember that material will deteriorate in the cabinet. The cabinet must be kept switched on so that it remains cold. it should not be loaded above the marked load line; if it is, the material above the load line will suffer an increase in temperature.

No attempt should be made to use the cabinet as a freezer since this will result in damage to the material already in storage because its

temperature will increase before the new material is frozen.

Where one is available, a competent refrigeration engineer should be employed to service the cabinet at regular intervals. Some cabinets defrost automatically at short intervals. If the cabinet is not automatic, it should be defrosted regularly. It is a good idea to make a daily check of the temperature of the air in the cabinet; the best way to do this would be to place at least two accurate, adequately protected thermometers in different positions in the cabinet. Neither of these should be in contact with, or near, the cooling coils.

If the wrapping of any of the packages delivered is broken or torn, drying of the commodity will occur. Quite apart from the fact that there will be a loss of weight, the final product will be dried and unattractive (i.e. freezer burn). Such damaged materials should not be accepted at delivery and, if damage occurs within the shop, the material should be destroyed. The cabinet should be situated so that it is not in direct sunlight, lighting should be sited so that it cannot warm the cabinet and, most important of all, the cabinet's vent should be unobstructed so that the refrigeration machinery can operate efficiently without overheating.

In some developing countries, a system of retail marketing of frozen

fish has been developed in which the fish are delivered frozen to a cold store and are then removed so that they thaw at point of sale. This material competes directly with wet fish. This system can work quite well but it is debatable whether it can be as effective as an ice storage chain. Where the system has developed, it seems to have done so because the market is readily supplied by large trawlers freezing the catch at sea as in West Africa. There is little doubt that better quality material can be provided by icing in most other circumstances; it seems likely that an icing chain would also be more profitable but, in designing a marketing chain for new points of sale, the alternative possibilities should be costed. As in other areas of fish handling and processing, much depends on the market demand.

Sales of smoked and dried fish

Fully cured, smoked and dried products are much easier to handle than wet or frozen fish since they do not require chilled or cold storage. They should, nonetheless, be carefully handled.

All cured products deteriorate quicker at high temperatures than at low temperatures so it is worthwhile taking some trouble to ensure that the products are not over-heated. At the same time, the products should be protected from excessive drying where they are sold by

weight since considerable weight losses could occur if the products continue to dry.

The product should of course be kept clean. Generally this requires that items be either weighed into packets or individually packaged. The modern plastics have revolutionised packaging but should be used with care. Most dried products are really only semi-dried and, if these are packaged in a sealed container, they will sweat and spoil. Most products therefore require a ventilated packet.

Sales of live fish and crustacea

Both fin fish and crustaceans, such as rock lobsters and lobsters, can only be kept alive for reasonably long periods by keeping them in water. A few catfish and other species with accessory air breathing mechanisms are exceptions to this rule.

Molluscan shellfish, such as cockles, oysters and mussels, can be kept alive in cool moist air. All that is needed for these is a container made so that it drains readily, i.e., a wickerwork or wire mesh basket in which the shellfish can be refreshed occasionally by pouring water over them. The container must, of course, be stored in the shade, not in the open sun.

Almost any container of suitable size can be used to hold live fin fish and lobsters for sale, including glass sided tanks in which the animals can be seen swimming. Such expensive and elaborate facilities are, however, not really necessary. Concrete tanks, galvanised iron baths and plastic dustbins have all been used successfully. Metal containers should always be treated with some suspicion, particularly for sea fish, since very minute quantities of copper, zinc and heavy metals will kill fish.

Any of the catch which dies should be destroyed and not sold.

The water in which the fish are kept must itself be clean and uncontaminated; chlorinated public water supplies are quite unsuitable since relatively small quantities of chlorine in the water will quickly kill the fish. Where the public supply is not chlorinated {as it should be), it could be used to keep fish alive and, under these circumstances, no aeration would be needed; water could be permitted to flow through the storage tanks. Water usually has to be bought, however, and, even under these circumstances, it might well be cheaper to provide aeration to the tanks.

Aeration

Aeration would best be provided by driving air stones from pumps operated from the electric main. The air stones should be sited at one end of a rectangular tank so that the water is caused to roll. This provides far more effective aeration than can be obtained just with the air stone bubbles. The aeration should be as vigorous as possible without causing physical damage to the fish. The fish must not be unduly crowded; a tank which holds 100 litres of water will not hold more than 25 - 30 kg of fish when fully loaded and, under these circumstances, even with very vigorous aeration, the fish are likely to die in a day or two. No hard and fast rules can be set. Oxygen deficiency is the cause of most deaths: different species have different oxygen demands and the warmer the water, the less oxygen it can hold and so on.

Certain obvious precautions should be taken: the fish should be permitted to scour before storage; they should not be fed in store; and the water should be kept as cool as possible, consonant with not killing the fish by cold shock.

It is perfectly possible to design a closed system, even for marine fish, at a distance from the nearest supply of clean, unchlorinated, running water. Such closed systems must include a good filter as well

as good aeration. Simple biological filters can be constructed using sand and these, when run in, can be very effective.

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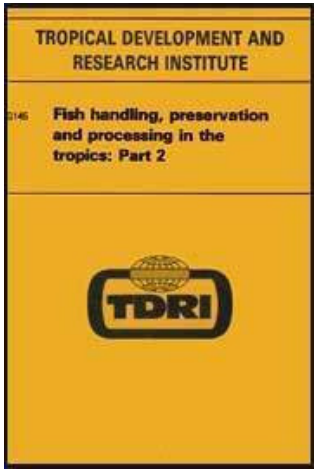

- Boiled fish products
- Fish canning: theory and practice
- Freeze drying
- Irradiation
- Miscellaneous products: crustaceans
- Miscellaneous aquatic products used as food
- Food by-products
- Non-food by-products
- New and delicatessen products
- Fish meal
- Fish silage
- Chemical and physical methods of quality assessment
- Organoleptic (sensory) measurement of spoilage
- Microbiology of spoilage

- Microbiology of fish spoilage
- Public health microbiology
- International standards for fisheries products

Fisheries extension services: their role in rural development

At the lowest levels of rural existence, there is no room for failure because there are no reserves. The failure of migratory fish to appear in their appointed season, the loss of a catch through gear failure, loss of gear through stress of weather or the loss of a batch of processed fish through spoilage are major disasters. In extreme cases, such disasters lead to starvation and death. No one should be surprised, therefore, if peasant fishermen are reluctant to give up established and thoroughly tested practices in favour of untried innovations. This is especially so when the new practices are presented by people who would probably starve on the beach if they tried to make a living out of fishing, fish handling or fish marketing.

Arguments against new practices range from, 'that is not our way', through, 'maybe that does work elsewhere but it won't work here', to, 'the spirits would not approve of that'. At the root of the speaker's objections lies the knowledge that his own operations are on such a tiny scale and offer such low margins of profit that he cannot afford to experiment. He dare not take any unnecessary chances with his all too fragile means of livelihood. So changes come slowly and, at each stage, the profitability must be adequately proved and demonstrated before a new practice can become acceptable. There is seldom any problem in introducing changes which can be shown to be profitable or to make life easier. The introduction of synthetic materials for net and line manufacture and of internal combustion engines to drive fishing craft are obvious examples. So is the use of ice to preserve the catch although it is often much more difficult to effect improvements in product quality. Such improvements almost invariably raise the price of the product as, of course, does icing and most consumers in developing countries are unable to pay a premium price for better quality, much as they may prefer a better product.

Problems of relocation

If we define rural development as the improvement of the living

standards of the people living in rural areas, we need to look far beyond the concepts of fisheries development which are usually uppermost in the minds of fisheries department administrators. Typically the eight or nine million artisanal fishermen of the tropics live in small groups in ramshackle housing, totally lacking the amenities of modern life such as piped water, electricity, effective sanitation, education, and perinatal, medical and dental care. Often villages are isolated by poor roads; some can be reached from outside only by water; some are seasonally inaccessible. So development requires attention to all these factors, as much as to the improvement of fishing boats, fishing gear, berthing or beaching facilities, and handling, processing, preservation and marketing methods.

One simple way to overcome many of the difficulties would seem at first sight to be to uproot entire villages and move them to new locations where the facilities, previously lacking, either exist or can readily be provided. This is seldom an acceptable solution. Many of the people involved are fishermen/farmers who own housing and land (Lawson, 1972). The land which provides much of the villages' subsistence could not easily be provided elsewhere. There are religious objections, too, based on such factors as the desire to be near ancestral graves; these and similar factors render the people

immobile. Most Governments are already battling against the ill-effects of the city ward drift of the peasantry and would wish to do nothing which might increase or accelerate this.

However, the main reason for deciding against relocation of whole villages lies in the factors which are responsible for their development on the existing sites. The most obvious of these is proximity to the fishing grounds which include estuaries, mud flats, shallow banks, lagoons, mangrove swamps and coral reefs. Such grounds can be fished most profitably from small vessels of shallow draught and, in producing fish from such areas, the artisanal fisheries can make useful contributions to the economy (Cole, 1973). Long runs to and from the grounds reduce fishing time, and thus profitability, and, of course, increase the time the fishermen are at risk in times of bad weather.

Research and development

The fish landed in these villages often include both low bulk, high value items, such as prawns and crawfish, on which export industries may be based, and bulky low value items, such as mussels, cockles and clams, which provide cheap food of high quality. These artisanal fisheries also provide much employment using low levels of capital

inputs; such important national assets should be developed so that the fisheries continue productive while the people involved enjoy at least some of the amenities of life which many take for granted. This usually requires that improvements are made in both the working and living conditions. While some of the improvements may be paid for by the injection of capital from outside, in the long run the improvements, or at least the maintenance of these, must be paid for by increasing the profitability of the fishing and fish marketing operations, thus increasing the real income of those engaged in the fisheries. James (1977) elaborates these points.

The development of the industrial elements of an artisanal fishery requires, as does the development of any other fishery, that all sectors of the industrial operations should be considered for improvement. Thus, a proposal to fish further to seaward or to use bigger nets may generate a need for bigger boats of deeper draught, which in turn need deeper water and mooring, more fuel and ice, and which demand a higher degree of skill in the crew. The heavier catches expected will require more, or possibly different, processing facilities, bigger or more markets, more transport and better roads and possibly the development of an export market with the attendant necessity to meet foreign standards of hygiene, packaging and

product quality. Thus expertise in a number of very different specialisations might be needed, and there will be a need for research and development (R&D) in many of these specialisations.

R & D is, of course, totally wasted unless the results are applied and, in the case of the artisanal fisheries, the results must be applied by people who suspect that all change is not necessarily for the better. Like any other people, they are likely to accept advice most readily from someone they trust as having their best interests at heart. R & D must, therefore, logically be followed by extension work (E) and, particularly in the artisanal fisheries context, it makes better sense to talk of R, D & E rather than R & D alone. It should certainly not be assumed that extension can stand alone either, for there are few cases where unmodified technology transplants successfully from temperate to tropical conditions.

Thus, the development of an artisanal fishery in most circumstances requires a modest amount of applied research and a great deal of hard work at the basic village level by officials (or non-officials) who have received adequate technical training, understand the intricacies of the technical and socio-economic aspects of the industry and are trusted and respected by the people who run the industry. This should be an

extension service. During visits to eighteen developing countries in 1974/75 (in South East Asia, South America and Africa), no single fisheries extension service was found which was thought to be even reasonably effective. So perhaps it may be worthwhile to examine the concept of a fisheries extension service in somewhat greater detail.

Organisation and administration of extension services

Wherever possible the extension service should be organised at the national or federal level rather than at the state or other subsidiary level. Of course, much good extension work is done by universities, regional laboratories and similar organisations. This is particularly so in the developed countries where the fishing industry is at an advanced level and where high level expertise is needed. In these situations, the industry solves the simpler problems for itself. Those working in the industry are educated to secondary school or higher levels and, if they cannot resolve a problem themselves, they can contact a laboratory or other organisation and explain their needs. The illiterate or semi-literate peasant fisherman cannot do this and needs a very different kind of service. He needs someone close at hand who can satisfy his simpler needs and can translate the more complex needs into terms easily understood by the more expert.

Simple problems can often exist undetected for years, simply because there is inadequate contact between the fishermen and those paid to serve them. Sometimes there appears to be no contact at all between Government and the fishermen, other than the minimum required for the collection of taxes and statistics.

This essential contact between Government and industry requires the employment of rather large numbers of people at the village level and the basic principle of the fisheries extension service is the employment of workers who live among the fishermen. Such people must inevitably be trained as generalists rather than as specialists. This means that their skill and knowledge in any particular subject will be limited and will, indeed, often be rather basic. They should be trained so that they can identify the need for a particular kind of expert assistance and know where this can be found. Thus, the service as a whole should be able to draw on the expertise and experience of various branches of the fisheries department, other government departments, research and experimental stations, universities, and the fisheries training institutes and schools. Co-operation from these organisations would best be assured by central controls.

Control structures

Where the fisheries department is responsible for fisheries development, it follows that the fisheries extension service should be a branch of the fisheries department. Other arrangements are, of course, possible but this is the one that usually seems to work best. Among other things, this permits financing of the service from the national treasury. It also provides for one of the essential requirements of the extension service, i.e., that those employed should work on a full-time basis. It also helps to provide a career structure offering the possibility of promotion within the extension service or into other branches of fisheries work. If the service is organised on a very small scale, it can provide few posts above the basic level and a further problem is that it cannot provide adequately for specialist posts for technologists above this level. The very smallest countries, of course, can afford to employ only one man as a fisheries extension worker and must seek from outside the expertise which he is unable to provide.

A further reason for suggesting that the extension service provided by universities and similar bodies in the developed countries would prove unsatisfactory in the developing world, is the need for

assistance with the socio-economic factors which control living, rather than working, conditions in the artisanal fisheries of the developing country.

A senior member of the fisheries department should be in charge of the extension service and it is preferable that he should have no other duties. In addition to employing approximately one worker for every 500 fishing families, the service should employ people in a supervisory grade at a ratio of roughly one to every five field workers; in very large countries, it may be necessary to employ people who control the supervisors at a similar ratio. Whether it will be necessary for the service itself to employ specialists or not depends largely on the size of the country and the way in which the fisheries department is organised. Where the extension service is large, it is obviously best to employ specialists who are trained in their own technology but have also been taught how to operate as extension workers. Where the service is smaller, it is certainly not essential that specialists should be employed; the specialists employed in other branches of the fisheries department can be trained for extension work and be required to perform extension duties as part of their normal functions.

Terms and conditions for the extension workers

The terms and conditions of service for the extension workers should be made as attractive as possible. It is extremely important that extension workers should be able to travel freely and quickly through the district in which they are required to work. In some cases, it may be possible for them to do this on a pedal bicycle but this is an energy-sapping and time-consuming means of transport. It is usually better to provide extension workers with motor bicycles; these are more useful than motor cars or other forms of four-wheeled transport in the isolated village conditions in which they are working. They should be taught to ride, service and maintain these.

All that has so far been said about the workers applies with equal force to their wives and families. It is important for the service to keep the wives and families happy in their isolation and arrangements should be made so that, as far as possible, they can enjoy the facilities available to the wives and families of workers at equivalent levels in the towns. Where this is impossible, an allowance should be paid.

One of the tenets which is often quoted by people discussing the organisation of an extension service for agriculture, fisheries or allied industries is that the extension worker should not be burdened with

any duties other than those normal to an extension service (Maunder, 1972). As far as is possible, it is certainly desirable that the extension worker should be able to concentrate full-time on his extension duties. The fisheries extension worker must be seen by the fisheries community as their friend: someone who is on their side, rather than a member of a revenue-collecting government department. Most fisheries departments have some responsibility for collecting revenue in the form of licence fees for fishing boats, fishing gear or both; because the officers who work in this department are seen as part of the government, they are often suspected of being in league with the collectors of income and other taxes as well. This is another powerful reason for saying that fisheries extension workers should be used solely as extension specialists wherever this is possible.

It must be recognised, however, that, in some countries, it is impossible to employ specialists for extension work because the country simply cannot afford this. In these circumstances, the fisheries assistants who have other duties, such as the collection of fisheries statistics, may also have to do the extension work. It is, however, best if licensing duties are not undertaken by these people. It is always possible to arrange for a team from regional or national headquarters to undertake licensing duties so that the extension

worker is seen by the fishermen as being part of a different organisation.

Responsibilities of the extension branch

While the head of the fisheries department will obviously be responsible to the government for the control of the department's expenditure, the head of the fisheries extension branch should be responsible for the preparation of an annual budget for extension work and should control it. This should include capital expenditure for major items which the extension branch needs for its work, annual salaries for the staff, and recurrent expenditure for purchase of minor items, travel and similar matters. This should enable the extension branch to plan its work rather more than one year ahead; indeed the branch should normally be planning the work that it will be undertaking during the next two or three years. Similarly, the extension branch should be responsible to the head of the fisheries service for the recruitment of extension workers and for their training. The branch should not be responsible for the recruitment of specialist technologists; generally, it is better if these are recruited by the fisheries service. The extension branch should, of course, be responsible for training specialists in extension work and for the

preparation of extension material.

Very few fisheries departments have arranged to give regular broadcasts to fishermen; these have generally been extremely well received and have proved very useful in circumstances where there is a considerable variation in fish prices either seasonally or from one part of a country to another. A very limited number of training manuals suitable for artisanal fisheries is at present available. For some of the simpler technologies, it should surely be possible to prepare suitable manuals in one of the major languages of the world which could be translated into local languages wherever they are needed. There are, of course, some difficulties in this; even the illustrations which would be needed are not necessarily universally applicable.

Finally the extension branch should be responsible for regular reports to the head of the service indicating the progress that has been made. More important, it should perhaps be responsible for preparing an annual assessment of the effectiveness of the various aspects of the work of the extension service.

The head of the extension branch must obviously be responsible to the head of the fisheries service for the planning of future work as

well as for the execution of the current programme. Equally obviously, any programme which is developed should comply with the objectives of the national development plan where one exists. However, while the head of the branch has this responsibility, he and his headquarters colleagues should not attempt to produce a master plan without consulting right down to the working level. The successful extension worker will be a self-reliant, intelligent individual who is in close contact with the people he serves. Together, they inevitably have a much clearer idea, not only of what is needed but also of what is practicable, than the headquarters staff. Planning should stars 'from the bottom up'.

In consultation with the members of the community he serves, the extension worker should plan a programme of work at least one year in advance; where problems which will obviously need a long-term solution exist, the programme may well look two or three years ahead. The programme should include possible means of solving the problem and must be agreed with the worker's superiors. They may be able to suggest alternative solutions and must, in any case, be aware of the budget that will be needed to see the plans through and of the calls that may be made on other staff, such as specialists. The plan should include the problems which most urgently require

solution but, within these, there should be a list of priorities and the worker must, of course, also be prepared to tackle unforeseen problems on an ad hoc basis whenever these arise.

Work of the field staff

The work of the extension staff in an artisanal fishery is very different from the work pattern followed by the members of a university staff who undertake extension work. The university worker normally lives in a community apart from that in which the fishermen live and he is almost invariably a specialist. The extension worker in the artisanal fishery, on the other hand, is a generalist and he lives right among the people with whom he works so that he can develop an understanding of the pattern of life in the fishing community. He must learn how local conditions affect the way in which fish are caught or cultured, the way in which they are processed and marketed, and how these operations are financed. He also needs to know how profits and earnings are used. Thus, the first task of any extension worker newly appointed to a particular district must be to prepare an inventory of the capital equipment available, including the human resources, and the ways in which these are employed (Yaseuda, 1972).

In preparing his inventory, the extension worker should note any

obvious deficiencies in the infrastructure (such as lack of berthing facilities, communications, transport and marketing facilities) as well as noting what particular skills are present or absent in the community. He will succeed in his job only when he gains the confidence of the community in which he is working and must, therefore, be on the look-out for obvious deficiencies which can be quickly and easily remedied. Examples might include: the placing of leading marks or lights in the approach to the landing point; the marking of a known hazard to navigation; improving the supply of engine spares, fuel, bait, salt or ice; making dental, medical and perinatal facilities available on a regular basis; improving marketing or storage facilities. If he does find that something simple is obviously lacking, he should not proceed to make good this deficiency without consulting the community first; many communities have a pet project of their own. If the extension worker can discover what this is and, if it is something which is practicable, then he should go ahead with this rather than attempting to introduce a project of his own. His own projects are likely to be equally important, or more important, than the ones that the community prefer but it is also important that the community should recognise early on that the extension service is intended to help them, not to indulge its own 'fancy' ideas (Cole, 1975).

Identification and handling of problems

As soon as the extension worker has obtained a good working knowledge of the pattern of life in the communities for which he is responsible, has established good working relationships with the members of the communities, and has set out his inventory, he should identify the most important and urgent problems in consultation with the communities and should work on these. He must, of course, prepare a work plan and discuss this with his superiors. He should meet his immediate superior at least once a month, report on the previous month's work and outline his plans for the coming month. In some cases he may be able to find solutions to local problems himself. In other cases, he will need to seek the help of colleagues or workers from other departments. Sometimes no-one in the government will be able to help and he must go to a commercial company for assistance. However, it is important that problems should be reported up through the service because sometimes the answer to a particular difficulty will already be available, a solution having been found in another part of the country or elsewhere. Sometimes no answer is readily available and research is needed to provide a solution.

The extension worker can, thus, be an important link between the

research stations and the fishing communities. This is one of the many reasons for saying that research stations carrying out fisheries work should be under the direct control of the officer in charge of the fisheries service. It then becomes possible for the extension branch to ensure that the work which they know is needed is given proper weight in the programme of work of the research stations. The immediate superiors of the fieldworker should require that he provides regular reports, which can conveniently be submitted verbally, as well as in writing, at a monthly meeting. The reports should note progress achieved, new problems that have arisen and any other matters of interest in the area in the worker's charge. There will be failures as well as successes and the reasons for both must be assessed and analysed; the service as a whole should adopt a very flexible outlook and be prepared to modify and change its plans as this becomes desirable.

A list of national objectives is, of course, a useful guide to the individual worker; a number of districts can often work on the same aspect at one time. The provision of literature is then a simple matter and the districts can be backed up with radio or television programmes.

Education

An extension programme is essentially an educational programme; the extension worker has to create situations in which others can learn and be stimulated to learn through the teaching systems (Bradfield, 1966). Since no two people have precisely the same physical or mental ability, some will learn faster than others; some will learn most easliy by listening, others by seeing, doing or by discussion. Some people will need all four processes, so the extension worker must be prepared to vary his approach and to use a variety of methods.

Suitable methods fall into three broad groups: those used with individuals, those used with groups and mass methods. Contacts with individuals may include home visits, office calls, casual contacts and personal letters. Home visits can be particularly useful since they provide opportunities for discussion of private problems which may not take place in other circumstances; they also give the extension worker an opportunity to meet the families as well as the fishermen to learn about family problems. Particular care is needed in writing letters to give advice. These should be as simple and to the point as possible and all letters must be readily understandable. Whenever

possible, a suitably illustrated fact sheet or pamphlet should be sent rather than a long personal letter. Even where there is no regular postal service, it is often possible to send letters by hand through delivery men or, for instance, through fish buyers.

Once an extension worker becomes known in his district, he can expect to do much useful work by means of casual contacts made in such places as fish markets, gear supply shops and boat yards or even by visiting fishing villages. Fishermen who do not come to his office or who cannot write will contact him informally in this way and he should treat these approaches just as seriously as the more formal ones.

Proper detailed records should be kept of all individual contacts; reference to these records would tell the extension worker, or his successors, all that they need to know about a particular fisherman, his way of life, his methods and problems, what has already been done to help him and the results. It is vitally important that any promises made during these contacts are kept. If an extension worker promises to send written advice, to make a contact on someone else's behalf or obtain advice for him, he must carry out his promise. Every extension worker should keep a detailed daily diary in which he

records all contacts and promises made besides his other activities. The diary is an official document and should be kept in such a form that it will be useful, and available, to his superiors and his successors.

Chambers (1974) suggests that agricultural extension workers should issue notebooks to the farmers in their district in which they record notes of their visits. This has the two-fold advantage of enabling superiors to check on the number of visits made to individual farmers and of providing a form in which any advice given can be left with the farmer. As far as is known, no fisheries extension service has ever done this but there are obviously some situations in which it might be useful. It might not be necessary to issue notebooks to individuals: these might be left with village headmen and then serve just as useful a purpose as if issued to individuals.

Group methods generally require even more careful planning than individual contacts. They may include meetings on a village or larger scale, demonstrations of methods or results, visits to other villages or fish landings and participation in shows. Group meetings are particularly useful in developing countries. They should be treated as opportunities for discussion rather than as lectures; the people, more

particularly the leaders, should be fully involved and encouraged to take active roles.

Fishermen are accustomed to learning by 'method demonstrations' since this is the way in which fathers teach their sons to fish. Subjects which would best be taught in this way include net making and hanging, net repair, new methods or variations in old methods of handling, processing and preservation (such as salting, smoking, drying and icing fish), manufacture of fish boxes and smoking kilns - all the usual practical skills.

'Result demonstrations' differ only in that they go a step further and show what happens as a result of varying or carrying out a particular process, for instance: that by hanging a net to the correct length you catch more fish; that properly iced fish keep longer than poorly iced fish; that well made smoked fish look and taste better and keep longer than poorly made smoked fish: that by doing it the new way, you can show a bigger profit for your labours. The essence is to compare two or more procedures.

Visits should be made when some parts of the country are carrying out advanced techniques which are not used in other parts. They are then especially useful as the visitors can imagine for themselves what

conditions were like before the changes were made, and can see the advantages of making the changes. It would obviously be very difficult to reach all members of the fishing communities; when new laws are enacted, fish prices changed or new methods prove outstandingly successful, then the mass media and other mass methods should be used. Newspapers, magazines and television cannot be used to reach all developing country fishermen; methods which can be used include radio (fishermen often sit mending their nets beside transistor radios), posters and handouts. Such material should be prepared for the extension service as a whole rather than by the individual extension worker.

As with any other educational programme, in an extension service programme it is necessary to check the progress being made and to evaluate results. This is more difficult with extension programmes than with any others because the students and teachers meet at undefined times in a variety of different places. Nonetheless an attempt must be made, otherwise no one will know whether the service is succeeding in its objectives or not. In most countries it would be difficult, if not impossible, to attempt to use even moderately sophisticated methods of evaluation such as systematic formal enquiries by teams of trained research workers; much simpler

methods are needed, particularly when dealing with illiterate or semi-literate people.

Effective checks on progress are made by requiring extension workers to submit regular reports in which they detail what they have done, where they have been and what they think the results have been, not only for the current period of work but also of work done in the past. Such reports are best presented verbally with accompanying notes at a regular meeting with the individual extension worker's immediate superiors. Every extension worker should of course have a clear planned programme showing exactly what he is going to do during the year and, in particular, what points he is trying to convey to fishermen or their families. This gives the individual workers confidence and makes it easier to check on the effectiveness of their programme. The extension programme is really aiming to change the attitudes of people in the fishing villages; even in the best circumstances, it is difficult to make anything other than a purely subjective evaluation of this.

Liaison between government departments and with other bodies

Advice about the technologies involved in fishing and fish handling will almost invariably be available within the fisheries department.

However, not all fisheries departments are able to advise on matters such as boat construction and, in most countries, there are specialised departments which deal with the marketing of agricultural and fisheries products and with the formation and operation of cooperative societies. Many of the projects with which an extension worker will be involved require that capital is provided from outside the immediate area in which he is working, often by the national government. Sometimes the running costs for some of his projects will be provided in the same way. Often fishermen or their families need advice on the care of their animals, the growing of their crops, fruit, coconut trees, or vegetables. Where major public works such as roads or bridges are required, then the public works department or its equivalent will be involved. In medical matters, workers at the Ministry of Health will be involved.

Clearly the people needed, some of them fairly senior in government service, will not 'come-a-running' when the extension worker, who is comparatively junior, whistles. Indeed, officers of other departments often show a marked reluctance to appear in fishing villages at all. When they do appear, their visit is often so brief that the dust raised by their arrival still hangs in the air as they make their departure. It is necessary to evolve a method of working which will ensure that the

fisheries extension worker is able to obtain the advice and assistance he needs from other departments and to integrate the efforts being made by the various government departments to develop a particular area.

Management of rural development

In recent years, a variety of different methods of providing for the integration of development have been tried in different parts of the world. Chambers (1974) provides a very valuable review of the management of rural development based on ideas and experience obtained in East Africa. The methodology recommended by Chambers is based on what he calls the programming and implementation management (PIM) system which was developed in Kenya from 1971 onwards. According to Chambers the PIM system has three main components:

1	A programming exercise, (which was annual and held just before or just after the beginning of the financial year). This is a meeting attended by all those directly concerned with implementation at which they jointly and freely draw up a phased work programme for the year.
2	A management meeting, (which was usually monthly). At this meeting

	attended by those concerned directly with implementation, progress is reviewed against the phased work programme, bottle necks are identified and remedial action agreed upon.
3	An action report, (which was described as a monthly management report), summarising briefly the progress made and problems encountered, naming those responsible for action. It is sent quickly and simultaneously to those concerned at different levels in Government.

Anyone concerned with rural development would find Chambers exposition of great value. In some situations, it is possible to hold regular meetings attended by all departments involved in rural development. However, the group meeting must be small or it degenerates from a 'workshop' to a 'talk shop'.

A somewhat similar system was evolved in Malaysia in the 1950s and 1960s, which suggests that a system of this kind can be made to work under widely differing conditions. Like everyone else who has been involved in the development process, Chambers is insistent that the people who are being helped should be intimately involved at every stage of the process and that their thoughts and ideas should be incorporated in any programme which is developed. Development must come from the bottom up not from the top down.

Training for extension workers

In Europe and North America, the people who carry out extension work in the field are often university graduates. Such people are seldom broadly trained generalists; most usually they are specialists and, in some cases, so highly specialised that they may be responsible, for example, for quality control aspects of fish processing rather than working in fish handling generally. These people could, of course, be very useful in the development of an artisanal fishery; unfortunately, they are far too expensive to be employed in these situations. In the developing world, the fisheries extension worker should be a well-trained generalist technician who has a good understanding of a number of different technologies including boat-building and maintenance, fishing gear maintenance and fish handling, processing and marketing, among other subjects. In most territories which were formerly under British control, three levels of grading in the government service are recognised: the more senior posts being filled by university graduates, the middle level posts by diploma holders who have attended a three-year course of instruction following secondary school and the more junior posts by certificate holders who have attended a two-year course of instruction following secondary school. Cole and Hall (1973) discuss job specifications and

standards of proficiency in considerable detail. The fisheries extension worker would normally be a certificate holder, his immediate superior would have a diploma while the more senior officers in a fisheries department are usually graduates.

Cole and Hail (1973) set out in their curriculum No. 39 'Fisheries Assistants' the training syllabus used for fisheries assistants in Uganda. The course was designed for people who would be working in freshwater fisheries and needs modification for people working in marine fisheries in other parts of the world. In addition to the basic science, mathematics and technology set out in this course, a student who is to work as a fisheries extension officer needs training in the principles of adult education and mass communication, and the management and operation of fisheries co-operative societies. Cole (1975a) suggests a curriculum for use in Nigeria for training extension workers during a two-year certificate course; unlike the Uganda course, this one is not yet in operation.

Any course of this type needs to include subjects such as basic sciences and mathematics, statistics, fisheries co-operative societies, principles of adult education and mass communication, ecology, fisheries biology and aquatic sciences, handling, preservation,

processing and marketing, fisheries management, fish culture, fishing gear technology, navigation and seamanship. It is also very important that students should be taught to write clearly and concisely; they should be given plenty of practice in this and in taking part in and controlling meetings, delivering lectures and carrying out demonstrations. In general, the aim should be to arrange the course so that at least half the student's time is spent in practical work.

In some countries, students are selected for a three-year diploma course rather than for a two-year certificate course at the time they leave school. Since this frequently results in the training of people who then prove unsuitable for the type of work they are expected to do, it seems to be much more sensible to arrange that new recruits to the fisheries department work for at least several months in the field before they undergo any training at all. They should then attend a two-year certificate course before returning to the field; only those who have passed the two-year course satisfactorily and have then proved themselves useful in the field should be selected for a third year of training leading to a diploma and, in most cases, to immediate promotion. No one should fill, or attempt to fill, a supervisory role in a fisheries extension service unless he has himself worked at the most basic field level.

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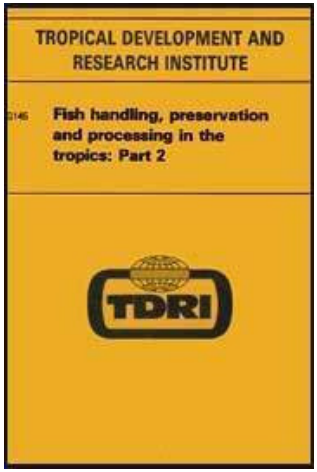

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- Food by-products
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- Fish meal
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- Chemical and physical methods of quality assessment
- Organoleptic (sensory) measurement of spoilage
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- Microbiology of fish spoilage
- Public health microbiology
- International standards for fisheries products
- Large-scale fish landing facilities
- Small-scale landing facilities: design and operation
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- Fisheries extension services: their role in rural development

Training in the field

Most developing countries have training programmes designed to help the rural community improve its standard of living. These are often in the form of extension services aimed at the peasant farmer or fisherman. The aim of extension services is to help the villager to help himself and the aim of every extension worker should be 'to leave the community in a better state than he found it'. The extension worker usually has a general knowledge covering a particular field; however, he must have easy and direct access to experts in other fields, in case problems arise with which he is not capable of dealing. The extension worker must ascertain what is best for the community in which he is to work and he must also realise that there are many constraints which tend to prevent any improvement. It is most important that, as far as possible, the results of his efforts should be quantified; for example, he should be able to demonstrate that any innovation he may suggest to a fisherman or his family will show some benefit. This should ideally be in the form of cash benefits to the fisherman; for example, he may be able to sell his processed fish at a higher price because it is of better quality or he may be able to catch more fish for

the same effort because of improved gear or boats.

Not only should an extension worker be able to give advice and demonstrate improvements in his own particular field but he should also be able to see what is necessary for the improvement of the community as a whole. For instance, a village may require a clinic, a water supply or better sanitation, a primary school or advice on growing crops. The worker may not be able to do any of these things himself but he should know whom to contact in order that something can be done.

Training extension workers

Before an extension worker can go out into the villages and start training others, he will need training himself. It is in this area that many difficulties begin to arise. To determine the most appropriate training for an extension worker, we need to know the sort of problems he is likely to encounter in his work and the training organisers must, therefore, be familiar with the village situation. All too often, people from outside the country come into a particular area to teach extension workers improved methods for the fisheries industry and, before they start work, they do not get to grips with the real problems that are being encountered in the local fishing

community. To import known technology from other countries without at least seeing whether it is appropriate to the particular situation is foolhardy to say the least. The technology and knowledge that should be imparted to an extension worker comes from various areas i.e. from the experience of others in similar situations, from the experience of the trainer himself, and from people working in the country concerned The trainee should be able to ascertain from this information and from his own experience the sort of improvements that are most likely to be of use to the fishermen. This groundwork is most important; otherwise the extension worker may get into the field and find that what he has learned is of little value. Once the method to be taught (e.g., improved processing, net mending etc.) has been decided, a syllabus can be drawn up. The details and background to be included depend to a large extent on the education and the previous experience of the extension workers.

This brings us to the next point for consideration. Whom does one select for training? In most cases, the prospective extension worker will be someone who is already employed by the fisheries department. He will, therefore, have some knowledge of the fishing industry in his own country and should know something about the fishery in which he is going to work particularly. Before undergoing

any training, the extension worker must also realise that his life in the field will not be easy: extension work can entail spending many months away from home and family under fairly arduous conditions. It is often advisable that a worker should spend a probationary period in the field with an already established extension worker before he undergoes any training. This will select out from prospective candidates those that really do not fit in to the type of life-style which will be encountered. He will be working without direct supervision most of the time and must, therefore, be conscientious and hard-working. He must be able to get on with people without losing his patience and drive. He will also be working in a strange environment where he will be unknown and his presence may be resented by some members of the community which he is in fact trying to help. He must not tee 'put off' by the initial reaction of the group in which he is to work; he may find them hostile to begin with but, if he is doing his job properly, they should accept him and gain confidence in him. However, when improvements can be introduced and adopted by the community, extension work can be very rewarding. It is extremely important, therefore, that the right sort of people are chosen to become extension workers.

In addition to the personal qualities outlined above, there are

professional qualifications that must be taken into account. The most important consideration is that the extension workers must be more able than those they set out to advise. If extension workers are to demonstrate fishing techniques, they must be able to out-fish the local fishermen; if they are to demonstrate processing techniques, they must be able to show that the products they make will keep better than the traditional ones, or fetch a better price or both. Extension workers must be well-educated in the first place so that they can keep abreast of developments within their own country and they must be well-trained. This training must include practical instruction and practice in the methods they are likely to be demonstrating. The level to which the workers must be trained depends on the level of competence of the fishermen themselves. The general principal is that the workers should be at least one stage ahead.

Methods of getting information to the fishermen

In the previous session, three separate methods were outlined for making sure that a fisherman gets the information which he requires to increase his livelihood:

1. Individual training on a one-to-one basis

2. Group discussions and meetings
3. Mass media methods.

Individual methods

The purpose of making individual visits to fishermen includes: giving information to a particular fisherman that suits his own individual situation and problems; arousing interest in problems which the fisherman has yet to recognise; and obtaining information from the fisherman about his own problems and the local situation.

By making these visits, the extension worker gains first-hand knowledge of the actual problems encountered by the fishermen. He develops the goodwill and confidence of the fishermen in himself and his recommendations. Individual teaching on a one-to-one basis is most effective. However, these types of visit require a great deal of time and the number of people who can be reached through this method are few. The visits are, therefore, a costly method of extension. Another disadvantage is that there will be a tendency for the extension worker to visit the same fisherman time and time again after he has built up a relationship with him. This will make problems of contact with the community as a whole and may arouse jealousy and resentment amongst the other fishermen who are not visited as

regularly. It is important that a visit to an individual fisherman should be planned beforehand. Some points worth noting are as follows:

Plan the visit by:

(a) Making an appointment if possible.

(b) Deciding the purpose of the visit.

(c) Reviewing the record of previous visits.

(d) Checking any subject matter and information which is needed by the fisherman that may have arisen from previous visits or may be likely to arise during the planned visit.

(e) Scheduling visits to a number of different fishermen to save on time and travel.

Whilst making the visit:

(a) Be punctual.

(b) Be friendly and greet the man with whom you are going to talk openly with good manners.

(c) Find something to praise amongst the fisherman's activities. This will give him confidence in you.

(d) Get the fisherman to talk about the problems which he has at present.

(e) Get the fisherman to ask you for a solution to the problem that he has outlined.

(f) Give alternative solutions and information so that the fisherman could follow any one of the different alternatives.

(g) Demonstrate any skills that the fisherman may need to learn to put into practice any of the new methods demonstrated.

(h) Encourage the fisherman to come to a decision as to which of the alternative solutions may be the best for him.

(i) If the fisherman is able to read, give him essential information about the methods in writing.

(j) Keep any information about the fisherman confidential, especially his personal circumstances.

(k) Make notes for your own records of what has been achieved.

(1) Encourage the fisherman to participate in any group extension activities.

Follow-up

Fill in a record card or book and send any literature requested to the fisherman. If there is need for specialist help in any particular areas, make arrangements for this to be provided.

Not only does the extension worker need to make visits to individual fishermen but he will also have the fishermen call on him in his office. These will be either personal visits or in the form of letters written to him individually asking for information and advice. It is important that these visits are treated with as much importance as the visits by the extension worker to the fisherman. If the fisherman has a problem and has taken the trouble to come to the extension worker's office, then he must feel that it is an important problem and that the extension worker can help him.

Literate fishermen will write for information and these letters must be answered punctually and with all the information that is required by

the fisherman. Letters should be clear and concise and should not be too long. Badly written letters may destroy any confidence that the extension worker has built up within the community. Although extension workers do not reach many people by means of individual letters, they are important in gaining confidence and creating a good impression of the extension service.

Group methods

Individual extension teaching methods as outlined above are costly to undertake in terms of time and effort and only reach a limited number of people. For these reasons, much extension teaching activity consists of group methods. Group activities are organised for a variety of purposes. It may be to give and receive information about a programme; to encourage and advise and train leaders; to create awareness and interest in a new fishing practice; or to focus attention on group problems and possible solutions. Very often, fishing skills can be taught to a group at demonstrations or in a training centre. Group methods can be divided into three broad types:

Extension meetings

Extension meetings are held to introduce and discuss a new idea or

practice and to obtain from the community their opinions as to whether it is feasible within their own situation. If meetings are to be really effective, then they must be planned carefully and good publicity given to the meeting so that all the important people within the community are available. Meetings should not be held unless they are absolutely necessary. Unnecessary meetings are a waste of everyone's time and, if one meeting proves to be unnecessary, then support for further meetings will not be forthcoming. For a check list of the areas that must be considered in planning a meeting, one should refer to 'Guide to Extension Training' by D. J. Bradfield published by FAO.

Demonstration meetings

The main purpose of a 'result demonstration' is to prove to fishermen that a new recommendation is practicable and increases either his catching ability or the quality of his product. For example, if an extension worker wishes to introduce a different sort of fishing gear to the community, he may well make a demonstration comparing the traditional gear with the new design. From this demonstration, it will be clear to the community that there are advantages to the new gear proposed by the extension worker. It is important that, as much as

possible, the local community and fishermen should themselves be involved in making the demonstration. For instance, they should be responsible for actually setting a new net using their own boat etc. for that purpose. If the extension worker was to do all the work himself, there would be doubts amongst the community as to the validity of the results obtained. A demonstration meeting must be planned very well in the beginning if it is to be effective. Again reference to 'Guide to Extension Training' by Bradfield should be made.

A second type of demonstration meeting is the 'method demonstration'. The purpose of a method demonstration is to actually teach a fisherman or a group of fishermen new skills rather than suggest why a new skill might be worthwhile. A method demonstration is usually attended by fishermen who have already accepted that the particular practice being demonstrated is of benefit to them. They have been taught why it is of benefit by means of a results demonstration or some other extension method. Now they want to know how to carry it out themselves. These sorts of demonstrations must again be carefully planned and carried out. It is important that, before the meeting, an outline is made of the operation to be demonstrated in logical steps. Certain points will need particular emphasis and these should be clearly defined during

planning. If possible, a fisherman himself should carry out the demonstration. He will need to be rehearsed in advance to explain to the audience what he is doing and why. Again a useful list of points to bear in mind when planning a demonstration of this sort is in the book by Bradfield.

Field days

It is often useful for an extension worker to be able to demonstrate a particular practice in the actual situation in which the fisherman finds himself. With the co-operation of a local fisherman who has adopted a particular method, a field visit to that fisherman will be useful for others in the community. Field visits are usually organised for small groups. If too many people are involved, they will not have enough time for discussion, questions, and inspection. People invited to attend a field visit should usually be those who will benefit most from the visit and who are likely to be most effective in supporting the extension programme. Once again, field visits need very careful planning. Another sort of visit can be arranged as a tour. A number of people from the fishing community may be invited to visit various places of interest to them so as to acquaint themselves with practices used by other fishermen.

Mass methods

Individual and group methods involve personal contact between the extension worker and the fisherman as an individual or a member of a group. In mass media methods, there will be no direct personal contact between individuals but messages of importance to all fishermen can be imparted through such media as the newspapers, radio, publications, agricultural exhibits etc. It is found throughout the world that many fishermen have a radio and will listen to it whilst sitting beneath a tree mending their nets or they will take a radio with them when they go fishing. To impart information concerning new methods and to give publicity for meetings, a radio may well be the most important means. Mass media are not especially costly when it is remembered that, with little effort and experience, an extension worker can reach very many people with his message. Newspaper stories can also reach many people who might not otherwise seek information from extension workers. However, it must be remembered that many fishermen throughout the world are illiterate and would not be able to read the message if it was printed in their local paper.

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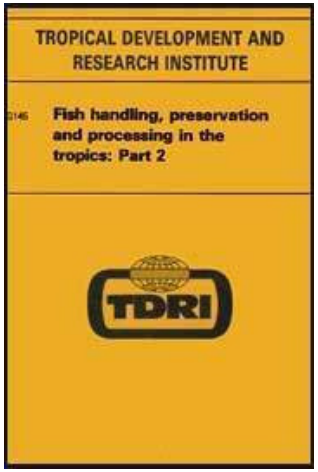

- Boiled fish products
- Fish canning: theory and practice
- Freeze drying
- Irradiation
- Miscellaneous products: crustaceans
- Miscellaneous aquatic products used as food
- Food by-products
- Non-food by-products
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- Fish silage
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- Organoleptic (sensory) measurement of spoilage
- Microbiology of spoilage
- Microbiology of fish spoilage
- Public health microbiology
- International standards for fisheries products
- Large-scale fish landing facilities

Appendix

Films shown during the course

1. 'Handling the Catch': Colour (10 mins) 1962 Illustrates good practice in handling the catch on a distant-water trawler.

Producer and distributor: Central Office of Information Overseas Distribution Section Hercules Road London SE1 7DU

2. 'Cold as Ice': Black and white (10 mins) 1960 Stresses the need for good icing of wet fish in the UK at all stages in the distribution chain.

Producer and distributor: Central Office of Information (address as for

1)

3. 'Freezing Fish at Sea': Colour (14 mins) 1970 Demonstrates good practice in handling, freezing and storing the catch aboard a freezer trawler.

Producer and distributor: Central Office of Information (address as for 1)

4. 'Handling Frozen Fish': Colour (18 mins) 1969 Illustrates bad practices in handling fish before and after freezing on shore and during the distribution chain, and points out ways of improving these practices to maintain quality.

Producer and distributor: Central Office of Information (address as for 1)

5. 'Allibert Plastic Fish Crates': Colour (22 mins) Plastic stack/nest fish crates are shown to have many advantages over wooden and metal boxes. Their use in several French fishing ports is demonstrated.

Producer: The Allibert Co., France

Available from: Film and TV Section
Food and Agriculture Organization of the United Nations,
Via delle Terme di Caracalla
00100 Rome
(Film No 282A, FAO Film Loans Catalogue)

6. 'Fish Spoilage Control': Colour (10 mins) 1957 Animated cartoon illustrates the importance of care and hygiene in avoiding bacteriological contamination of fish at all stages of distribution. Correct methods of handling are shown.

Producer and distributor: National Film Board of Canada
Available from: FAO (address as for 5) (Film No 855, FAO Film Loans Catalogue)

7. 'Como se Produce el Bacalao': Black and white (10 mins) in Spanish Demonstrates the production of salted cod in Norway for export to world markets. Shows handling on board fishing vessels, processing stages on shore and transport in refrigerated vessels.

Producer: Toralf Sand, Norway
Distributor: Association of Norwegian Codfish Exporters

**Available from: FAO (address as for 5)
(Film No 285, FAO Film Loans Catalogue)**

8. 'The Key to Cleanliness': Colour (22 mins) Demonstrates potential hazards from bad handling practices in handling foods. Illustrates that microbiological safety can be ensured through proper attention to cleanliness. The film is aimed at improving hygienic standards in food processing factories.

**Producer: J Lyons & Co.
Hired from: Guild Sound & Vision
Ltd.
Woodston House
Oundle Road
Peterborough PE2 9PZ**

9. 'Fisheries Development on Lake Malawi': Colour (17 mins) 1976. Also available with Spanish commentary. Illustrates co-operation between the Government of the Republic of Malawi, the Food and Agriculture Organization of the United Nations and the Tropical Products Institute in a fisheries development project.

Producer: Tropical Products Institute

**Distributor: Central Office of Information
(address as for 1)**

10. 'Shark Processing in the Caribbean': Colour (13 mins) 1972 Shows part of a UNDP/FAO fisheries development project, aided by Surinam Fisheries Foundation, in which shark are caught, processed and marketed. The shark meat is salted, dried and smoked or prepared as a smoked salmon substitute.

**Producer and Distributor: UNDP/FAO
FAO (address as for 5)**

(Film No 860, FAO Film Loans Catalogue).

**Printed in the United Kingdom for HMSO
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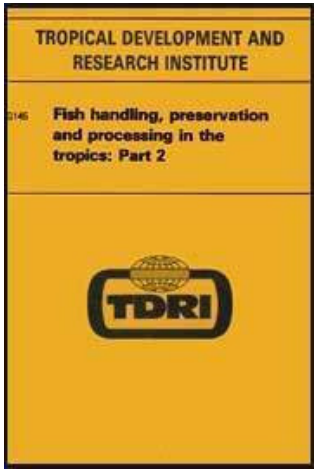

Introduction

The set of fifty-two lectures covered by TPI Reports G144 and G145 has been prepared for a course lasting approximately eight weeks. The course is designed for people at middle-management level in both Government and Industry. Government staff would include Fisheries Officers and Senior Extension Workers who have a fisheries background and degree level qualifications.

Each lecture session would normally last for about 45 minutes, although some might be expanded to provide two such sessions. Much depends on the linguistic competence of the lecturers and participants and also on the students' level of understanding of basic science. The course should include many practical and demonstration sessions to illustrate the theoretical considerations presented here. In general terms one half of the course time could be devoted to lecture sessions and one half to practice and observation. Extensive use of overhead projector, blackboard, colour transparencies and films is recommended. A list of films suitable for showing during the course is appended.


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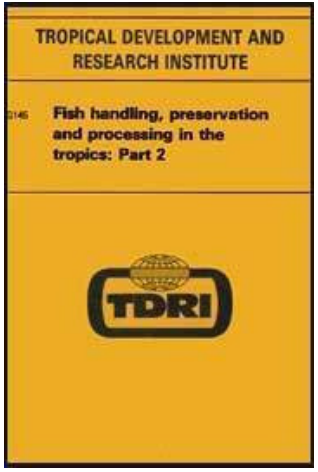

Fish Handling, Preservation and Processing in the Tropics: Part 2 (NRI)

Salting of fish: salt

Salting of fish is a traditional processing method in most countries of the world. Very often salting is used in combination with drying and smoking; the following lectures on salting, drying and smoking outline the basic principles and discuss the practical application of the various methods that are in common use.

The presence of sufficient quantities of common salt (sodium chloride) in fish can prevent, or drastically reduce, bacterial action. When fish are placed in a strong solution of salt (brine) which is stronger than the solution of salt in the fish tissue, water will pass from the tissue into the brine until the strength of the two solutions is equal. At the same time, salt will penetrate into the tissue. This phenomenon is known as osmosis. A concentration of between 6 and 10 per cent salt in the tissue will prevent the activity of most spoilage bacteria; the removal of some water from the tissue during the salting process will also reduce the activity of the spoilage bacteria.

If fish are salted before drying, less water needs to be removed to achieve preservation. A water content of 35 - 45 per cent, depending on the amount of salt present, will often prevent, or drastically reduce, the action of bacteria.

Salt: sources, composition and properties

Pure common salt is sodium chloride (NaCl) but almost all commercial salts contain varying levels of impurities depending on the source and method of production.

Commercial salt can be classified into three main groups depending on the source and the method of manufacture:

(i) Solar salt - prepared by the evaporation of sea or salt lake waters by the action of sun and wind. Major centres of production tend, therefore, to be found in tropical or sub-tropical countries.

(ii) Brine evaporated salts - underground salt deposits are brought to the surface in solution (a brine) and this is evaporated, usually by heating.

(iii) Rock salt - natural deposits of salt are ground to varying degrees

of fineness without any purification.

The suitability of salt for any particular application depends upon several factors, the most important of which are:

(i) the chemical composition;

(ii) the microbiological purity;

(iii) the physical properties.

Chemical composition

Commercial salts vary widely in their composition; high quality salt may contain 99.9 per cent sodium chloride, whereas low quality salt may only contain 80 per cent sodium chloride. Apart from contaminants such as dust, sand and water, the main chemical impurities of commercial salts are calcium and magnesium chlorides and sulphates, sodium sulphate and carbonate, and traces of copper and iron. Solar salts tend to be less pure than mine-evaporated salts.

Calcium and magnesium chlorides, even when present in small quantities, tend to slow down the penetration of salt into the flesh;

the presence of these salts may also increase the rate of spoilage. Magnesium chloride is hygroscopic and tends to absorb water, making the fish more difficult to dry and to keep dry.

Fish salted in pure sodium chloride may be soft and yellow in colour. Calcium and magnesium salts give a whiter colour but tend to impart a bitter taste. Very often the consumer demands a whitish colour in salted fish products and small quantities of calcium and magnesium compounds in the salt are usually considered desirable. Excessive quantities, however, lead to a bitter flavour and the dried product tends to be brittle which can cause problems during packaging and distribution.

Trace quantities of copper can cause the surface of salted fish to turn brown; this does not reduce the eating quality but it does make the fish look like a spoiled or poor quality product.

Microbiological purity

Many commercial salts, particularly solar salts, contain large numbers of salt tolerant bacteria (halophiles) and counts of up to 105/g have been recorded. One group of halophiles, the red or pink bacteria, can be a problem in commercial fish curing operations as they cause a

reddening of wet or partly dried salt fish. They do not grow when the fish are fully immersed in brine or when they are fully dried. Halophilic moulds can grow on fully dried fish and cause the formation of dark patches, which is called 'dun'. Halophilic moulds tend to occur more frequently in rock salt.

It is possible to sterilise or add preservative agents to salt to control the growth of halophilic organisms but this is very often too expensive for commercial use. Most salt used in fisheries contains appreciable numbers of halophiles.

Physical properties

Fine grain salt dissolves more rapidly in water and is preferred for making brines. If fine grain salt is used directly on a fish, it may cause a rapid removal of water from the surface which becomes hard and prevents the penetration of salt to the inside of the fish; this condition is called 'salt burn'. For dry salting, a mixture of large and small grain sizes is recommended.

Uptake of salt by fish

Several factors which affect the rate at which salt is taken up and

water is replaced in fish are:

(i) the higher the fat content, the slower the salt uptake;

(ii) the thicker the fish, the slower the penetration of salt to the centre;

(iii) the fresher the fish, the more slowly salt will be taken up;

(iv) the higher the temperature, the more rapid the salt uptake.

During subsequent drying the presence of salt has the following effects:

(i) the higher the salt concentration, the greater the replacement of water and, therefore, the less water that remains to be removed during drying;

(ii) the higher the salt concentration, the less water that needs to be removed to produce a satisfactorily preserved product;

(iii) the higher the salt concentration, the more slowly the fish dries;

(iv) salt tends to absorb moisture from the air and at relative

humidities of more than about 75 per cent during the drying process or during subsequent storage, fish will not dry further; they may even absorb more moisture.

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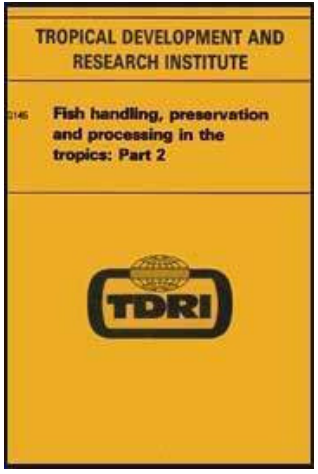

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Salting of fish: methods

Methods of salting

Salt is applied to fish by the following basic methods:

Brine salting	- the fish are immersed in a solution of salt in water.
Dry salting	- granular salt is rubbed into the surface of the fish.
Kench salting	- granular salt is rubbed into the surface of split fish and the fish are stacked with a sprinkling of salt between each layer of fish. The liquid

(pickle) which forms is allowed to drain away.

Pickle salting - fish are covered with salt and then packed in water-tight containers in layers with salt sprinkled between each layer. The pickle which forms covers the fish; if the fish are not completely covered in 3 - 4 hours, saturated brine is normally added to completely immerse them. A cover should be placed on top of the fish to hold them below the surface of the pickle.

With most brine salting techniques, a saturated brine solution is used. The presence of impurities may reduce the actual concentration of sodium chloride in solution and, in practice, the brine strength ranges between 80 and 100 per cent, which corresponds to 270 - 360 grams of salt to each litre of water. When fish are placed in saturated brine, the concentration of the brine begins to fall as soon as salt begins to penetrate the fish and water is removed. Unless plenty of brine is used and the fish are stirred frequently, the rate of salt penetration and water removal may be seriously reduced.

During pickle curing, the fish are surrounded by granular salt which, initially, dissolves in the surface moisture of the fish. Sufficient salt is then available to go into solution and maintain the pickle at saturation point as salt penetrates the fish and water is removed. The water

extracted from the fish also contains blood and other compounds that help to reduce the rate at which fat in the fish is oxidised.

Dry or kench salting cannot be recommended for general use in the tropics as the fish are not covered by the brine or pickle and are, therefore, more susceptible to spoilage and insect attack. Exposure to the air and the presence of salt also encourages the rate of fat oxidation which gives rise to discoloration and the characteristic rancid flavours. Fish should be covered with a saturated brine or pickle as rapidly as possible and kept covered until salting is completed.

The various chemical and physical effects of using salt on fish were discussed earlier. Several of these are apparently contradictory and in commercial salted fish production a compromise may have to be reached to resolve the various factors. The rate of salt penetration of the flesh increases as the temperature rises; increasing the temperature also increases the rate of spoilage. If fish are salted at a reduced temperature, e.g., +5°C, although the rate of salt penetration is reduced, the rate of spoilage is more drastically reduced and it may be possible to salt the fish to the centre before any serious spoilage occurs. Similarly, salt penetration is slower in fresh fish than it is in

partly spoiled fish but it is impossible to make a good salt fish product from spoiled fish. If fish spoil in the centre before the salt can penetrate, it produces in cod (Gadus sp.) what has been termed 'putty fish', where the centre is very soft and the texture is destroyed. In many fisheries, large fish are split before salting; this increases the surface area and also reduces the depth of flesh that the salt has to penetrate.

Wooden and plastic barrels are suitable for brine or pickle curing fish; the container should be of a size and shape which allows the largest fish normally handled to be laid flat. Cement-lined vats or tanks are suitable for larger quantities of fish and the vats should be able to hold one days' catch with an internal depth of one metre. Wooden lids fitting internally to the tanks which can be weighted down to hold the fish beneath the brine should be provided. Vats and tubs should be situated in the shade to keep the fish as cool as possible.

The quantity of salt used depends upon the type of cure required, the type of fish and the method used. For a strongly cured product, approximately 30 kg of salt per 100 kg of fish is required.

Spoilage of salted fish

Although salt prevents the growth of spoilage bacteria, other micro-organisms are not so affected by the presence of salt. Micro-organisms can be conveniently divided into three groups by their sensitivity to salt:

(i) Low tolerance - growth is stopped, or the organism is killed, by the presence of low concentrations of salt. Most of the normal spoilage organisms fall within this group and a salt content of a few per cent will prevent growth.

(ii) High tolerance - organisms which can tolerate high concentrations of salt although the rate of growth is usually reduced, or stopped, at very high salt concentrations.

(iii) Halophiles - those organisms which cannot grow without salt.

With dry salted fish, the salt-tolerant and halophilic organisms can continue to grow but they cannot do so in pickle-cured products: most of them are aerobic organisms and the fish and brine of pickle-cured fish contains very little, or no, oxygen.

Most enzymic activity is stopped in heavily salted fish but, with lighter cures, the fish may develop characteristic flavours as a result of

enzymic activity and the growth of certain salt-tolerant organisms. If the salt levels and fermentations are not carefully controlled, putrefactive spoilage may occur.

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