FISH HANDLING AND QUALITY CONTROL WORKSHOP - VICTORIA

ASSESSMENT AND FOLLOW-UP

(A) Attendance: (i) Melbourne
92 registrations - 120 attended during day

(ii) Lakes Entrance
16 registrations - 18 attended during day

(iii) Portland
39 registrations - 55 attended during day

: Amended registrations outstanding - VFITC action

: NB. Attendance excludes speakers and organizers

(B) Participation: 1. General

(i) Eight speakers delivered 40 minute papers each. Broken into 15 to 20 minute papers followed by discussions with workshop attendants.

(ii) Lakes Entrance and Portland Workshops ran beyond time limits due to level of discussions that ensued each speaker.

(iii) Melbourne lunchtime guests - Mr Gordon and Mr King (backed by valuable promotional services Eric White and Associates/VFITC Ltd) successfully demonstrated the following:

(a) Education, public awareness and industry involvement in promoting fish as a "two way level" in improving quality and profitability.

(b) Relating c nsumer needs to the workshop especially in the area of handling, preparing, cooking and eating seafoods.

(iv) More fishermen were expected at the workshops (many had paid registration fees) but fine weather prevented their attendance.

(v) Channel 8 ABC Sale provided television coverage of Lakes Entrance workshop. Televised throughout Victoria regional area on the evening news of 28/5/80. Possibly explains high attendance at Portland.

2. Involvement: discussion (forum) details. The major points of discussion raised at the workshops were as follows:

(i) Definition of Quality

Defining quality (sensory method) not well understood. Familiarization of species at present outside those not involved in the industry. Need for information in this area. Appreciation of handling chain which effects quality - limitations imposed. Appreciation of fish tasting panels, health inspectors etc. roles in extracting knowledge and quality of Australian fish species.

(Portland and Melbourne workshop)

(ii) Species Identification

Call for standardization of fish names (nationally) so that retailers, restauranteurs and the public can buy, sell and prepare fish with greater confidence.

(All workshops)

(iii) Containers for fish (Lakes Entrance and Portland)

Better quality could be achieved if fish containers as used in the fresh (scale) fish industry were adapted ie. call for

(a) Modifications of bulk bins (400 kg to 600 kg containers) as used in transporting fish. Could be conveniently shelved to prevent physical damage (excessive weight) eg. gemfish, blue grenadier and shark.

(b) Smaller containers for lesser species and quantities eg. Terikihi (morwong), flathead, latchet, etc. to improve quality ie. improve shelf life and presentation.

(iv) Supply and demand Factors influencing quality and profitability. General discussions on how well organized the fish marketing chain can/should be in relating requirements to each other. Marketing systems (Vic.) capacity for national profit flow. Indications that co-operatives, processors etc. should continue to co-operate to maximise fish usage eg. transhipment of fish in glut situation. Limits imposed by marketing (auction) logistics with respect to handling fish correctly - boxing and re-icing fish. Discussions on automation of vessel/shore installations in regard to correct icing procedures (especially in glut situations). Processors outlined limitations in processing, freezing and packaging fish (keep fish cold, keep it clean, keep it moving maxim).

3. Assessment

(i) Pending Dennis Mirabella VFITC Ltd/Dr John Summer RMIT/David Malloy Vic. State Fisheries analysis of complete taping of all three workshops.

(ii) Follow up

.....1. Need for further education of industry/public to improve knowledge of, awareness and confidence in handling fish.
Re: Action taken by Export Standards/ Marketing/Education sections.

.....2. Need for follow-up at the research/assistance level to improve container/handling system of fish (perhaps experimental - pilot study basis).

.....3. Role of co-ordinating body to help implement changes DPI education/AFIC/NFITC/Extension services (CSIRO).
Re: Mr Purnell-Webb's letter F75/326 No.50.

.....4. Follow-up of iniatives taken by Workshop committee aimed at needs of industry (as outlined by those that attended workshops), otherwise efforts/image of State Fisheries/ VFITC Ltd/DPI will be jeopardized.

L. Barnes

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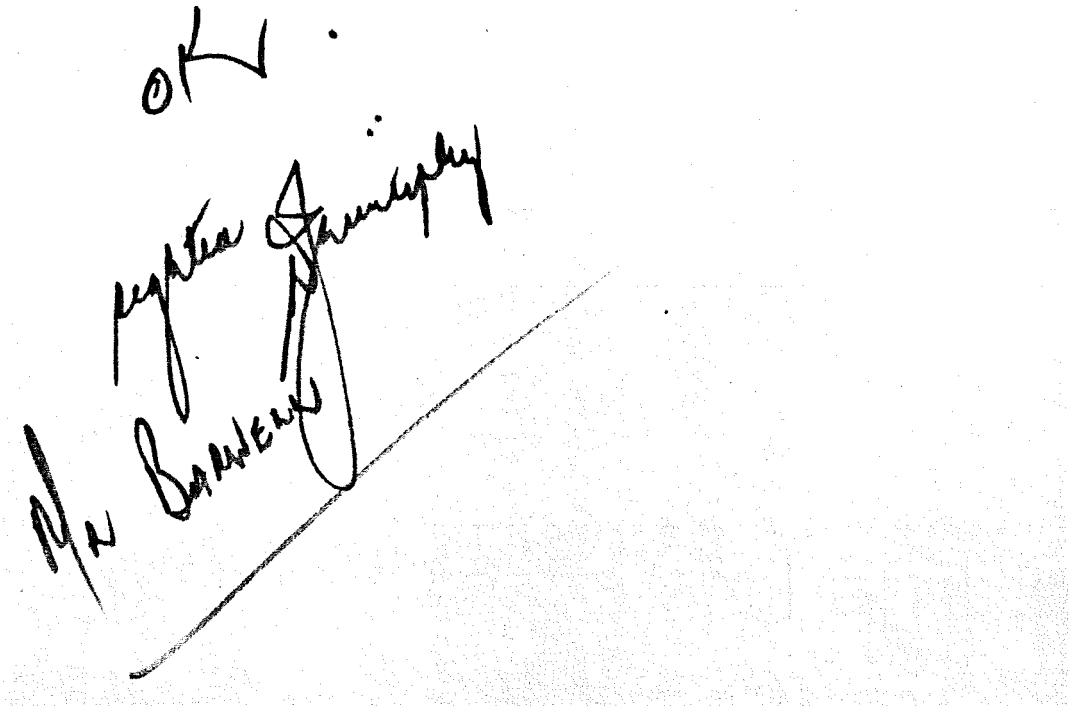

HANDLING AND PROCESSING OF FRESHWATER CRAYFISH

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Handling and processing of all Aquatic Foods must be viewed with caution. The reason for this is because most seafoods are "highly perishable".

Foods are complex mixtures, made up of organic chemical constituents biologically active. These organic chemicals contribute to the delicate sensory attributes of all foods.

Foods are recognised by their characteristic sensory attributes, and the development or loss and degradation of these characteristics is a function of the biological activity of the constituents.

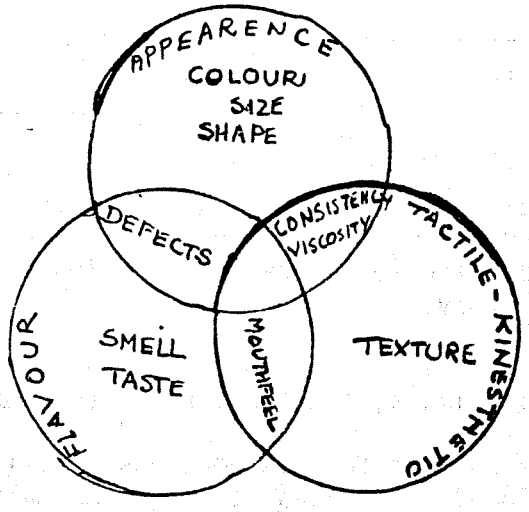

FIGURE I: Composite of Food Characteristic.

The general acceptance of certain desired characteristics of the food, constitutes the quality of the food, so that the term "Fresh" can be defined as that quality in which the desired characteristics, are retained to a maximum with little or no change.

Unlike many fruit and vegetables, in most animal foods, biological degradation is very rapid after the death of the animal, resulting in a very rapid loss of the sensory characteristics. A stage could be reached whereby not only the sensory characteristics are effected, but the products of decomposition could make the food unfit for consumption.

The composition of foods are expressed in terms of the basic constituents:

Moisture	75% to 90%
Protein	15% to 20%
Fat from less than	1% to more than 10%
Ash (Minerals)	1% to 2%

The flavour and texture of foods is largely influenced by the balance of the above constituents, and a small change in the above constituents can alter the sensory characteristics of the food products.

Most seafoods, unlike meat and poultry and fruit and vegetables have a very delicately bound composition.

The reason why specific fish flavours can be recognised is because constituents like proteins, fats, contain specific groups which contribute to the particular characteristic of the seafood. This unique condition in the grouping of the constituents is used to determine not only the quality of the seafood, but also techniques have been developed so that the species of the seafood can be detected even after the seafood is processed or cooked..

In this paper the discussions will be confined to the role of moisture and protein, since in the composition of most crustacea fat plays a very unimportant role.

Fish and shellfish are terms used to indicate the more common forms of aquatic foods.

The edible portion of these foods is referred to as the "muscle" and it is obvious from the terms used that the type of protective coating, is that the distinguishing characteristic. In most shellfish the hard shell cover is the protective coat.

The protective coat in fish is the skin and scales, which are protein in composition, and are provided with a mechanism, for lubrication against friction during its movement in aquatic media, by the ejection of a slimy fluid. Hence fish are fast moving and migratory.

Crustacea on the other hand, are provided with a hard califerous shell. These are normally slow moving animals, and their habitat is bottom aquatic floors.

Although the edible portion in crustacea has a similar composition to the fish muscle, the edible portion in crustacea is less than half the live weight and further looses considerable weight during handling and processing.

Reference here is made to crustacean in general, and these include prawns, crabs, lobsters, crayfish. With the exception of crabs, the edible muscle of prawns, lobsters and crayfish is in the tail. The edible muscle yield will vary for the different types of crustacea, and from species to species, while the method of handling and processing can also effect the edible muscle.

The proximate composition of crustacean muscle can be represented as

Moisture		75 - 80%
Protein		15 - 22%
Fat	less than	1%
Ash		1%- 2%

The moisture content in the composition of the muscle, which is about three quarters the weight of the muscle plays a very important role. Besides contributing to the mouth watering and juiciness characteristics, the type of water binding within the muscle plays a very critical role. Seafoods that have been processed or cooked immediately after harvest, have pronounced characteristic flavours of the species, are firm and mouth watering, while seafoods processed or cooked after being held in storage for prolonged periods loose the characteristic seafood flavour, and are soft, flabby, stringy, without the characteristic mouthful of freshly processed seafood foods.

The loss of the water holding capacity in the muscle of crustacea plays a most important role; one of the reasons why crustaceans like lobsters, crabs, crayfish should be delivered for processing alive, is so that the moisture binding system within the muscle is at its maximum to give the crustacea that characteristic elastic curl, when cooked, or processed.

In lobsters, crayfish and prawns, the loss of the moisture binding capacity tends to give a limp texture to the processed products.

In crustaceans particularly in lobsters, crayfish, crabs and prawns, there exists a complex enzymic system, and like in all other foods these systems are accelerated to work in the direction of degrading and breaking down the muscle, and the amount of damage done to the muscle will depend on the substrate within the muscle, and the temperature and atmospheric oxygen.

At higher than ambient temperatures these reactions are more rapidly accelerated, there is a more rapid development and growth of bacterial population, resulting in the production of substrates favourable for enzymic reactions, and these reactions are further accelerated by exposure to atmospheric oxygen.

The type of damage done by such systems are primarily those that effect the sensory characteristics, however, these reactions can reach a stage at which the products of decomposition are unsafe for consumption.

It must be remembered that the above enzymic and bacterial reactions take place only after the death of the fish or shellfish, and the extent, and the speed of the reactions, is dependent on the temperature and the method of handling.

At low temperatures the rate of reactions is considerably slowed down, and with quick and sanitary handling the break down and the adverse effect on the product quality is greatly reduced.

This is another reason why crustaceans should be processed while almost alive, and fish handled immediately after death.

The sensory characteristics which are mainly effected by bacterial, enzymic and oxidative reactions are:

Colour
Flavour
Texture

The natural bright colour and in most lobsters, crabs, crayfish, which is a bright green to bluish shades of green, tend to darken to brown, and in advanced stages of degradation reactions, even turn to shades of red and pink, a reaction similar to that which takes place with heat treatments, the conversion of the carotenoid pigments to the characteristic orange-red.

In prawns the well known black "spots" or "melanosis", is an enzymic reaction in the presence of atmospheric oxygen.

Although the colour of the shell is effected, it is quite often that there is hardly any noticeable effect on the muscle, however, the effect on the flavour and texture, are noticeable in the processed product.

The characteristic flavour of crustaceans is quickly lost, due to enzymic reactions, and crustaceans tend to get a starchy dry cardboardy flavour, because of the nature of their composition, which also is known to contain small amounts of glycogen as in animal muscle. Further glycolysis, and water binding are related, and which accounts for the elasticity, the limpness, and the starchiness in the muscle

of crustaceans, when inadequately handled and processed.

Prawns, crabs, lobsters are cooked for consumption, and the characteristic bright orange-red pigmentation, the firm elastic curl in the tail, and the pronounced, seaweedy crustacean flavour, are the high quality notes that are indicated when crustaceans are efficiently handled and processed.

Whilst to this stage the discussions have been related to the effect on the sensory quality of shellfish, effects which are noticeable, and which therefore serve as indication of warning, whether the shellfish can be consumed or not. A more important aspect which should be taken note of, and particularly for fresh water seafoods, is the hazards from pathogenic infection, referred to as organisms of public health significance.

These organisms which when present in food, either present a direct food poisoning hazard or because of their close association with food-borne pathogens, act as indicators of their presence. These organisms are of the type E.Coli (fecal coliforms) and S.Aureus.

Although Salmonella has been less frequently detected in marine shellfish the presence of E.Coli and S.Aureas has been reported.

The importance in the consideration of the incidence and significance of bacterial hazards from eating shellfish is becoming of greater concern particularly in farmed seafoods. Of these the two organisms of particular concern are the clostrium botulinum and Vibro parahemolyticus.

The incidence of clostridium botulinum in Trout Farms has been investigated in Great Britain. Although the incidence of the organism in Britain is low in comparison with many other countries, doubts about the safety of the farmed trout have been raised following an incidence of clostridium botulinum poisoning from ingestion of packaged hot smoke trout, exported to Germany. It has been reported that the organism was demonstrated in 13 of the 17 farms examined ranging from 2.9 to 100%.

The contamination of Clostridium botulinum in marine species is very rare, and there is evidence, which indicates that Clostridium botulinum is essentially a terrestial organism, and can accumulate and grow in pond bottoms. The soil areas surrounding the farms could also be potential sources of contamination particularly the areas through which the water supply to the farms passes, and also whether the conditions of the farm permit proliferation of the organisms. Considerable work done in Great Britain, indicates that clean water supply and effective liming of pond bottoms may be used as a control measure to reduce the contamination of the organism clostridium botulinum.

Health related bacteria in commercial freshwater crayfish in the Southern States of the United States has also been investigated.

As long as the crayfish were marketed alive, so that the consumer cooked them, before eating, incidence of food poisoning through health related organisms was hardly known. However, with farm productions reaching commercial capacity, particularly because the crayfish had to be partly scalded prior to peeling, and processing, and the amount of hand labour involved, there was concern because of the ample opportunity for the introduction into the product of various organisms of public health significance.

Vibrio parahaemolyticus, is a marine organism and has become increasingly recognised as a food poisoning agent in many countries.

Handling and Processing

Although there are several species of freshwater crayfish, the group under discussion are of the species "cherax", which are known to inhabit streams of low coastal areas, inland rivers, bodies of standing water, lakes and dams. It also appears that all Australian freshwater crayfish are able to survive long rainless seasons, when water dries from the bed of streams, lakes or dams. By burrowing deeper than usual they reach parts moist enough to enable them to survive in a state of selfanimation. This would suggest that the source of production, and harvesting areas have to be carefully watched, and pollution controlled.

It is important that the crayfish are harvested alive and held in fresh running water before processing.

Processing plants handling crayfish must meet Public Health and Sanitary standards, particularly the source and supply of fresh water to the processing plant.

While there are risks of primary contamination which can be said to occur up to the time of harvesting, the risk from secondary contamination is equally great, and which begins at the time of handling with the inevitable introduction of bacteria of human origin, which may be "non-specific" or potential food poisoning pathogens. For control of contamination during handling and processing the standard of hygiene that is practised must, therefore, be first and foremost in importance.

Earlier reference was made to rapid growth and development of bacteria at high temperatures. In general it could be stated that rate of bacterial growth is almost halved for every 10^{0}C lowering in temperature, so that it is very important to chill as soon as possible, immediately after the crayfish are killed, particularly if the crayfish are not boiled immediately.

Crayfish can be frozen and marketed as cooked frozen whole, uncooked frozen whole or uncooked frozen tails, depending on the size, the species and the particular demand. In the U.S. crayfish tails are canned, and also used in the production of canned crayfish soups, and bisques.

Cooking of crayfish is done by cooking the crayfish in a boiling salt solution (3% Nacl). In cooking crayfish it is important to control the following:

(a) The solution brought to boil, before the crayfish are put into the boiling solution.

(b) The ratio of crayfish to boiling solution, should be such that there is no appreciable reduction of the temperature of the solution, and that the crayfish are completely immersed in the boiling solution.

(c) The cooking time calculated in relation to the size and the quantity being cooked.

(d) The cooked crayfish immediately cooled by dipping in fresh running cold water.

The cooked, chilled crayfish can then be Quick Frozen, preferably in a Blast Freezer, and packed in master cartons for storage and distribution.

Crayfish, and particularly "yabbies", could be frozen green, whole, but preferably as tails. In the first stage of handling, it would be useful to hold the yabbies in fresh running chlorinated cold water, so that primary contamination is reduced, and at the same time earthy slime and dirt is washed out.

The next stage is to kill the yabbies, which in some countries is controlled by organisations similar to the R.S.P.C.A. The method of kill can vary from drowning and suffocation to killing by shock either by a slight knock on the head to anaesthetic treatment. In a few experiments conducted by the author, cold shocks appear to effectively kill the animals, also facilitating the separation of the head from the tail. This also has the advantage of instant chilling, so that the tails could be more efficiently washed in chilled water, to remove and wash away most of the dirt and slime.

Since crayfish and yabbies are bottom feeders, it is useful to remove the intestinal sand vein, as is done in peeled deveined prawns. Although thorough cooking before consumption could ensure the destruction of organisms inside the sand vein, there is a risk that inadequate cooking may not completely destroy the organisms, and which could effect the sensory qualities, if these organisms are not of the pathogenic type or could lead to the growth and development of the health related organisms.

Depending on the size of the crayfish tails, the freezing can be done in a similar manner as that for headless prawns, viz; the prawns are packed in aluminium moulds or waxed cartons, to which clean, bacteria free water is added and the cartons frozen as blocks. However, if the tails are large in size, then these are individually Quick Frozen, after each is wrapped in polythene, and the frozen wrapped tails then packed in cartons for distribution and storage.

"Yabbies" could also be frozen as peeled and deveined. The tails are slit open, the muscle removed, and the intestinal vein pinched out. To facilitate the removal of the muscle and the vein, the tails should be held in crushed ice before peeling. Wash the peeled, deveined tails thoroughly and pack them in waxed, or moisture proof cartons, add fresh cold water, just enough to cover the top surface of the pack, and freeze. The addition of cold water before freezing helps in preventing dehydration and oxidation, during freezing, storage and distribution.

Gustametric status of Seafoods, inparticular Crayfish

Reitz in his book, titled "Guide to the Selection, Combination and Cooking of Foods Vol. I (1961)," has produced a gustametric chart for most common foods.

The eating quality, and appreciation of foods is related to flavour, a sensation experienced through a combination of taste and odour.

In the gustametric chart the flavour ratings of different foods were evaluated based on two theorems:

(a) flavour intensity scale of foods given a flavour intensity rating of an arithmetic value

(b) foods accordingly placed on a scale some on the top, some on the bottom.

Thus the chart has flavour ratings for Animal Foods (aquatic, animals, poultry, dairy products), vegetable matter, carriers, beverages, and other accessory foods which includes spices.

Flavour intensities were rated from 0 to 1000, and it is interesting to note that, that crayfish was at the bottom of the scale with flavour intensity rating of 12.

The following is an abstract from figure 25 of the Gustametric Chart-Food Scaled according to Flavour Intensities, "A Guide to Selection, Combination and Cooking of Foods", Vol. I (Selection and Combination of Foods by Carl. A. Rietz (1961) AVI. Pub. Corp.

Flavour Intensity Rating	Seafood	Other Foods
1000	-	Cayenne pepper
500	-	Whisky
250	Smoked fish	Sweet wines, salt
200	Caviar	Cambert, Vermoth, Chocolate Cream
100 - 90 - 80	Mackerel, Crab, Tuna, Lobster	Sausages, coffee, sugar
50 - 45	Barracuda, oyster	Lamb,Turkey, Tea
25	Trout	eggs, cauliflower
12	Crayfish	Skim milk, white bread

It is important that the food is in its ideal condition to evaluate the flavour intensity because even the slightest change in the characteristics of the food can markedly alter the flavour rating of the food.

It is also obvious that foods with low flavour ratings, like the crayfish, should be handled with extreme care, and this is another reason crustaceans should be handled alive for processing.

Suggestions for utilisation of Yabbies and Crayfish

The fact that the flavour intensity rating is very low, it is obvious that flavour enhancers would be necessary to uplift the appreciation of the prepared product.

Referring to the Gustametric Chart previously discussed, smoked fish flavour ratings are reasonably high, and smoking of scampis which is similar to the yabbies, has been done with good results.

Spices and wines have high flavour intensity ratings, and just like curried prawns are popular. There is no reason why curried yabbies should not attain similar popularity.

Similarly the use of a seafood cocktail sauce or wine sauce, could enhance the flavour and increase the appreciation.

In cooking yabbie muscle, and to get maximum flavour retention, steaming in a close pot or casserol dish gives good results. For cooking the tails, with shell, a boiling 3% to 5% salt solution cooks the tails well. The indication of a good "cook process", is the development of the bright orange-red colour, and the curling of the tail. However, to stabilise the cooked product, extra cooking time of at least 5 minutes should be given. Immediately cool product.

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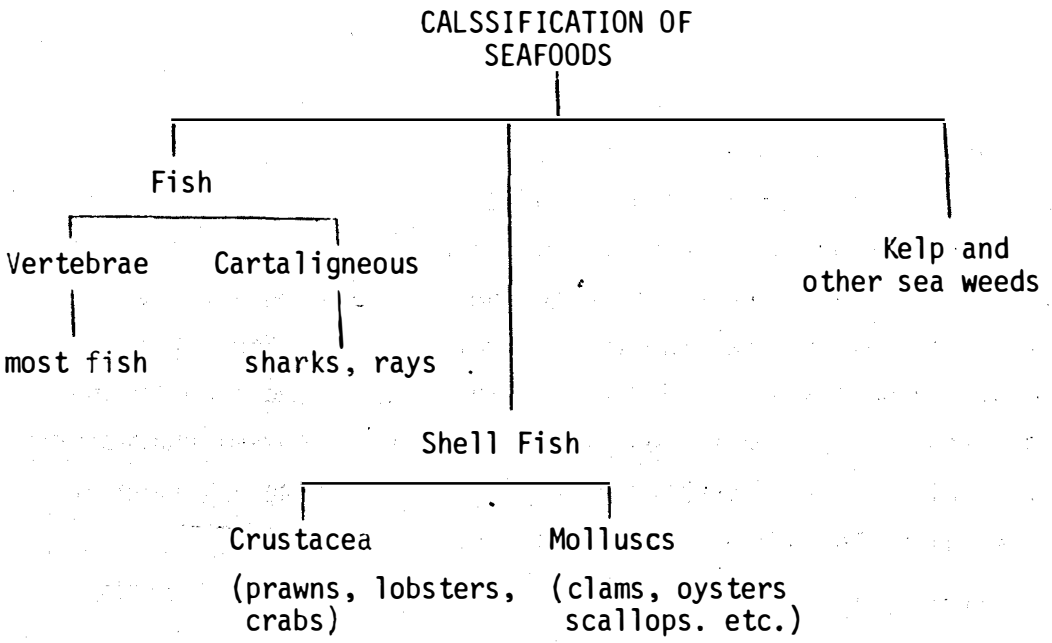
SEAFOOD TECHNOLOGY

A. F. D'Mello H.A.C.

Seafoods are normally referred to as food, produced within aquatic environments, and therefore, marine fish and shellfish, and fresh water fish, including some species of frogs and edible aquatic vegetation, can all be classified as seafoods.



ANATOMY OF FISH & SHELLFISH

Unlike meat, poultry, fruit and vegetables, the structure and composition of fish and shellfish, is such that during the life of the fish, the various constituents of fish play an important role in the life cycle of the fish but after death these constituents are seriously affected, leading to very rapid adverse changes. Hence fish and shellfish are classified as highly perishable foods, and in order to get a better insight into the mechanism of post-mortem changes, it is useful to examine and study the anatomical structure of seafoods.

Structure of Seafoods

Shape
Protective Coat
Respiratory Organs
Blood and Viscera
Muscular Structure
Bony & Cartaligneous portions

Shape

The shape of fish are related to their habitat and migratory habits. Fish possess a wide variety of shapes, however, the common forms are:

Fusiform (offering less resistance to water - Salmon, Tuna)
Eel like - the eels
Compressed - sunfish
Depressed - thin and flat like the skate, rays

The propulsion and movement is controlled through undulations of the body and rapid lateral motion of the fins, particularly the caudal fin. The fins are the appendage which plays a similar role as the limbs in mammals. There are two pairs of lateral fins: the pectorals are found behind or below the gill opening and the pelvic or ventral fins lie near the median ventral line. Fins on the median line of the back are called dorsels, the tail of the fish is the caudal fin. In a true salmon, there is a second dorsel characterised by a complete lack of supporting rays, the fin being a tissue of muscle called the adipose fin or tissue.

Protective Coat

The protective coat consists of the skin; in some fish it is thick and leathery and in other it is thin. Most fish are covered with an extra coat of scales. The scales of fish are proteinaceous, while crustaceans have a chitin coat, and molluscs a calcified coat. The scales of fish, the carapece of crustaceans and the shells of molluscs are not edible.

Although the skin is meant to serve as a protective coat, as long as the fish is alive, the slime ejected by the fish serves as a good lubricant, against friction during swimming. However, after death of the fish, the slime serves as a nutrient for bacterial development and, therefore, the condition of the skin can often be used as a guide to the freshness of fish. Thorough washing and cleaning to remove all traces of blood and slime is vital to the retention of the quality of fish.

Respiration

Most fish breathe through the gills. Oxygen is taken up from the water through the cellular structure of the gills. After the

death of the fish because of the lack of oxygenation of the blood, the white mucous over the gills which is thrown out when the fish is fresh turns to a light pink, and finally to a bloody brown to black when the quality of fish is bad and putrid. The gradual change from bright red to brown is another index of quality.

Blood and Viscera

Blood which carries food and oxygen to the muscular and nervous system of the fish, is again a good nutrient for microbial development. Hence complete removal of all traces of blood will help to prevent deterioration and also prevent the dark brown discolouration along the belly flaps and the backbone, which are easily noticeable, especially when frozen fish are thawed or cooked.

The guts and other visceral organs which normally collect the food, also contain the filth and organisms which are a potential danger not only to the quality of the fish, but could also be a health hazard.

On the other hand the liver and the roe, which are edible portions, are also a good source of nutrients particularly vitamins A and D.

Muscular Structure

Under the skin coat, the segmented muscular blocks form the main edible portion of the fish, referred to as the fish muscle. The segmented sections, which is protein, is separated by thin connective tissues, and this is the reason why the muscle of fish easily breaks down into flabby structures during deterioration and spoilage or flakes on cooking.

The other organs like the eyes, the otholiths (balance mechanism) the anbladder and reproductive organs are non-edible.

Composition of Fish Muscle

Moisture which makes up almost three quarters of the composition of the fish muscle, is an important constituent. The good juicy palatability is related to the water holding capacity of the water in the fish muscle, while deterioration of the flesh is easily noticeable by the leaching out and drip of fluids due to the loss of the water holding capacity.

The *fat* in seafoods is most variable not only from species to species, but within the same species, and from age to age. There are the depot fats and muscular fats, and most fish fats are highly unsaturated fats. Signs of deterioration in fatty fish are noticed by the discolouration and rancidity due to the oxidation of the fats.

The *protein* which is the nutritive constituent of the fish composition is made up micelles held together as a thread-like network with water molecules filling in the intersteal spaces. On cooking, these form a gel which give the fish muscle the characteristic cheese-like consistency. On the other hand loose flakey consistency is usually associated with deterioration of quality.

Ash content, which makes up the remaining component in the composition of fish is mainly made up of mineral salts, of sodium, potassium and other metalic compounds. Although present in small amounts these serve as regulatory components. Fish has a higher potassium content than sodium content and therefore, is a good dietetic food, as a low sodium diet.

Seafoods are also a good source of the various vitamins, both fat soluble as well as water soluble vitamins.

SPOILAGE OF SEAFOODS

The term "Fresh" may be defined as that quality where the original characteristics have undergone little or no change.

Within the seafood industry quite often the term "fresh" fish is used to indicate market fish, or fish that is not frozen.

It would therefore be appropriate to define the term "spoilage" or "spoiled fish" in industrial terms as that quality rated as "unacceptable".

Changes in the characteristics of biological components can be physical, chemical and biochemical, however, the initial change in the characteristics of seafoods is due to the action of microorganisms.

Fish muscle is known to be sterile, but because microorganisms are everywhere there are certain types of these microorganisms that are responsible for the changes in the fish after death.

The sensory characteristics, like the changes in the appearance, colour, odour and texture of seafoods are brought about by the Saprophytic type organisms, which generally may be not harmful yet the changes brought about by the development and growth of these

organisms degrades the quality of the seafood, to the extent that the seafood becomes unacceptable for consumption. These changes are easily recognised before the food is used for consumption.

The more dangerous type of organisms are the "pathogenic type" which are actually the food poisoning type, and because the sensory qualities of seafood are not affected, contamination by the pathogenic type of organisms is not easily recognised until the food is consumed. The consumption of food contaminated by the pathogenic organisms results not only in serious illness but can also be fatal. The source of contamination is from unhygienic and unsanitory conditions.

Temperature plays an important role, and the control over the development and growth of these organisms is dependent on the temperature of the food product.

The rate of microbial development is related to the temperature. The rate at which microorganisms grow more than doubles for every $10^{o}C$ rise in temperature. It is thus obvious that the presence of organisms and rising temperatures are both potential dangers.

Changes After Capture of the Fish

Rigor Mortis: Immediately after death, the fish goes into rigor, i.e. rigor mortis. This is due to an autolytic biochemical activity that leads to the stiffening of muscles. The duration of rigor will depend on the activity of the fish before death. Thus the method of capture will influence "Rigor Mortis". The effects of rigor can last for a few hours to a couple of days. Fish in rigor are difficult to handle because of the stiffening of the muscle, and particularly if the fish is frozen, this canlead to rupture of the tissues which gives the thawed muscle a ragged appearance. Similarly if the fish is filleted before it goes into rigor, the muscle after processing tends to contract considerably. On the other hand fish processed after rigor does present certain problems, chiefly because the muscle tissues begin to get soft, and if further handling has to be done, this has to be done immediately and with care.

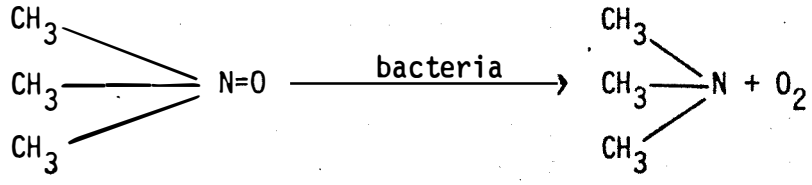
Loss of water holding capacity and flavour. After the period of rigor, there is a slow but gradual loss of fluids because of the weakening bonds holding the water molecules. The ability of the muscle to hold moisture is termed "water holding capacity", however, with the

loss of fluids, the fresh fish flavouring compounds and certain nutrients are also lost. Hypoxanthine is one chemical constituent which has been used to test the freshness of fish, because as it increases there is a corresponding increase in bitter flavours. The hypoxanthine content has been used as an index for the freshness of fish.

Changes due to chemical and biochemical activity. Most seafoods lose their natural brilliance, firm texture and begin to get an unpleasant fishy taint due to a chain of reactions triggered by microorganisms and accelerated by high ambient temperatures and exposure to the atmosphere. When the fish is alive the biochemical reactions maintain the life processes with the aid of enzymes and oxygen. However, after death of the fish the natural defences are broken down and the fish is exposed to the attack by microorganisms while degradative reactions prevent the formation of compounds that would normally have synthesised the characteristic fresh fish odour and flavour compounds.

Trimethyl Amine and other spoilage compounds. The rate of degradative reactions increase at a rate almost double for every $10^{o}C$ rise in temperature, and particularly the rate of microbial growth is extremely rapid with the result that the attack by these organisms not only produce foul smelling compounds but in the advanced stages of decomposition this profuse bacterial growth produces very foul smelling coloured slime, a condition classified as "to be condemned".

During the process of degradation a compound, Trimethyl Amine (TMA) is formed which is responsible for the characteristic foul fishy odour. THis compound (TMA), is formed as a result of the trimethyl amine oxide, a compound present in most fish, which is reduced to trimethyl amine, the oxygen being used up by bacteria.



Trimethyl amine oxide Trimethyl amine + oxygen

Besides Trimethyl amine, there are other base volatile compounds formed, particularly compounds like Ammonia.

ASSESSMENT OF SEAFOOD QUALITY

Both the freshness and spoilage can be measured by sensory methods and objective measurements, however, since the degradation in most seafoods is so rapid, the changes in the various characteristics are easily recognised, and sensory methods are just as effective as many of the objective methods.

Sensory Methods

Sensory methods are only effective if the assessment is done by experienced people using a well designed and planned svstem. It is difficult to define freshness, but because the various characteristics of the seafood undergo changes, therefore, the quality of the seafood is better assessed by expressing the quality, in relation to the quality of the various components.

In raw seafoods, the appearance, colour, odour, and texture are the characteristics normally assessed. The components of the seafood which are affected are the skin, eyes, gills and the muscular portions. There are many systems that are used, however, most are designed so that the final assessment can be mathematically evaluated giving various scores for the various stages of degradation of the characteristics of each component of the seafood.

The following table is an example to indicate the system that can be used for the assessment of fish quality by sensory methods.

ORGANOLEPTIC SCORE CARD FOR FRESH FISH

Individual Rating →	EXCELLENT 5	VERY GOOD 4.5	GOOD 4	FAIR 3.5	FAIRLY GOOD 3	BELOW AVERAGE 2.5	POOR 2	VERY POOR 1.5	BAD 1
GILLS G	Bright red gills Profuse white mucous		Bright red gills White mucous on compression of operole		Faint pink gills Pinkish white mucous		Reddish brown gills with reddish brown mucous		Dark brownish gills and brownish mucous, or dry
ODOUR O	Fresh sea weedy		Not sea weedy Not fishy		Fishy		Fishy Stale		Putrid
APPEARANCE A	No bruises Very bright and distinct colours lustrous sheen		No bruises Bright with lustrous sheen, but colours not distinct		No bruises Tarnished		Slight bruises Dull		Bruised skin Damaged very dull
TEXTURE T	Very firm, elastic and cannot be easily be pressed		Firm, elastic and leaves no thumb impression when pressed		Very slightly soft and leaves thumb impression when pressed		soft		Very soft, muscle falling apart
EYES E	Shiny cornea, full. Jet black pupil. Eyes not sunken		Full shiny cornea, Jet black pupil Eyes not sunken Slight blood spots		Cloudy cornea Black pupil Sunken slightly Blood spots visible		Cloudy cornea Faded pupil Sunken and Very bloody		Very cloudy and broken or completely sunken
COLOUR C	Very bright lustrous sheen, with distinct varied colours		Bright lustrous sheen, but varied colours not very distinct		Tarnished with colours fading		Dull		Dull and brownish spots
TOTAL SCORE	30 29 28 27 26 25		24 23 22 21 20 19		18 17 16 15 14 13		12 11 10 9 8 7		6 5 4 3 2 1

There are several objective methods and these include physical and chemical methods.

Physical Methods

The pH of fish muscle and the refractive index of fish eye juice have been used to assess the quality of fish by using a pH meter and a refractometer. Using the dielectric properties of fish skin and muscle the G. R. Torry meter has been designed to measure the freshness of fish. The readings can be taken within a few minutes, and in the latest version of the meter readings from 16 fish are memory stored and later displayed as average.

Chemical Methods

There are several methods which can be used for measuring incipient spoilage. The most common are:

(a) The measurement of hypoxanthine for freshness
(b) Determination of Trimethyl amine
(Ref. Dyer W. J. Journal of the Fisheries Research Board of Canada 6, 351-367, 1945, revised Feb. 1976.)
(c) Determination of Total Volatile Bases (Ref. Howgate P. "Measurement of Determination of Iced and Frozen Fish, T. D. 864, 17.11.1976 unpublished)

HANDLING FRESH SEAFOODS

It is obvious from the previous discussion that to keep seafoods in good condition the following are of vital importance:

(a) Keep bacterial contamination to a minimum;
(b) Lower the temperature as quickly as possible, remembering that the rate of reaction and bacterial growth are reduced by half for every $10^{o}C$ lowering in temperature;
(c) Prevention of exposure to atmospheric conditions.

Keeping Bacterial Contamination Low

Immediate and thorough washing and cleaning with fresh cold running water is essential to reduce the bacterial load. It must be remembered that the types of microorganisms responsible for the

deterioration of seafood quality are:

(i) Autolytic organisms
(ii) Saprophytic organisms
(iii) Pathogenic organisms

Autolytic Organisms - Most autolytic type organisms are in the visceral and gut cavity. The characteristic browning around the belly portion "belly burn", is caused by the autolytic enzymes present in the visceral cavity. Thus immediate removal of the visceral organs, and thorough washing of the belly cavity free of all blood and slime is essential. The process of evisceration is referred to as dressing and fish marketed with the viscera removed are referred to as "dressed fish".

Saprophytic organisms - These organisms are found in most environments, in which natural nutrients can be utilised for their development and growth. These organisms are responsible for the gradual deterioration leading to putrefaction. The development and growth of these organisms is accelerated by blood, slime and temperature. The metabolism of the fish provides resistance to the attack of these organisms when the fish is alive, but after death blood and slime provides an ideal nutrient for the growth of these organisms. The growth of these organisms is also related to temperature, in that the optimum growth takes place within a certain specified temperature range and these can therefore be grouped into three classes:

Microorganisms	Optimum Temp. growth range Temp. °C
Psycrophiles	20° - 28°
Mesophiles	30° - 37°
Thermophiles	50° - 100°

These organisms are both of the gram negative and gram positive type and include organisms of the genera, pseudomonas, moraxella, acimetobacter, flavobacterium, cytophase, micrococcus and corneform group.

These bacteria can grow anywhere, where the right conditions for growth exist. Thus unclean fish holds, boxes, knives, slime, blood, even contaminated ice provide the conditions for the growth of these organisms. Although attempts are made to wash and cool fish to low temperatures but if this is done under unhygienic conditions, and though bacteria may not proliferate at a rate normally taking place at high temperatures, there will still be organisms that will grow,

though at a much reduced rate yet enough to affect the sensory quality of the seafood. Therefore, proper handling will require not only lowering and maintaining low temperatures, but preventing growth or access of more organisms by contamination through unclean, unsanitory and unhygienic conditions.

Pathogenic type of organisms - These organisms which normally are the cause of food poisoning, are not a natural flora of seafoods, except in oysters, prawns and shellfish that have their habitat in estuarian waters or polluted waters. The main source of pathogenic type organisms is through contamination and infection from unsanitory handling, particularly unhygienic handling by people and unsanitory equipment.

This group of organisms, although they do not affect the sensory quality of the food, are organisms that produce poisonous toxins in the food, which when ingested by man produces severe gastroenteritis type illness, sometimes is fatal. The three common groups are:

Salmonella type
Clostridium velchii
Staphylococcus aureus

The other type of food poisoning organisms commonly occurring in processed, particularly in canned food is "botulism". While food poisoning caused by the bacterium Vibrio parahaemolyticus has been reported to have been found in some species of fish and shellfish.

Thus thorough washing and sanitisation of equipment and working areas and working personnel practice sanitary habits, particularly washing of hands, will help to reduce contamination and infection of pathogenic organisms.

Low Temperature Handling of Seafoods

Thorough washing will certainly help to reduce bacterial contamination, however ice cold fresh water will also be useful in rapid lowering of the temperature.

The temperature of washed fish can be very effectively lowered with ice, made from good sanitised potable water. The proportion of ice to fish will depend on the desired storage temperature and the

length of the storage. Normally fish is iced so that the temperature of the fish is close to freezing but not frozen, and this is essential if a high quality of the seafood is to be maintained. Thorough icing from catch to distribution is essential. It must be noted that processing will not improve the quality, and good quality processed products are produced from good quality raw material.

Ice not only serves the purpose of lowering the temperature, but if the icing is properly done, it forms a protective glaze, which not only keeps the fish from drying out, but also prevents contact with atmospheric oxygen.

Fish can be chilled by refrigerated air, however, the surface of the fish not only tends to dry out, but could also lose weight, and lose the characteristic gloss of iced fish. On the other hand, fish can be stored in ice, in a chill storage room kept at a temperature slightly above $0^{o}C$. This has two advantages: the surface of the fish is kept moist by the slow melting of the ice; and the risk of the fish being frozen is small.

Today there is a large amount of fish chilled at sea, using the Refrigerated Sea Water (RSW) system, where mechanically refrigerated sea water, or chilled sea water (CSW) is used for rapidly lowering the temperature of fish. Studies are also being made, where refrigerated sea water (RSW) or chilled sea water (CSW) is used along with a gas like carbon dioxide, to serve a dual role of lowering the temperature and maintaining a media, unfavourable for the development and growth of spoilage organisms.

Chilled fish is normally channeled for distribution through the fresh fish markets, hence, in handling chilled fish, the temperature and the packaging will have a significant influence on the quality of the fish. The temperature of chilled fish should be maintained just above freezing temperature around 1° to 3°C. Exposure to higher temperatures even for a short time could affect and substantially reduce the shelf life of the fish.

Whole fish or fish packed in ice would normally be transported or stored in returnable plastic fish boxes, or non-returnable waxed cardboard cartons or wooden or expanded polystyrene boxes. Fish that is filleted should be packed in moisture proof packing, either in

vacuum satchets, overwrap or overpouch with trays.

PROCESSING SEAFOODS

Freezing Fish

A large amount of the catch is nowdays frozen at sea, particularly where an extended storage period is desired, when fishing vessels have to go to more distant waters. Seafood thus frozen should be of high quality provided the freezing operations are properly done. Lean fish freeze better than fatty fish. Fatty fish should be glazed preferably with an anti-oxidant glaze, otherwise the fat in the fish tends to get rancid. Moisture proof wrapping is also essential, to prevent "freezerburn" and subsequent oxidation and rancidity. Ascorbic is used as an anti-oxidant for frozen fish.

The rate of freezing does have an effect on quality. Rapidly frozen fish looks whiter than slow frozen fish which appears to have a gell like gloss.

Storage temperatures and fluctuations in freezer storage rooms also have a significant effect on the quality fo the frozen fish. Fluctuating temperature cause dehydration and "freezer burn". Lowering the temperatures of storage will reduce the possibility of changes during storage.

The recommended temperatures for commercially freezing fish are -40°C, and storage temperature below -20°C.

Freezing operations may be summerised as:

Preparation for freezing and chilling
Freezing Packaging
Glazing Packaging
Storage

Preparation for freezing. Fish must be thoroughly washed free from blood and slime, the scales removed and the stomach cavity eviscerated and thoroughly washed. If the blood from the stomach cavity is not thoroughly washed, this will show up as dark black stains after freezing and thawing. Normally if the fish is not frozen whole, the appendages (i.e. the fins) are also removed.

The forms in which fish can be frozen are:

Whole - eviscerated (guts and viscera removed)
Dressed - the head, fins and viscera removed
Filleted
Steaks or cutlets
Fish Sticks

Crustaceans - viz prawns can be frozen as
Whole - individual quick frozen for large prawns
Headless
Peeled and deveined
Cooked and cocktail
Breaded Fan tail

Lobsters can be frozen as -
Whole cooked
Green tails

Seafoods at all stages of the processing must be kept hygienically chilled.

Freezing - There are several methods for freezing fish, however, the recommended temperature for freezing is below -40°C. Since freezing at low temperatures can cause excessive dehydration and freezer burn and even oxidation, most are packaged in moisture proof material before freezing.

Prawns on the other hand, if individual quick freezing is not done, are frozen in crates, frozen as a block of ice, so that not only dehydration is prevented but oxidative reactions which cause the blackening in prawns is also prevented.

Most packaged seafoods like fillets or prawns packed in waxed cartons are frozen in multiplate contact freezers, while whole fish are blast frozen or by immersion freezing.

Glazing - Glazing is done by immersing the frozen seafood in ice cold water so that it picks up water forming a thin layer of ice on this surface. Glazing is particularly useful for controlling drying and dessication of the frozen product during frozen storage.

Frozen Storage - Rooms for storage of frozen seafood should be maintained so that fluctuations in temperature are kept to a minimum. Most dessication and oxidation of the seafood takes place during storage and the fluctuating storage temperatures tend to dry out fish surfaces, as moisture evaporates during fluctuations of the room temperature.

Thawing of frozen fish and re-freezing is not advisable, and should be avoided.

Canning of Seafoods

Seafoods can be canned as:

(a) Fish in its natural juice, i.e. the fish releases its juice within the can, and the only ingredient added is the required quantity of salt. Salmon is canned in this style, the Japanese also can mackerel in its own natural juice.

(b) Seafoods precooked, and canned with prepared brines or oil. This type of processing is done to fish that normally have a high oil content; the oil of most fish is unsaturated, which, when processed results in undesirable odours, taste and colour in the canned product. Tuna is normally precooked and then canned in brine or oil. Sardines and herrings are normally pre-fried before they are canned in oil. Prawns are blanched and then canned in brine.

(c) Fish cured and packed in brine, oil or sauce, produce very good products. These include products canned as kippers and fish in various types of fill-in sauce or gravies. The curing process, is mainly salting or smoking, however, in the case of marinades, the fish is cured in an acidified salt brine, and packed in an acidified salt spiced brine.

Curing of Seafoods

The process of curing includes:

Salting
Smoking
Pickling.

Salting is carried out as a heavy salting - dry cure or a milk salting called mild cure. In both, the process involves the use of common salt in varying concentrations.

In the dry cure, the fish is subjected to the curing process, using dry salt in almost equal proportions of salt and fish. The penetration of the salt, into the fish muscle, toughens the muscular portion, releasing water, with the result that the salted fish can

be stored for long periods; the salted fish is desalted before use; however, because of the touchening of the muscle, desalted fish is used in the manufacture of canned fish cakes.

The mild cure, which is important in smoke curing is done by soaking the fish in strong brine solutions. The strength of brine and the period of holding will depend on the desired length of storage, and the subsequent use of the salted fish. When smoking fish, a short dip is given to the fish, just enough to produce a smooth gloss, and a shiny surface for the smoke deposited.

The purity and quality of the salt used for making up the brine, has some influence on the curing.

Smoking of fish and the consumption of smoked seafoods is gaining popularity. Traditionally there are two methods used: the cold smoking process, and the hot smoking process.

The cold smoking process, which is used for preparation of "kippers", is a process in which the brine cured herrings are smoked at a temperature of 26^{o}C but are consumed after heating the smoked fish. On the other hand in hot smoking process, as that done for "bloaters", is carried out at a temperature of about 80^{o}C, and unlike the cold smoked fish, the hot smoked fish is ready to eat and can be consumed cold.

Pickling of seafoods; pickled products like "rollmops", "Bismark Herrings" and other pickled seafood products the pickling is done after thoroughly curing the seafood. The factors constituting the preservation of pickled seafoods, is the partial reduction in moisture by the curing process, acidification by the use of vinegar, food and or spirits and flavouring agents particularly sugar and salt.

Other Seafood Products

There are several other types of seafood products, like fish fingers, fish cakes, various types of soups, broths and bisques, however, there is a trend today towards the maximum utilisation of fish muscle protein, in the production of Fish Protein Concentrates and "fish gels". The fish gels can be used in the production of the

Japanese "Kamaboko" type products, fish sausages, fish loafs, etc. Similarly breaded prawns, fish, fish fingers are also finding their way into the commercial market with increasing popularity.

Miscellaneous Seafood Products

Besides the above mentioned canned, frozen and cured products, there are several seafood products that are available or could be produced. These include products from various types of fish like the eel or squid or the wide variety of shellfish, which include oysters, clams, scallops; and the use of certain types of seaweeds like kelp, carageenin, fish moss.

THE AUSTRALIAN SEAFOOD INDUSTRY

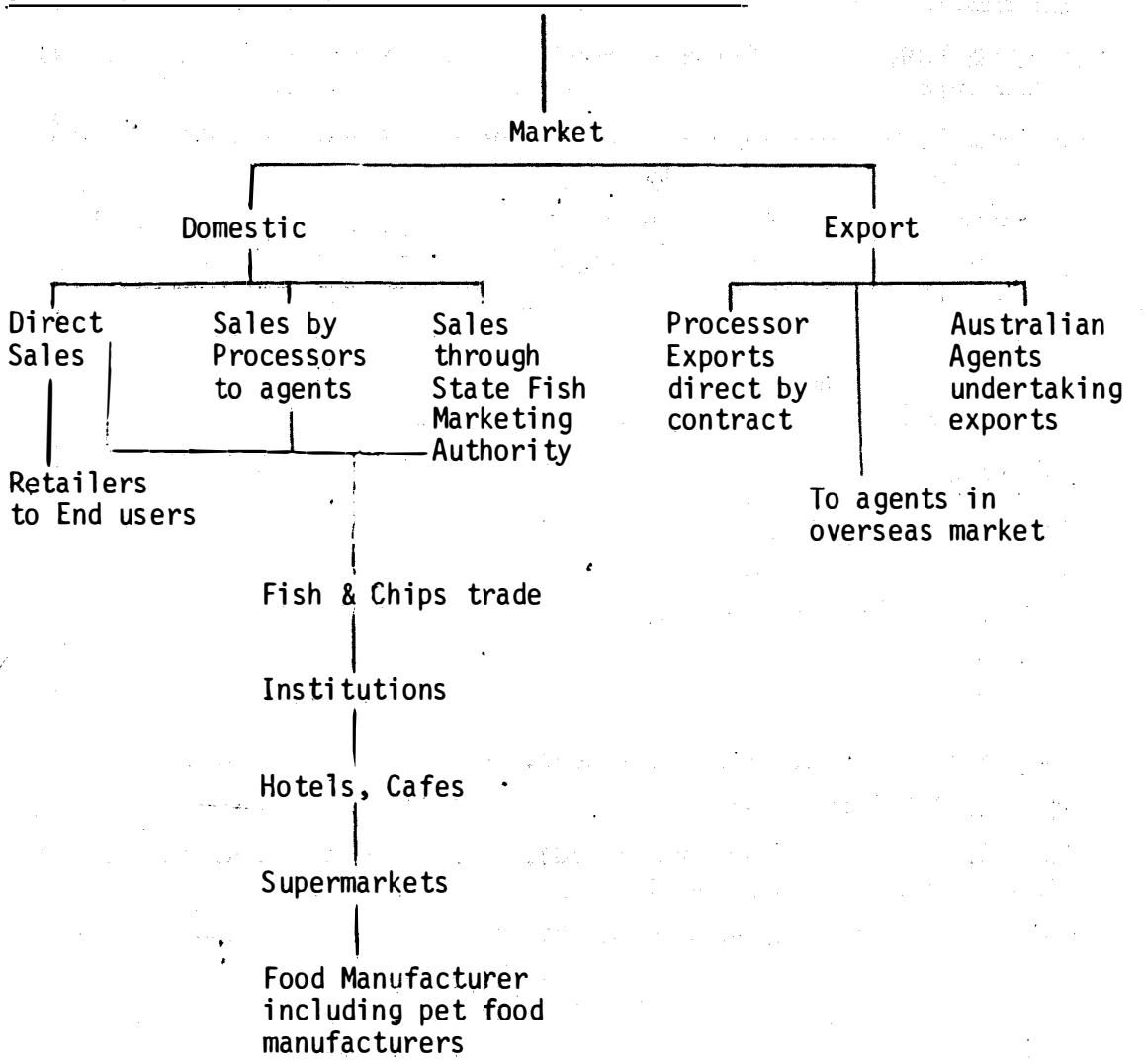
Australia has a very vast coastline over 12,000 miles, supporting nearly 2,000 species of fish, yet the commercial production of seafoods is small compared to the Northern Hemisphere seafood producing countries.

This is mainly due to the fact that the basic primary production is on land (agriculture). The fertility of the coastal waters does not contribute much to the production of commercial fish species and not much has been done to explore offshore and deep sea fishing, in spite of the fact that there has been a considerable amount of fishing being done by International Fishing vessels inside the 200 miles from the Australian coast.

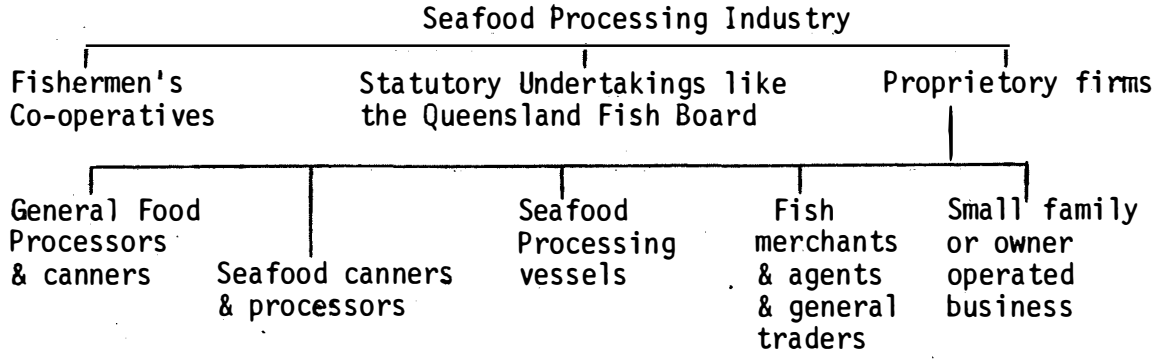
The production of fish in the past few years averages about 50,000 live weight tons, which meets about 50% of the domestic consumption.

Prawns, abalone, lobster and scallops appear to be high market value priced seafoods while most of the fresh fish produced is distributed as fresh, there is a considerable amount of tuna canned and prawns, abalone and lobster tails are frozen for export. The internal market consumes a considerable amount of oysters both fresh and frozen and cooked chilled prawns.

Distribution of Produced and Processed Seafoods



Seafood Processing Industry



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Australian Publications

Australian Fisheries - (monthly publication)

Commercial Fish of Australia

Smoke Curing of Fish

Fisheries of Australia Folder

Australian Fish Exports Manual

Fisherpo ' 76 Seminar

Available from: A.G.P.S. Bookshops, P.O. Box 84, Canberra A.C.T. 2600

also at: 309 Pitt Street, Sydney.

C.S.I.R.O. - Delhi Road, NOrth Ryde, N.S.W. put out Consumer Service Fisheries leaflets phone 888 1333

N.S.W. Fish Authority Annual Report is also available phone 660 1611