THERMAL PROCESSING OF FISH

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Causes for spoilage of food

1. Enzymatic decomposition
2. Bacterial action
3. Oxidation process

Preservation Methods

Approaches	*Examples of process*
Low temperature	**Chilling, Refrigeration, Freezing**
High temperature	**Pasteurization, Thermal processing, smoking**
Reduced water availability	**Drying, salt curing, spray drying, freeze drying**
Chemical based preservation	**Organic acids, natural extracts from plants**
Microbial product based	**Bacteriocins**
Radiation	**Ionizing (Gamma rays) and non-ionizing (UV rays) radiation**
Hurdle technology	**Altered atmosphere (vacuum and modified atmosphere with CO_2, O_2, N_2 and other gases); active packaging; high pressure treatment; smoking etc**

Thermal processing methods

- Blanching
- Pasteurization
- Cooking
- Sterilization / Canning
- HTST

Thermal processing / sterilization / canning

Thermal processing is a means of achieving long-term microbiological stability without the use of refrigeration, by heating in hermetically sealed containers to render the contents of the container sterile

Thermal processing / sterilization / canning…

- Thermal processing is not designed to destroy all microorganisms in a packaged product. Such a process may destroy all the important nutrients and results in low product quality

- Instead, the pathogenic microorganisms in a hermetically sealed container are destroyed by heating and a suitable environment is created inside the container which does not support the growth of spoilage type microorganisms

Health benefits of canned seafood

- Provides easily digestible protein with rich essential amino acid content
- Provides essential nutrients like vitamin B12, D and A leading to the metabolism improvement
- The canned product offers health benefits including improvement eye sight, reduced risk of depression, increased immunity
- In addition, the calcium content provided by this product helps in increasing bone strength

Factors considered for deciding the extent of Canning

1) pH of the food

2) Type and heat resistance of the target microorganism, spore, or enzyme present in the food

3) Heating conditions

4) Thermo-physical properties of the food and the container shape and size

5) Storage conditions

pH classification of food

1. **High-acid foods** (pH < 3.7; e.g., apple, apple juice, apple cider, apple sauce, berries, cherry (red sour), cranberry juice, cranberry sauce, fruit jellies, grapefruit juice, grapefruit pulp, lemon juice, lime juice, orange juice, pineapple juice, sour pickles, vinegar)

2. **Acid or medium-acid foods** (pH 3.7 - 4.5; e.g., fruit jams, frit cocktail, grapes, tomato, tomato juice, peaches, pineapple slices, potato salad, prune juice, vegetable juice)

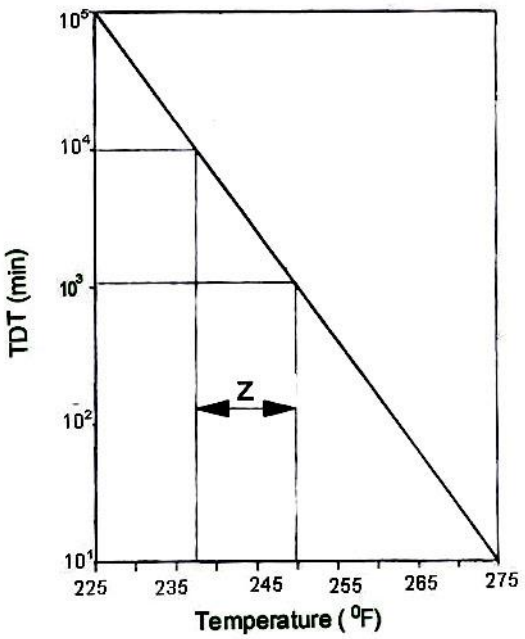
3. **Low-acid foods** (pH > 4.5; e.g., all meats, fish and shellfishes, vegetables, mixed entries, and most soups)

Approximate pH range of food

Lemon Juice	2.0 - 2.6	Tuna	5.2 - 6.1
Apples	3.1 - 4.0	Sweet Potatoes	5.3 - 5.6
Blueberries	3.1 - 3.3	Onions	5.3 - 5.8
Sauerkraut	3.3 - 3.6	White Potatoes	5.4 - 5.9
Orange Juice	3.3 - 4.2	Spinach	5.5 - 6.8
Pineapple, canned	3.4 - 4.1	Beans	5.6 - 6.5
Apricots	3.3 - 4.0	Peas, canned	5.7 - 6.0
Tomatoes, canned	3.5 - 4.7	Corn, canned	5.9 - 6.5
Peaches, canned	3.7 - 4.2	Soy Beans	6.0 - 6.6
Pears, canned	4.0 - 4.1	Mushrooms	6.0 - 6.7
Bananas	4.5 - 5.2	Clams	6.0 - 7.1
Beets, canned	4.9 - 5.8	Salmon	6.1 - 6.3
Asparagus, canned	5.0 - 6.0	Coconut milk	6.1 - 7.0
Beef	5.1 - 7.0	Milk	6.4 - 6.8
Carrots	4.9 - 5.2	Garbanzo Beans	6.4 - 6.8
Peppers, green	5.2 - 5.9	Chicken	6.5 - 6.7
Papaya	5.2 - 6.0	Eggs, whole	7.1 - 7.9

Thermal Death Time (TDT)

- TDT is the time required at any specified temperature to inactivate an arbitrarily chosen proportion of the spores
- TDT is the heating time required to cause complete destruction of a microbial population



✓**The thermal death time curve is obtained by plotting the thermal death time on logarithmic scale against temperature of heating on linear scale on a semi-logarithmic graph**

Time – Temperature combinations

From thermal death curves, the following time/temperature treatments yield the same microbe killing effect:

0.78 min @ 127°C	10 min @ 116°C
1.45 min @ 124°C	36 min @ 110°C
2.78 min @ 121°C	150 min @ 104°C
5.27 min @ 118°C	330 min @ 100°C

D value & Botulinum cook / 12 D process

✓For food with pH values greater than 4.5, it is necessary to apply a time–temperature regime sufficient to inactivate spores of *C. botulinum* which is commonly referred to as a ***BOTULINUM COOK*** in the industry

✓A process equivalent to twelve decimal reductions in the population of *C. botulinum* spores is sufficient for safety. This is referred to as a 12D process

✓If initial spore load of 1 spore/g of product, the corresponding probability of *C. botulinum* spore survival for botulinum cook is 10^{-12}, or one in a million million.

✓D value of *C. botulinum* at 121.1^{0}C = 0.21 min and 12D = 12 X 0.21 = 2.52 min

Properties of food

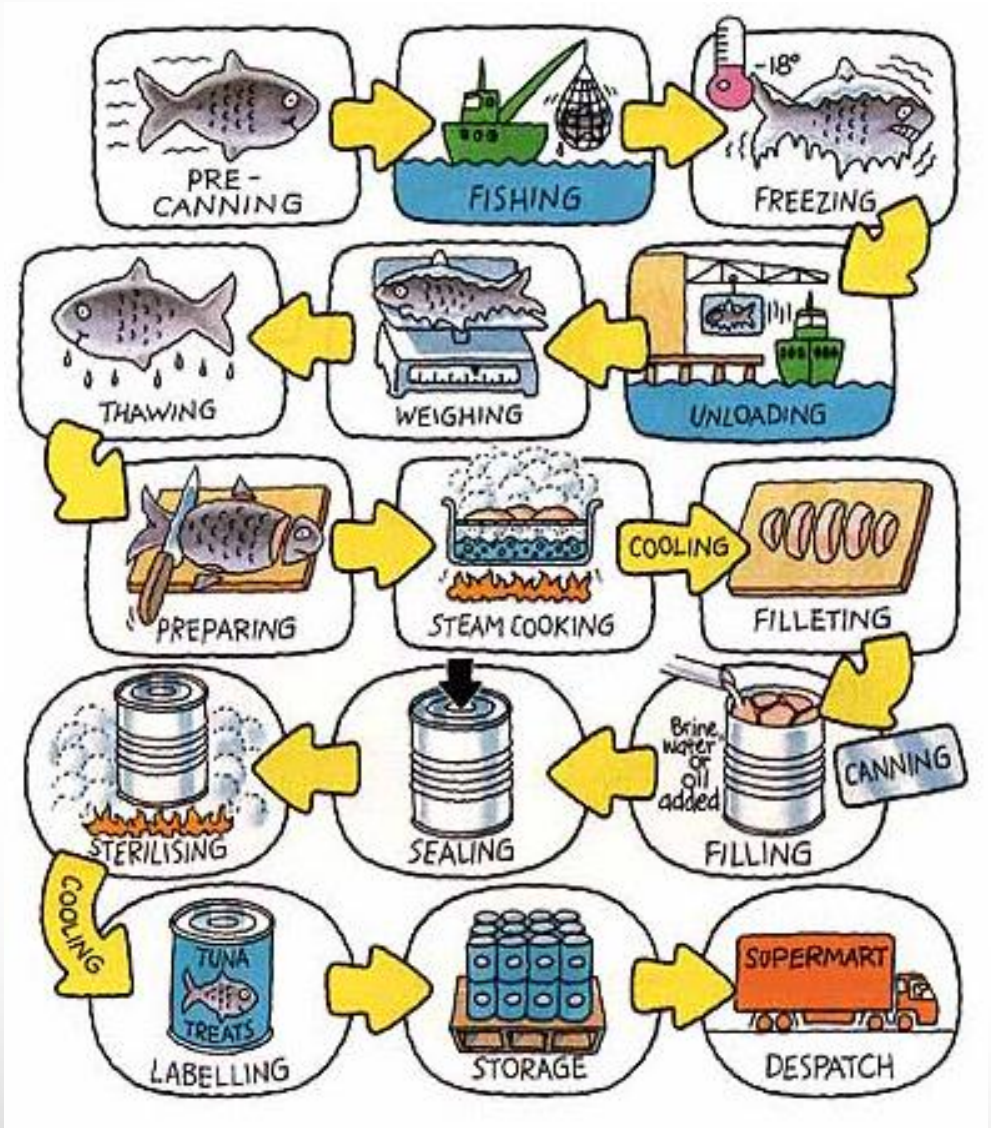
Salient features of canned products

- ✓ Assures very high safety
- ✓ Ready to consume products
- ✓ Canned foods are concentrated foods
- ✓ No special storage facility needed
- ✓ Very long storage life
- ✓ Processing methods are very simple
- ✓ The process can be applied to a wide variety of foods
- ✓ Suitable for automation

Unit Operations in a canning process

1. Selection and preparation of raw material
2. Pre-cooking / blanching
3. Filling in to containers
4. Addition of liquid medium
5. Exhausting
6. Seaming
7. Heat Processing / Retorting
8. Cooling
9. Drying, warehousing, labelling and casing

Fish Canning Procedure

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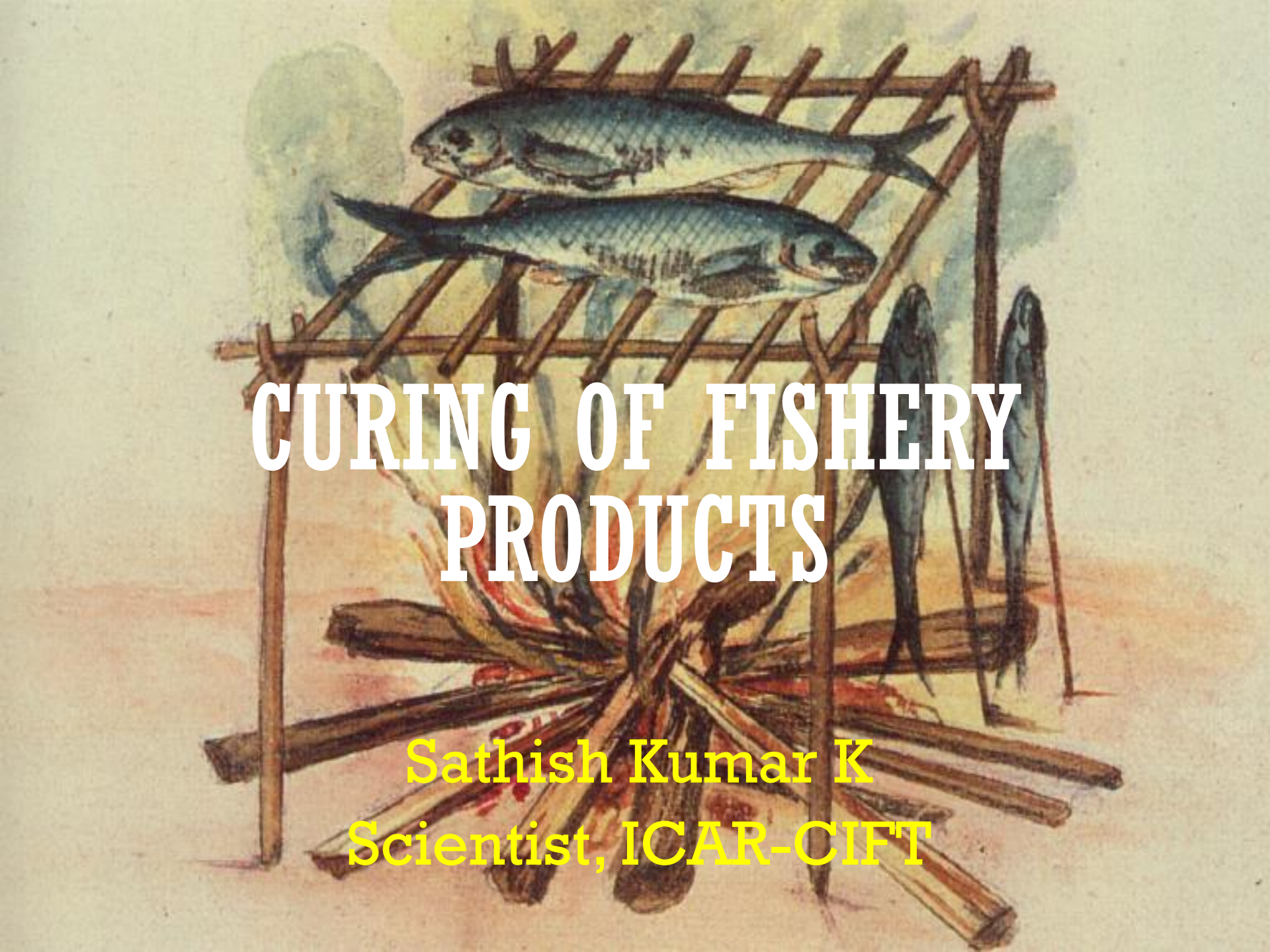

CURING OF FISHERY PRODUCTS

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FISH CURING

- Introduction
- Advantages
- Methods of fish curing
  - Salt curing
  - Smoking
  - Drying
- Status & Future prospective

WHY THE PRESERVATIVE METHODS???

- Fish is highly perishable food commodity due to its chemical composition and susceptible to deterioration without any preservative or processing measure
- Flavour and texture change rapidly during storage after death.
- In tropical countries, high temperatures mean that fish can spoil while still in the boat, at landing, during storage or processing, on the way to market and while waiting to be sold.

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- Fish harvesting, handling, processing, and distribution provide livelihood for millions of people, as well as providing foreign exchange to many countries.
- In many rural fishing communities, the infrastructures for post-harvest processing and preservation of fish are inadequate.
- As a result, losses reach up to 40% of the total catch by weight.

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- The fishing industry, despite its importance, suffers from enormous post-harvest losses which are estimated at 35–40% of landed weight
- It is estimated that post-harvest losses remain about 25% of the total world catch annually.
- These losses have a profound adverse impact on fishing communities whose status and income often depend on post-harvest activities.
- Such losses also have a detrimental impact on the socio-economic life of the fishing communities
- Reduce the amount of animal protein available to a large segment of the world population.
- So the preservative techniques starts emerged when the catch is high (surplus)
- These techniques are updating day to day….

TRADITIONAL METHODS OF FISH PRESERVATION

- **Curing:** The traditional methods are collectively known as Curing

FISH CURING

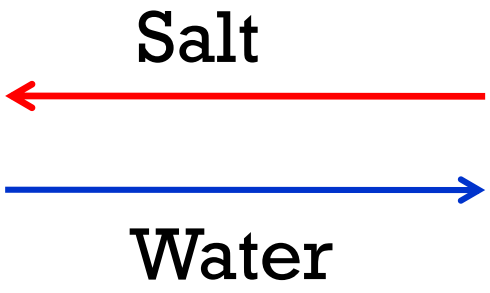
- There are various methods of preserving fish by curing, including drying, salting, smoking, marinating, combinations of these methods, and fermentation (FAO, 1983).
- Curing is an ancient preservation technique.
- Despite the fact that curing has undergone changes in the course of history, in principle, it remains fundamentally the same.
- White fish species are traditionally preserved by salting because they contain fewer lipids, while fatty pelagic species are generally preserved by smoking and marinating due to their high fat content.
- There have been changes in the methodology and/or the equipment used in salting and smoking, but marinating and fermentation processes follow the traditional practices, which are very closely tied to certain geographical regions.

ADVANTAGES

- Prolonging shelf life & Store for the lean season
- Reducing waste at the times of bumper catches
- Making fish easier to pack, transport and market.
- Inexpensive; little energy required; little equipment needed;
- Enhance the flavour, colour and texture
- Quality and nutritional value reasonable.

1. SALT CURING

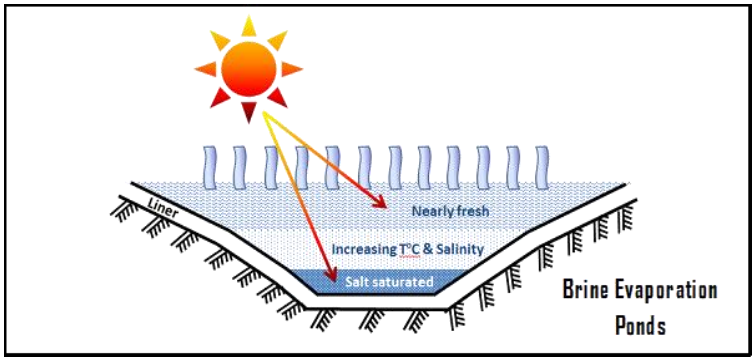
- Salting is one of the oldest methods of preservation of fish.
- Usually done as such or in combination with drying or as a pretreatment to smoking.
- The presence of sufficient quantities of common salt (sodium chloride) in fish can prevent or drastically reduce bacterial action.
- Penetration ends when the salt concentration of the fish equals that of the surrounding medium. This phenomenon is known as osmosis.
- This process facilitates preservation of fish by reducing the water activity.
- A water content of 35–45%, depending on the amount of salt present, will often prevent, or drastically reduce, the action of bacteria.

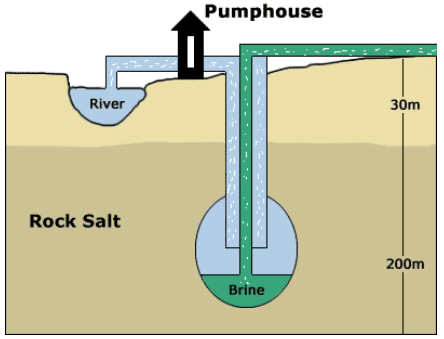


Salt curing

SALT : SOURCE

- Common salt, in its purest form consists of sodium chloride (NaCl).
- Based on the source as well as method of manufacture, common salt can be grouped as:
  - Solar salt: prepared by the evaporation of sea or salt lake waters by the action of sun and wind.
  - Brine evaporated salts: produced from underground salt deposits which are brought to the surface in solution form and is heat evaporated.
  - Rock salt: obtained as natural deposits from interior rock mines which are ground to varying degrees of fineness without any purification





TYPES OF SALTING

1. DRY SALTING

- This is the most widely used method
- Advisable for fishes of any size, except fatty fishes.
- The fish is gutted, beheaded or ventrally split open and the viscera removed followed by washing.
- Salt is then applied in the ratio 1:3 to 1: 10 (salt to fish) depending upon the size of the fish.
- The fish is then stacked in clean cement tanks or other good containers layered with salt and weight is applied from top for better salt penetration.
- The fish is kept in this condition for 24-48 hours.
- After salting period, the fish is taken out, washed in brine to remove adhering salt and drained.
- It is then hygienically dried to a moisture content of about 25%.
- Yield of the product by this method is about 35-40% with a storage stability of upto three months under ambient conditions.

TYPES OF SALTING

2. WET SALTING

- The initial stages of processing and salting are the same as for dry curing.
- However the fish kept in tank is allowed to remain in self brine till marketing without further drying.
- For marketing, as per the demand the wet salted fish is drained and packed in palmyrah leaf baskets or coconut leaf baskets.
- This method is particularly suitable for fatty fishes like oil sardine, mackerel etc.
- Wet salted fishes have short shelf stability with a moisture content of 50-55% and a salt content of around 25%.

TYPES OF SALTING

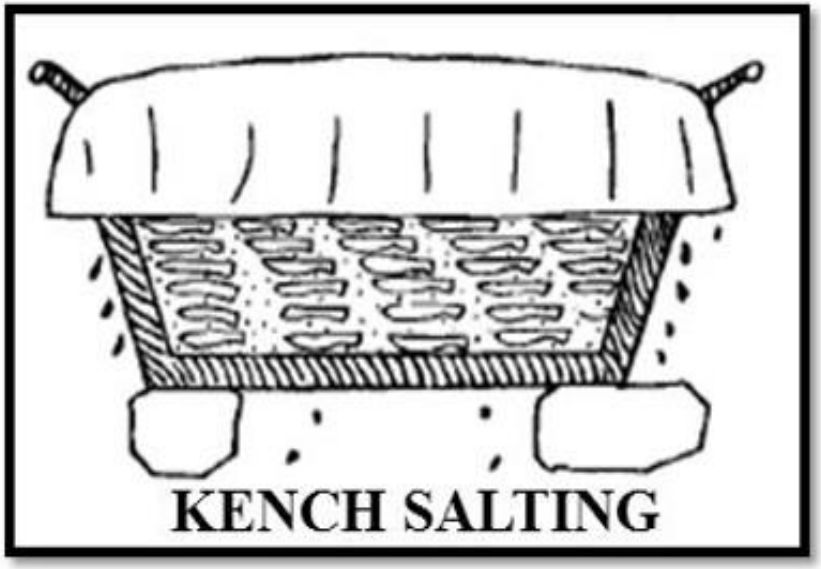
3. PICKLE SALTING

- Pickle curing is a type of wet salting where the fish is layered by granular salt which, dissolves in the surface moisture of the fish forming solution which penetrates into the fish removing moisture from the fish.
- The fish is allowed to remain in this self brine.
- If the self brine is not sufficient, saturated brine is added to immerse the fish.

TYPES OF SALTING

4. KENCH SALTING

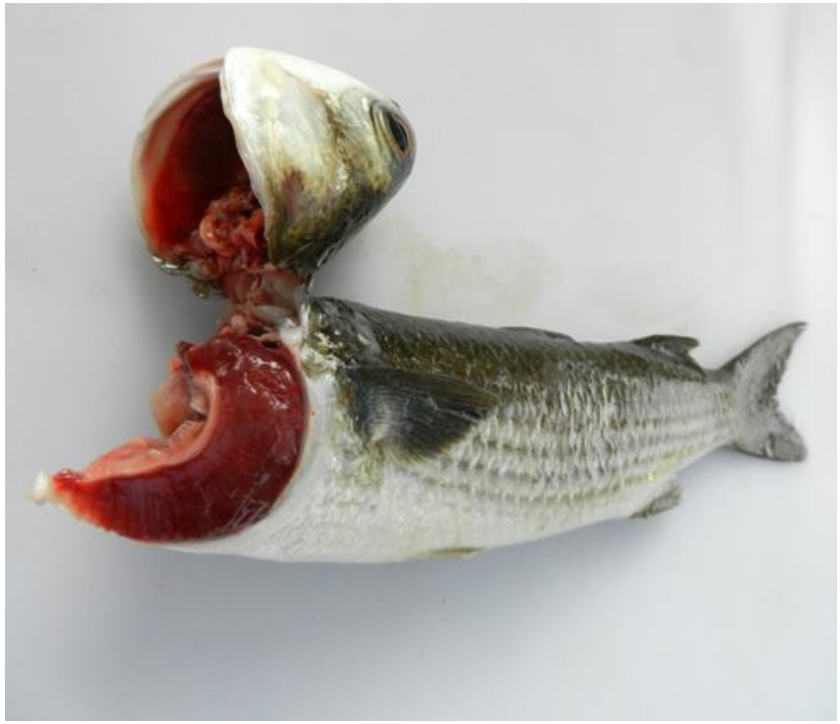
- A method of dry salting except that the self-brining.
- The self-brine formed is allowed to drain off.
- This method cannot be recommended for general use in the tropics as the fish are not covered by the brine or pickle and are therefore more susceptible to spoilage and insect attack.
- Exposure to the air and the presence of salt also encourages the rate of fat oxidation which gives rise to discoloration and the characteristic rancid flavours



TYPES OF SALTING

5. MONA CURING

- Mainly adopted for medium to small size fishes.
- Before salting, the intestine and entrails are removed by pulling out through the gill region without split opening the fish.
- The flesh is not exposed during salting thereby causing less contamination
- The product has a shelf stability of about two months.
- The yield obtained by this method is about 70%.



TYPES OF SALTING

6. PIT CURING

- In this method, fish is mixed with salt (4:1) and placed in pits dug on beaches.
- The pits may be lined with palymrah / coconut leaves.
- After 2-3 days of maturation, the fish is taken out for marketing in wet condition and packed in bamboo baskets and transported to markets without drying.
- The quality of fish cured by this technique is poor with a shelf stability of upto three weeks only.

TYPES OF SALTING

7. COLOMBO CURING

- Colombo curing is similar to pickling process which is widely practiced in Sri Lanka.
- A piece of dried malabar tamarind (*Garginia cambogea*) is kept in the abdomen portion of the gutted and cleaned fish which is further stacked in airtight wooden barrels filled with brine.
- Fishes cured by this method has a shelf life for upto 6 months.

QUALITY ISSUES IN DRIED AND SALTED FISH

Pink/Red

- Halophilic bacteria are present in most of the commercial salt cause pink/red patches on wet or partially dried salted fish.
- Usage of good quality salt is recommended to avoid this condition.

Dun

- Brownish black or yellow brown spots on the fleshy parts, referred to as "dun".
- This is mainly caused by growth of halophilic mould called *Sporendonema epizoum*.
- To avoid the mould growth it is necessary that the fish be dried, packed and stored properly to avoid uptake of moisture.
- Chemical method of prevention includes dipping the fish in a 5% solution of calcium propionate in saturated brine for 3-5 minutes depending upon the size of the fish.

QUALITY ISSUES IN DRIED AND SALTED FISH

Salt Burn

- If fine grain is used directly on the fish, salt burn may occur due to the rapid removal of water from the surface with no penetration of salt to the interior of the fish.
- A mixture of large and small grain sizes is recommended for dry salting of fish.

Case hardening:

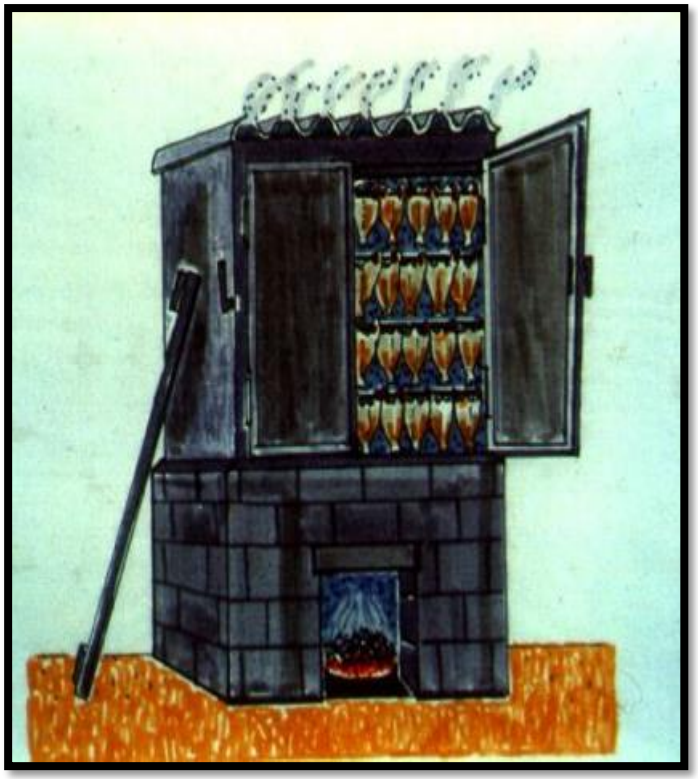
- Under certain conditions, where the constant rate drying is very rapid due to high temperature and low relative humidity, the surface of the fish can become 'case hardened' and
- The movement of moisture from the deeper layers to the surface is prevented. This can result in a fish which is dry at surface.
- However the centre remains wet and hence spoils quickly.

QUALITY ISSUES IN DRIED AND SALTED FISH

- **Rancidity**
  - This is caused by the oxidation of fat, which is more pronounced in oil rich fishes like mackerel, sardine etc.
- **Insect Infestation:**
  - Spoilage due to insect infestation occurs during initial drying stages as well as during storage of the dried samples.
  - The flies which attack the fish during the initial drying stage are mainly blowflies belonging to the family Calliphoridae and Sarcophagidae.
  - Beetles belonging to the family Dermestidae, and most commonly found beetles are Dermestes ater, D frischii, D maculates, D carnivorous and Necrobia rufipes.
  - Proper hygiene and sanitation, disposal of wastes and decaying matter, use of physical barriers like screens, covers for curing tanks etc, and use of heat to physically drive away the insects and kill them at 45 ° C.
- **Fragmentation:**
  - Denaturation and excess drying of fish results in breaking down of the fish during handling. Fish can become brittle and liable to physical damage when handled roughly. Insect infestation is also a reason behind fragmentation in dried samples. It is necessary that fresh fish be used as raw material to ensure a good finished product.

2. SMOKING

- An ancient method of food preservation, which is also known as **"smoke curing"**



- Process of treating fish by **exposing it to smoke** from smouldering wood or plant materials
- To introduce flavour, taste, and preservative ingredients into the fish.
- Usually characterised by an integrated **combination of salting, drying, heating and smoking** steps in a smoking chamber.

Flavors

Smoke
(Hot air)

Water

DEVELOPMENTS MODERN FOOD PRESERVATION TECHNOLOGY

- In the past, smoke curing was used to preserve the fish for lean seasons as a method for extending the shelf-life.
- Nowadays, the main purpose of smoking has been shifted for sensory quality (delicacy) rather than for its preservative effect.
- Around 2% of the total world catch is used for preparing smoked fish all over the world.
- In most countries in Africa, Nigeria, Ghana, Cote d'Ivoire, Togo, Benin, Senegal, Sierra Leone, Liberia, Kenya, Uganda, Tanzania, etc., smoking is the most widely practiced method
- It has been estimated that 70–80% of fish catch is consumed in smoked form.

HISTORY

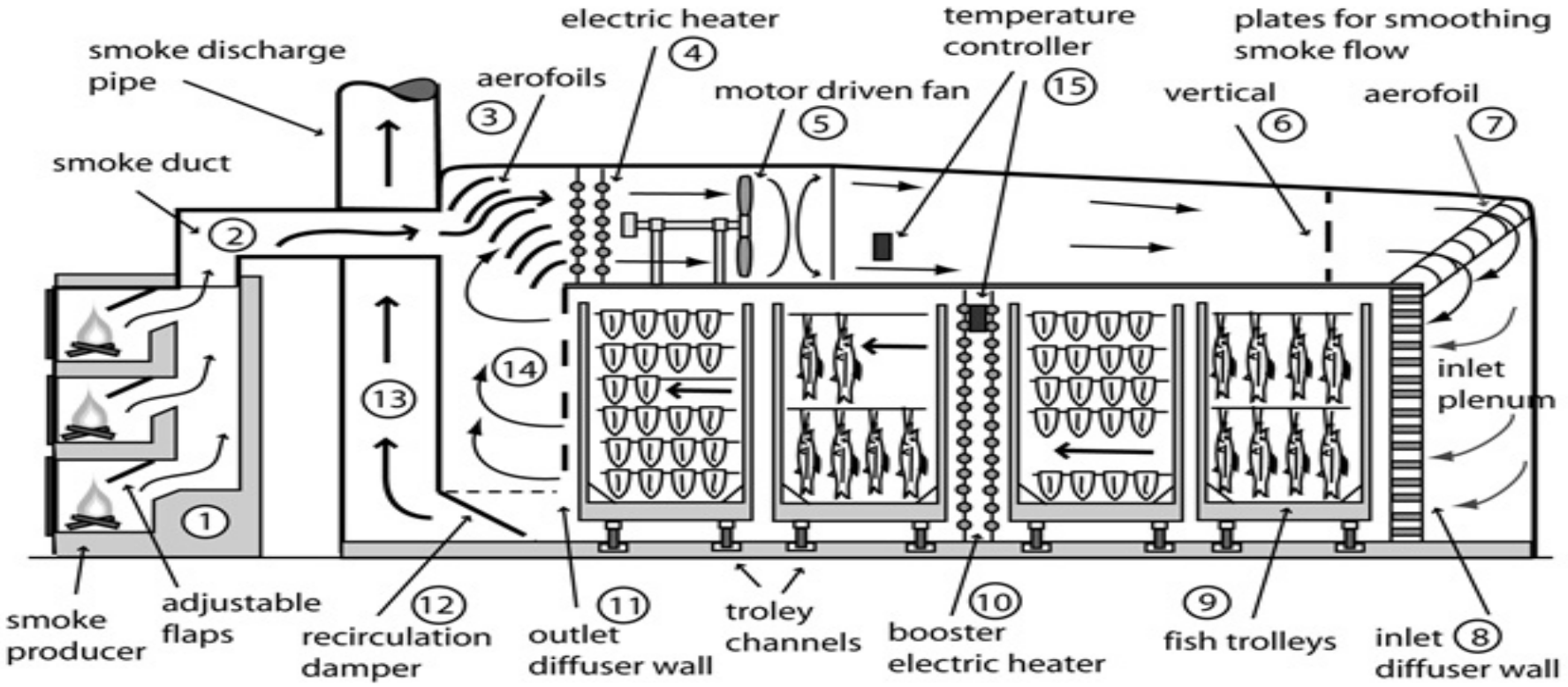
- Fish smoking can be traced back to as early as 1349 (Cutting, 1962)
- Two distinct types, hot and cold smoking were followed in different geographical areas (Anonymous, 1965)
- Before 20th century, fish products were heavily salted, thoroughly dried and heavily smoked (sometimes up to 3 weeks)
- The finished product was totally preserved for long periods

CONT..

- Refrigeration technology has reduced the need for harsh curing and allowed for milder cures.
- This has coincided with the modern consumers becoming more health-conscious and desiring milder cured fish
- Modern smoked fish products are thus salted, dried and smoked more lightly.
- The developments in mechanical and automated processing equipment's, including automated briners and controllable mechanical kilns, have been important innovations in quality control in the fish smoking industry

TORRY KILN

- Torry Kiln Smoke house was designed in 1939 at the Research Centre Torry in Aberdeen, Scotland that revolutionized the fishing industry.
- It allowed for precise control of smoking parameters like air temperature, its speed, and humidity.
- The finished product was always of the consistent high quality.



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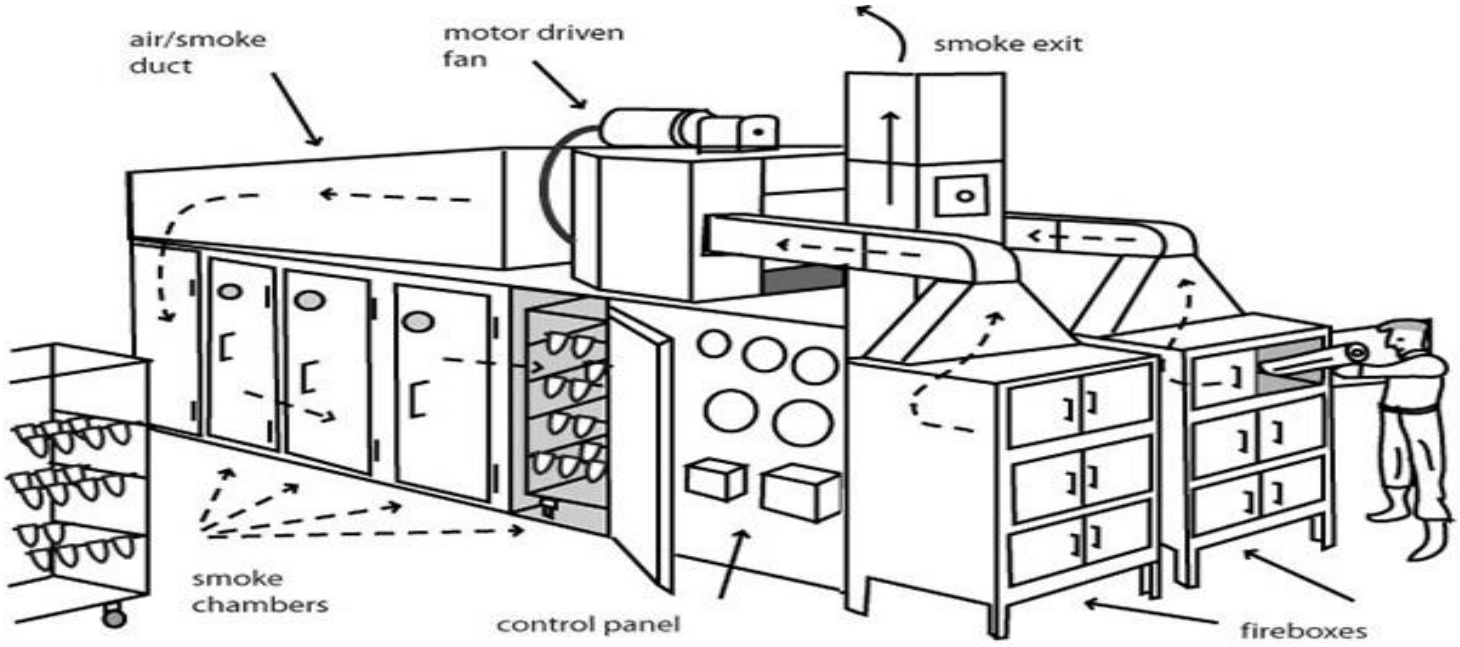
- It overcome the problems encountered with traditional kilns, such as inconsistency in product quality, influence of weather conditions and requirement for intensive labour.
- Since then, more modern kilns have become available with computer-programmable control of parameters such as smoke velocity, temperature, relative humidity and with automated smoke generators.



SMOKING OF FISH: TECHNOLOGICAL ASPECTS

- The processing of smoked fish involves five major steps:
  1. Selections, handling and preparation of raw material
  2. Brining/salting
  3. Racking/hanging and drying
  4. Smoking
  5. packaging

1. Selections, handling and preparation of raw material

- Top-quality fish are needed to produce a top-quality smoked product
- The important steps in proper fish handling are to quickly bleed, clean and cool the fish
- Fish that are relatively rich in oil are best for smoking
  - Because the oil absorbs the smoky flavour well and prevents undesirably dry texture
- Small fish can be gutted and smoked
- Larger fish can be smoked as whole gutted fish, fillets or chunks
- Smoking will not improve the quality of poorly handled fish

2. Brining/salting

- Proper salting is a key step for the flavour and safety of smoked fish
- Salting is the removal of water with its partial replacement by salt
- Done in either of two ways:
  1. Dry salting
     - The product is layered with salt at 5-10% (wt of fish)
  2. Liquid brining
     - The product is immersed in a prepared salt solution of a particular degree of salt saturation (° S)

CONT..

- Make sure that their size is as uniform as possible
- This ensures that the same amount of salt is absorbed during salting and that all of the pieces receive the required amount of heat without overcooking
- Salting is most effectively done using brine
- The length of time to keep the fish in the brine varies depending on the flesh thickness and fattiness, higher fish quality and the relative proportion of fish and brine
- The ratio of fish to brine should be 1:1

DRYING

- After brining, rinse and air dried before smoking.
- Rinsing will remove salts-tolerant bacteria that may cause spoilage
- Drying will help smoke deposit evenly on the fish surface during smoking (smoke does not deposit well on a wet surface)
- The time required for drying will vary (approx. 1-2 hrs)
- Cold smoking requires a certain amount of drying prior to smoking to help produce the pellicle
- But hot smoking can occur immediately after racking, since a pellicle would only be destroyed by heat.

DRYING (FORMATION OF PELLICLE)

- Drying process, gives a nice coating on fillets to help seal in moisture, natural juices, flavours and provides a better looking finished product (glossy skin forms on the cut surface) – this is called "pellicle"
- Due to the salt denatures the surface protein of the fillets
- Play important role in "cold smoking"

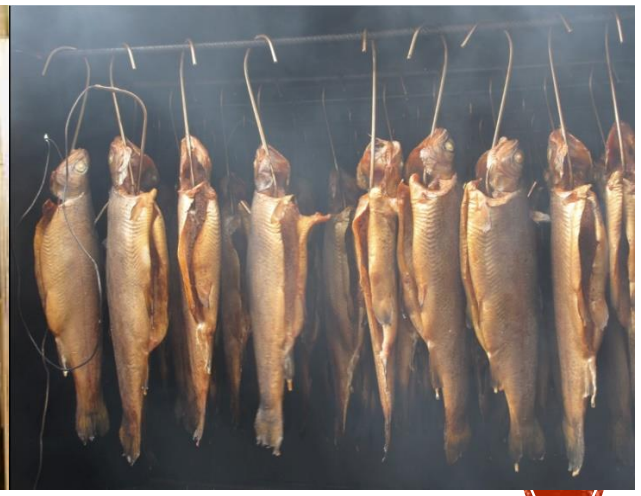
CONT…

- Some factors affecting drying would be:
  - Velocity of smoke
  - Amount of moisture in the fish
  - Temperature and amount of moisture held in the smoker
  - Amount of salt in the fish
- A relative humidity of 60-70% is most satisfactory for cold smoking of fish.
- If the relative humidity is lower than this, drying occurs rapidly with consequent "Case hardening"
- If it is above 70%, then very little drying occurs.
- Rate of drying can be controlled by allowing more or less fresh air into kiln.

3. Racking/hanging and drying

- Racking and drying aids in the formation of the pellicle, reduces drying time during smoking
- Provides maximum exposure of the fish to the smoke
- Racks are more widely used today, but some products still require the use of speats, or spits, to be threaded through the neck, eyes or the gill and mouth of the fish hanging.
- This procedure is known as "Speating"





4. Smoking

- Smoke is produced through the incomplete combustion of wood in the form of sawdust or woodchips.
- Smoke from wood is a highly complex mixture of chemicals including organic acids, alcohols, ammonia, carbon dioxide, carbon monoxide, carbonyls, esters, furans, hydrocarbons, lactones, nitrogen oxides, particulates, phenols, sulphur dioxide etc.
- Over 400 volatile have been identified in wood smoke (Maga, 1987)
- Although many researchers believe that phenols are the primary contributors to the smoke aroma, which is responsible for colour, odour and flavour
- Due to the interaction of smoke carbonyls with amino components on the flesh surface.

5. PACKAGING

- All smoked products, whether hot or cold smoked, require slow cooling to room temperature, immediately followed by chilling to 4°C, and if required, quick freezing and storing at -18°C.
- Smoked products can be
  - Vacuum packed
  - Shrink packed
  - Canned or bottled
  - Retortable pouches
  - Wooden boxes (90 x 60 x 45 cm, FAO)
  - MAP/CAP

TYPES

- Depends upon the smoke is delivered into the food and smoking temperature
  - Cold smoking
  - Hot smoking
  - Liquid smoking
  - Electrostatic smoking

COLD SMOKING

- The procedure for cold smoking and hot smoking differ only in the temperature at which the smoking occurs
- Cold smoking is the process of applying a smoky flavours to a fish at temperature below 30°C
- Further cooking of these smoked products occurs prior to consumption
- The formation of a pellicle is essential for cold smoked products.
- Most cold smoked products are laid on the racks and a heavy smoke initially deposited, tapering off towards the end.

HOT SMOKING

- Hot smoking uses a temperature of 70-80°C
- Consists of the same preparatory procedures as cold smoking, except for a reduction in the brining stage
- Because the product will lose much more moisture during cooking
- Hot smoking products are often hung rather than racked
- Products can also smoked immediately after brining without a drying stage, since the formation of a pellicle is not necessary.

LIQUID SMOKING

- Liquid smoke is smoke condensate that is dissolved in a solvent, such as water or oil and can be used directly on products by dipping or spraying.
- It is rapid and much easier to achieve a uniform smoke flavour
- Some potential harmful ingredients (e.g. polycyclic aromatic hydrocarbons, PAHs) in the nature smoke can be separated out and excluded from the liquid smoke
- Other advantages of liquid smoke include easy modification, lower operation cost, and less environmental pollution
- However, the application of liquid smoking may be expensive
- Liquid smoking of fish species had been reported on swordfish, salmon and rainbow trout.

ELECTROSTATIC SMOKING

- Another rapid way to smoke.
- Fish are sent into a tunnel where an electrostatic field is created.
- Smoke particles are given a positive charge and deposit onto the surface of the fish which are negative charged.
- The efficiency of smoking is still higher than that of the traditional smoking.
- It can also be operated continuously.
- This operation may present safety problems to employees.
- Applications of electrostatic smoking have been reported mainly in salmon and herring.

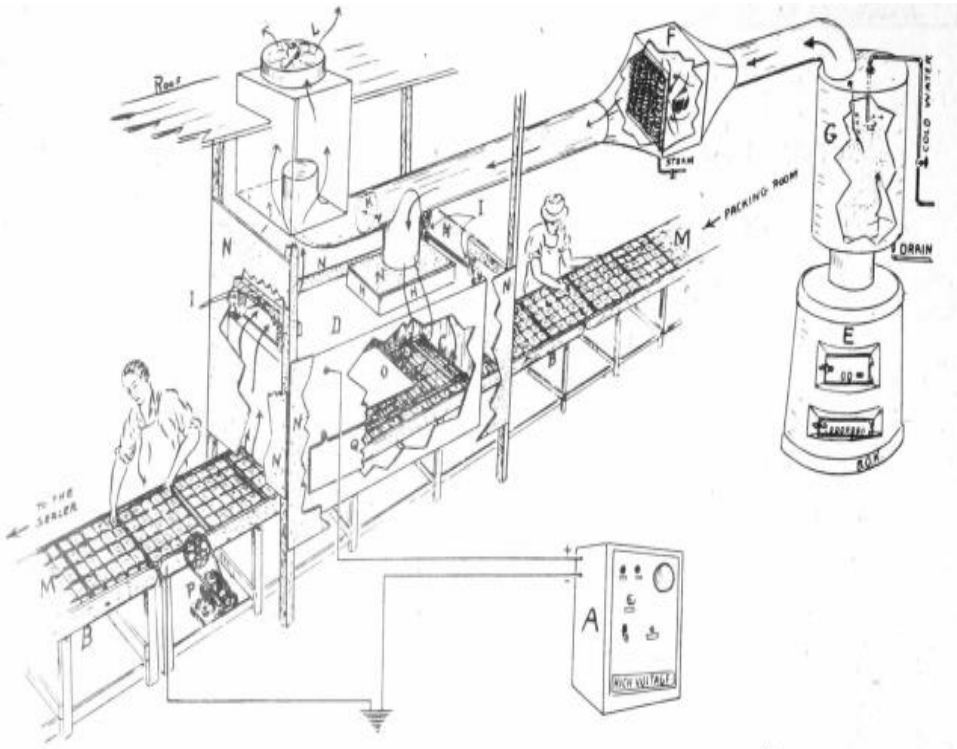


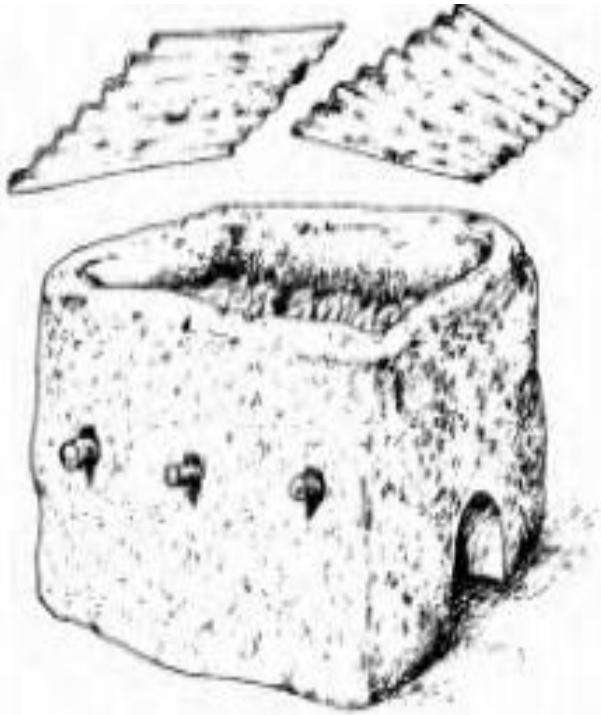
FIGURE 1 - PILOT SMOKING PLANT

A - HIGH-VOLTAGE CURRENT SOURCE
B - CONVEYOR
C - POSITIVELY CHARGED GRID
D - METAL SMOKE PRECIPITATION CHAMBER
E - SMOKE PRODUCER
F - SMOKE HEATER
G - SMOKE WASHER AND DEHUMIDIFIER
H - GLASS-PANE INSULATORS
I - SUPPORT INSULATORS
K - BY-PASS DAMPER
L - EXHAUST
M - PANS
N - ASBESTOS GUARDS
O - BAFFLE
P - MOTOR CONVEYOR DRIVE
Q - DOOR IN SMOKE PRECIPITATION CHAMBER

TRADITIONAL KILNS IN THE WORLD

'LUNYO' RECTANGULAR SMOKING OVEN

Region	Africa
Country	Kenya, Tanzania, Uganda
Product	Smoked fish
Local name	Mbutu
Raw material	Nile Perch. *(Nates niloticus)*
Prepared	Scaled, gutted and split without washing. May be sold fresh or further processed by smoking or frying.
Sold fresh	
Fried/Smoked	The cut pieces are placed on crude trays over an enclosed, rectangular mud oven. The fire is then lit inside the bottom of the oven. Alternatively, the fish may be fried in its own oil.
Marketed	The buyers (women) come to the site and buy fresh, fried or smoked fish to take to markets outside where the fish may be re-fried or smoked before selling.



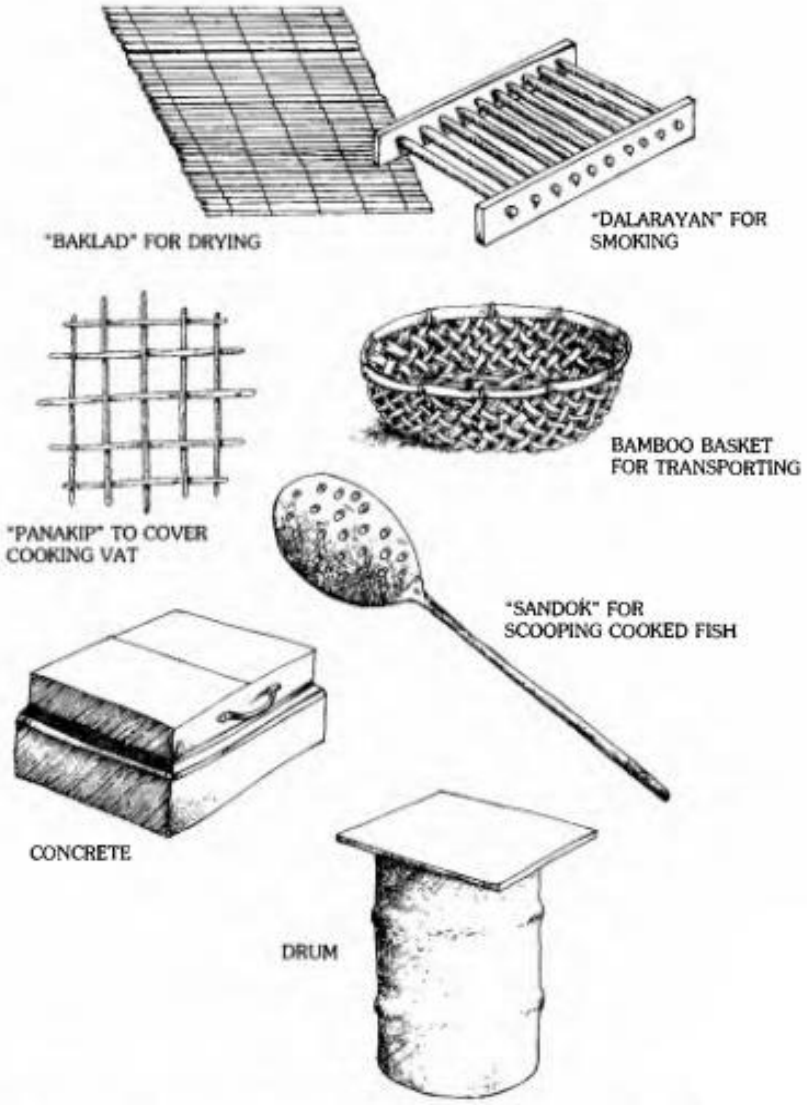
FISH SMOKING WAY IN NIGERIA

Traditional method

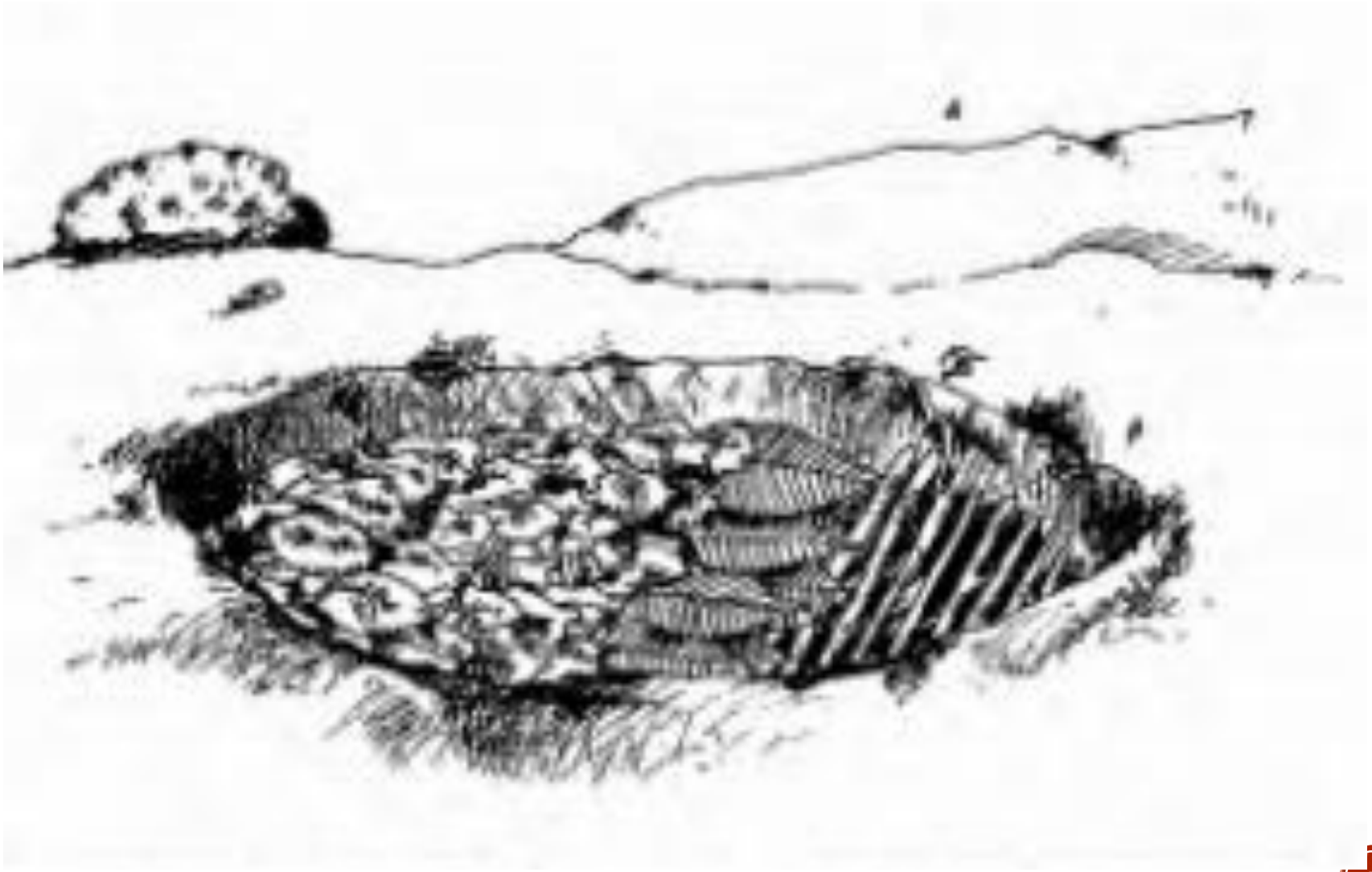
Mechanical method

TINAPÁ "SALINAS" METHOD
(BOILED SMOKED FISH)

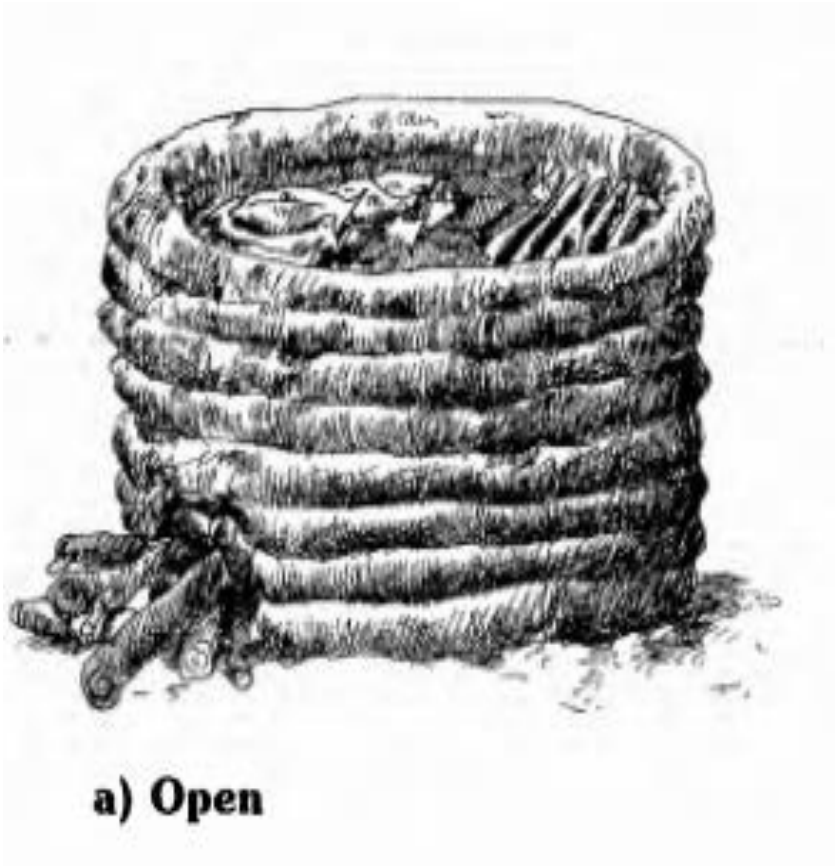
Region	South East Asia
Country	Philippines
Product	Boiled smoked fish
Local name	Tinapa "Salinas" method
Raw material	Roundscad, milkfish, sardines, mackerel
Prepared	Washed
Sun dried	Sun dried for 2 hours
Boiled	Cooked in saturated boiling brine until the eyes turn white.
Smoked	Sprinkle with water to remove scum and drain before smoking for 30-45 minutes. The smoking kilns used are completely closed except for the opening at the top where the smoking trays are placed.
Product	'Tinapa' cooled and packed in baskets covered with banana leaves.



TRADITIONAL SMOKING PIT IN EAST AFRICA



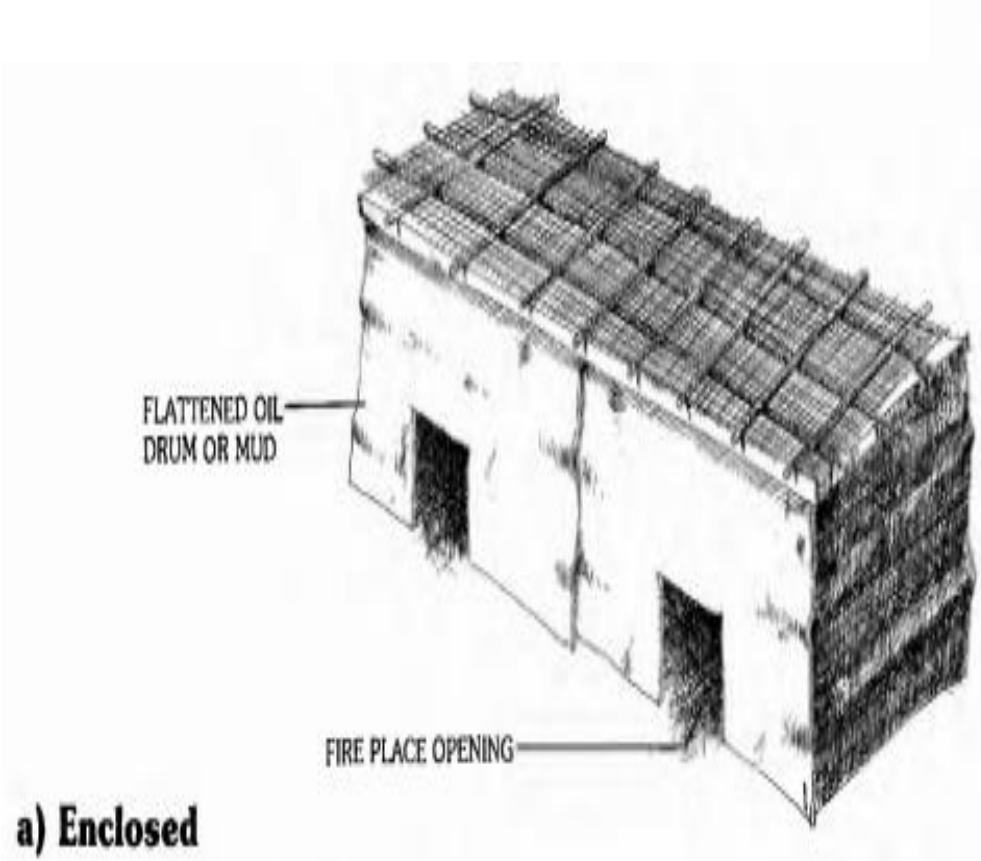
TRADITIONAL GHANAIAN CYLINDRICAL MUD OVEN



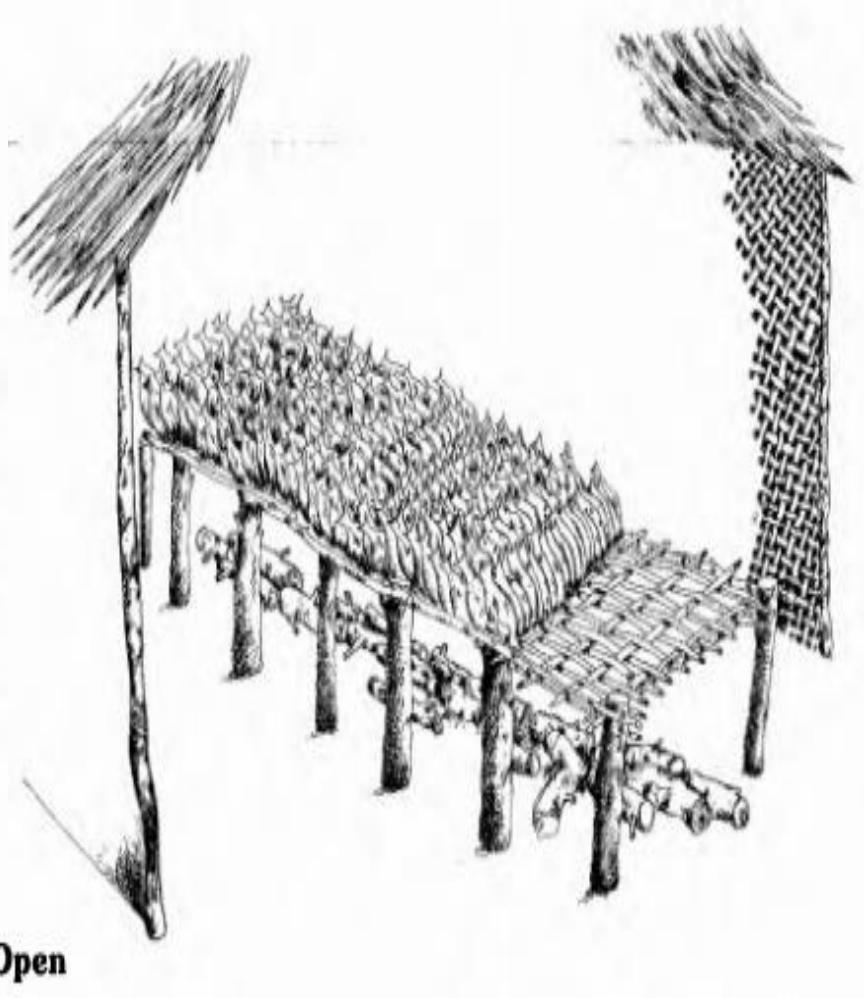
a) Open

b) With Thatched Cover

TRADITIONAL SMOKING PLATFORMS OR 'BANDAS' IN SIERRA LEONE, WEST AFRICA



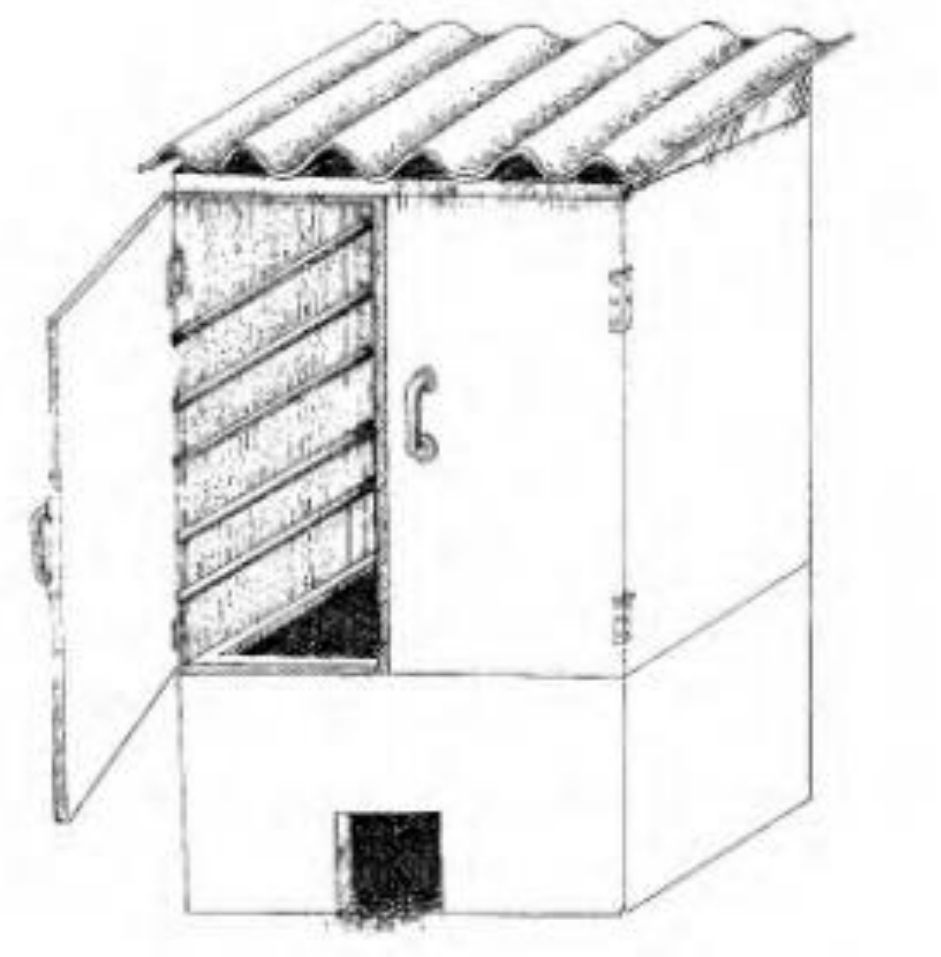
a) Enclosed



b) Open

IMPROVED TRADITIONAL KILNS
ALTONA TYPE OVEN

- Consists of a brick or cement fire box located below a smoking chamber made of metal.
- Developed in West Africa (Uganda)
- The fish are placed on trays which slide into the smoking chamber.
- Many other versions of this kiln have been constructed using less expensive materials such as mud or fired bricks instead of metal.



ROGERS SMOKING HOUSE, UGANDA

- A more complex design built of cement known as the Rogers Kiln, was introduced into Uganda.
- However, with both the Altona type and the Rogers Kilns the initial cost of construction makes them unaffordable for artisans.
- Although the Rogers Kiln was still being used in Uganda some time after its introduction, the fish processors had not built any other ones themselves.

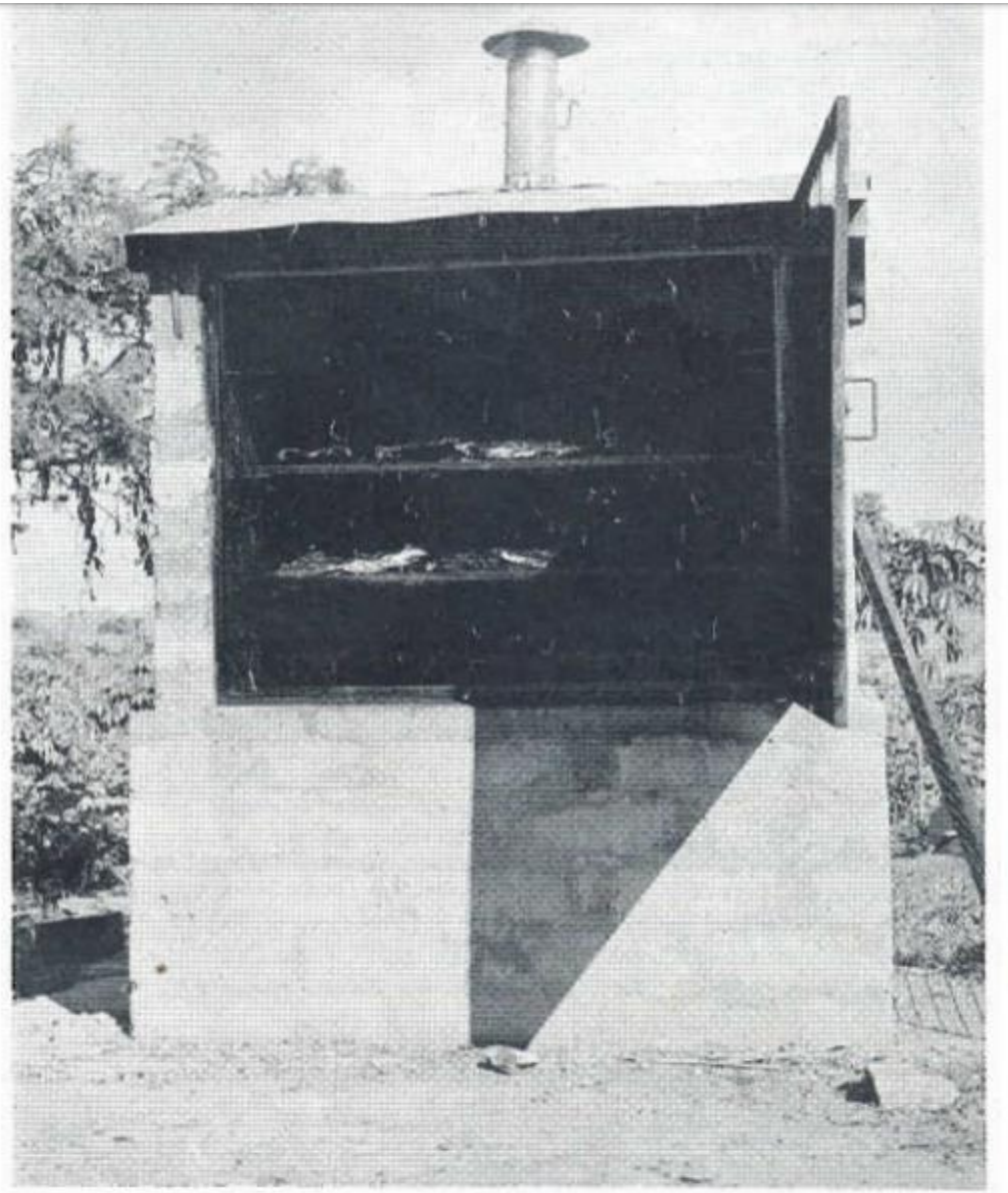
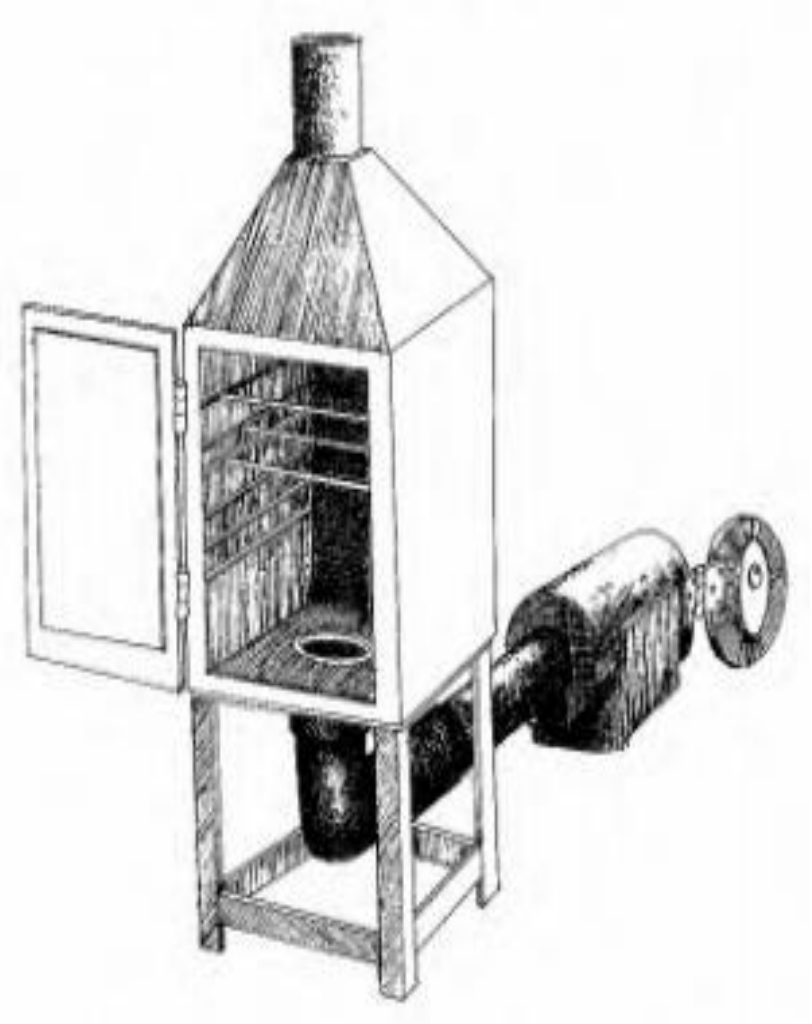


Plate I—"Rogers" smoke house—view of loading door.

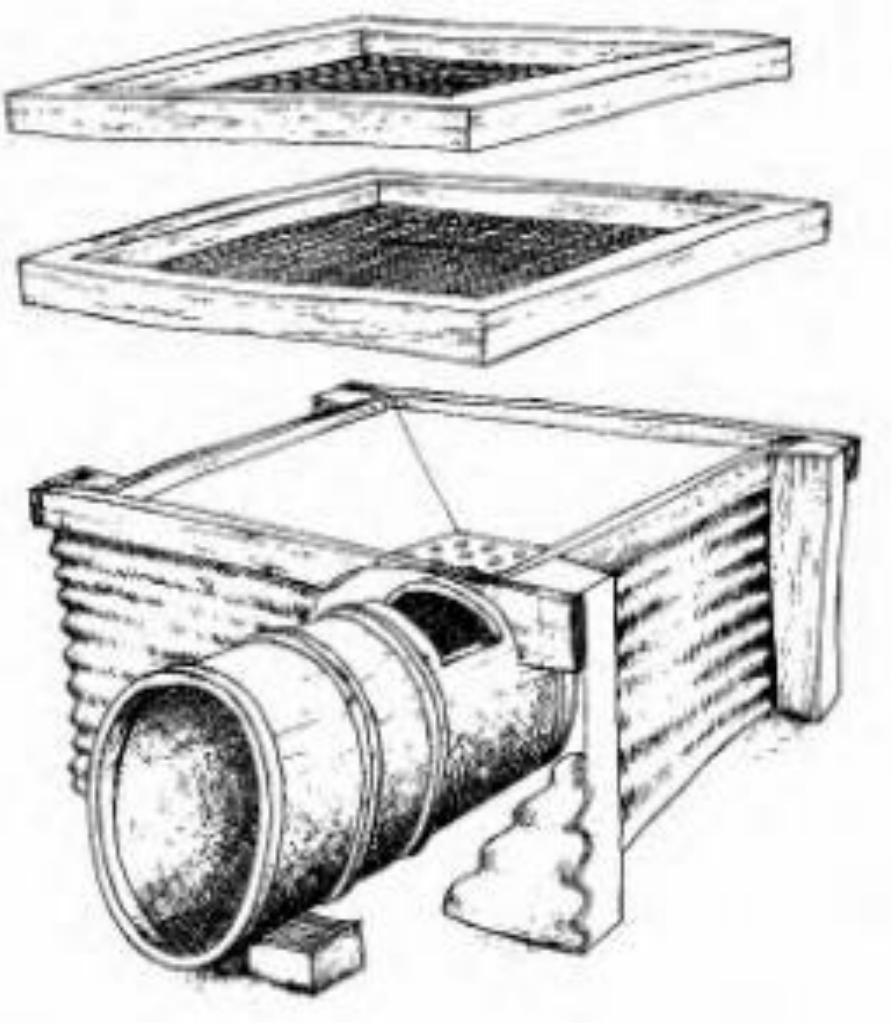
ADJETEY OVEN

- Designed in Ghana to overcome two main problems of the traditional cylindrical oven: an increased holding capacity for fish and greater control over the fire.
- The oven is made of iron and consists of a stand, a smoking chamber and a fire box.
- The oven is fired indirectly and a metal tube connects the fire box to the smoking chamber.
- The oven is rectangular with an inverted conical top providing a vent at the top, equipped with a simple damper to regulate air flow.



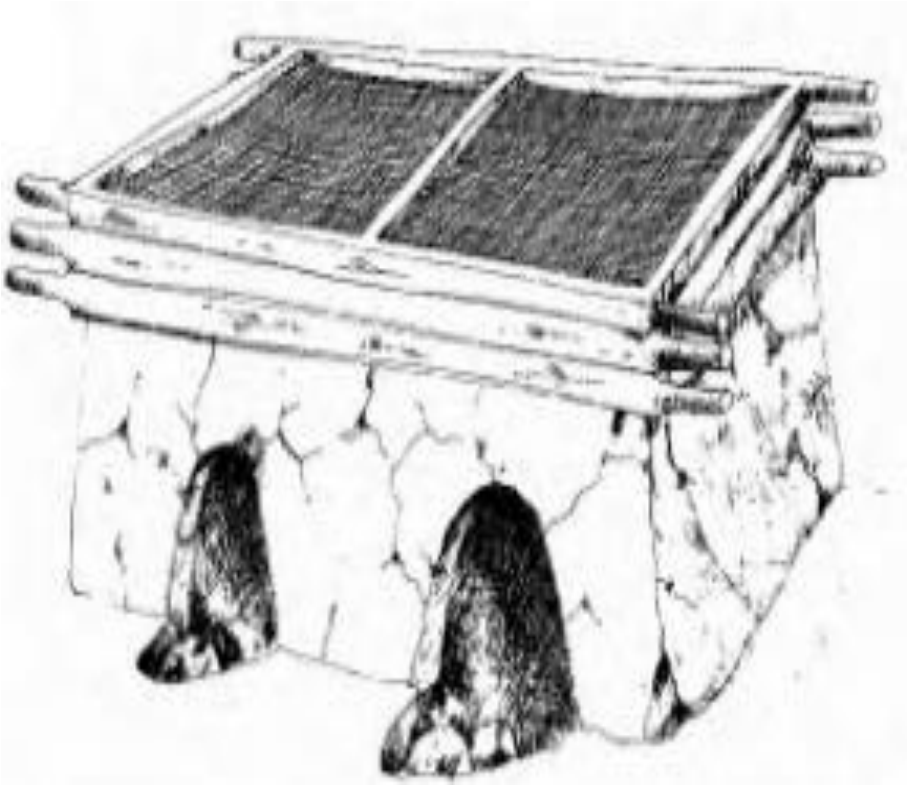
IVORY COAST KILN

- First-introduced into the Ivory Coast, this smoker can be made easily from locally available materials (pole and mud, cement with mud, corrugated metal sheets)
- Consists of a walled enclosure approx. 1 m high & 1-2 m^2 plan section
- The trays of fish are stacked on top of a base made from sheet metal (flattened oil drum) or asbestos roofing sheet.
- A fire box and a smoke spreader are enclosed in the base.



CHORKOR SMOKER

- Originally designed in Ghana to resemble the traditional rectangular smoking kilns,
- Contains two stoke holes to create two fireboxes and has its own fire entrance
- Wooden trays fitted with wire mesh are stacked on top of the rectangular base.
- Fishes are palced on wooden framed trays, upto 15 trays can be stacked at once.
- Upto 250 kg fish can processed at one time



CHORKOR SMOKER

Arranging

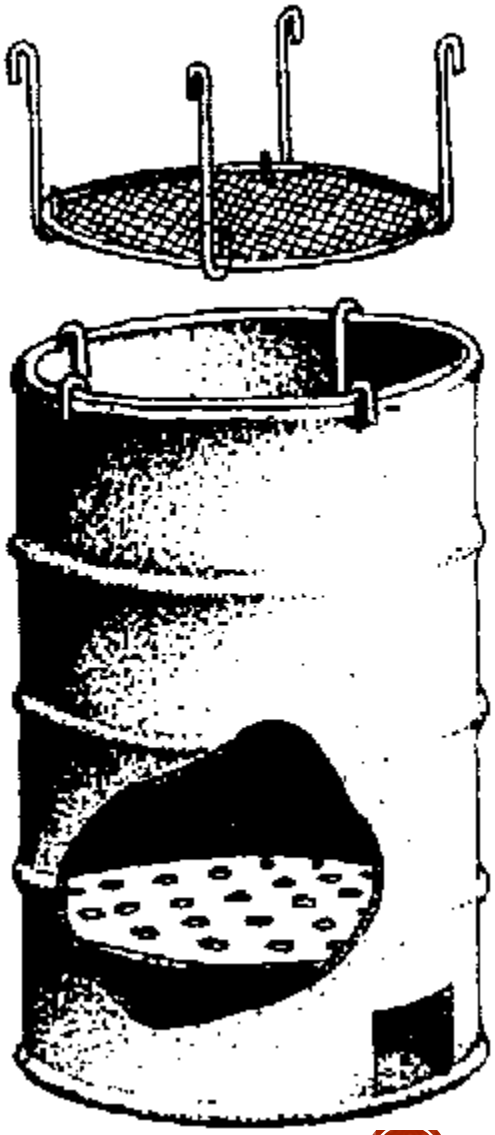
Stoking

SRILANKA

TRADITIONAL KILNS IN INDIA

MASMIN

- Masmin is a traditional product of Lakshadweep Islands and Malabar coast of Kerala
- Prepared from Skipjack tuna (*Katsuwonus pelamis*) fillets by cooking in sea water followed by alternate drying and smoking till the moisture content is less than 10% .
- It is a heavily smoked, hard-dried product
- High in protein and has a long shelf life of more than a year.
- The product is exported to Sri Lanka, Singapore, Malaysia and Hongkong



"JITHAGA" SMOKING OF PRAWNS

- Smoke-cured small estuarine prawn of mixed species, prepared by traditional method in coastal Andra Pradesh is locally known as "Jithaga"
- The prawn are spread over nets & dried for 3-4 hrs under sun, the spread over bamboo mats table top (3-5 m long, 1-2 m wide & 0.8 m high)
- Smoked by burning of mangrove wood, saw-dust, cattle dung cakes is produced in closed chamber
- Temperature of 40-50° C, RH 65-75% is maintained,
- After 4-5 hrs prawns are dried properly with attractive colour, the material is allowed to cool overnight, packed in Palmira leaves basket.
- About 25 species are used for smoking.
- About half a dozen varieties predominate, with mullets and shrimp being the preferred species.
- The capacity of individual kilns to smoke fish varies greatly ranging between 25-100 kg / cycle
- The moisture content is 18-20% & shelf life is 4-6 months by good packing in polythene bags & storage in air-tight container.

POTENTIAL HAZARDS ASSOCIATED WITH SMOKING OF FISH

- Biological hazards
- Chemical hazards
- Physical Hazards

BIOLOGICAL HAZARDS

- *Listeria monocytogens*
  - Generally, the typical temperature used for cold smoking is 22-28˚C.
  - However, this temperature is not sufficient to eliminate the risk from *Listeria monocytogens,* causing deadly septicaemia, meningitis, spontaneous abortion, and foetal death in adult human beings.
  - Specific high risk categories like persons with altered immune system, pregnant ladies, old aged persons etc. will be more susceptible to listeriosis followed by accidental inclusion.
  - Detected in several cold smoked products.
  - Comparatively high temperature used in hot-smoking process and long-time of exposure to that temperature (60-70˚C for 2-3 h) can inactivate the *L. monocytogens* effectively.

BIOLOGICAL HAZARDS

- ***Clostridium botulinum***
  - The toxin produced by *C. botulinum* can lead to botulism, serious illness and death to the consumer.
  - Even a few micrograms of intoxication can lead to ill-health
  - In cold smoked fish and fishery products, which undergoes mild heat processing
  - Whereas in hot-smoked products, high temperature application causes damages to spores of *C. botulinum* thus prevents the toxin formation.
  - By achieving proper salt concentration in processed fish, proper refrigeration during storage and reduced oxygen packaging like Modified Atmosphere Packaging (MAP) and vacuum packaging of the products can prevent the occurrence of *C. botulinum* in smoked fish and fishery products.

BIOLOGICAL HAZARDS

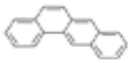
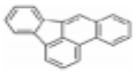
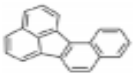
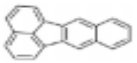
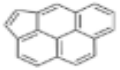
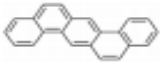
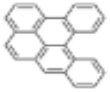
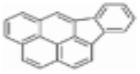
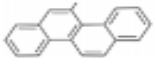
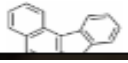
- **Aflatoxins;**
  - highly toxic compounds naturally produced by *Aspergillus flavus and Aspergillus parasiticus* etc
  - Mainly Aflatoxin B1 and G1
- Others
  - Salmonella spp.
  - Staphylococcus aureus
  - Escherichia coli
  - Campylobacter spp.
  - Yersinia spp.

CHEMICAL HAZARDS

Polycyclic Aromatic Hydrocarbons (PAHs)

- PAHs are large class of organic compounds containing two or more fused aromatic rings made up of carbon and hydrogen atoms.
- Incomplete combustion (pyrolysis), during smoking can lead to formation and release of PAHs into the smoked product.
- Some of them are carcinogenic and mutagenic substances causing serious health issues to the consumers.
- Many reports indicate that individual PAHs in smoked fish can go up to a level of 200µg/Kg.
- They are benzo[a]anthracene, benzo[b]-, benzo[j]- and benzo[k]fluoranthene, benzo[ghi]perylene, benzo[a]pyrene, chrysene, cyclopenta[cd]pyrene, dibenz[a,h]anthracene, dibenzo[a,e]-, dibenzo[a,h]-, dibenzo[a,i]-, dibenzo[a,l]pyrene, indeno[1,2,3-cd]pyrene and 5-methylchrysene.

Table 2
Name, abbreviations, relative molecular weights and chemical structures of the 16 polycyclic aromatic hydrocarbons (PAH) regulated in meat products by the European Union.

PAH compound	Abbreviation	Molecular weight	Chemical structure
Benzo[a]pyrene	BaP	252	
Benz[a]anthracene	BaA	228	
Benzo[b]fluoranthene	BbF	252	
Benzo[j]fluoranthene	BjF	252	
Benzo[k]fluoranthene	BkF	252	
Benzo[ghi]perylene	BghiP	276	
Chrysene	Ch	228	
Cyclopenta[cd]pyrene	CPP	226	
Dibenz[a,h]anthracene	DBahA	278	
Dibenzo[a,e]pyrene	DBaeP	302	
Dibenzo[a,h]pyrene	DBahP	302	
Dibenzo[a,i]pyrene	DBaiP	302	
Dibenzo[a,l]pyrene	DBalP	302	
Indeno[1,2,3-cd]pyrene	IP	276	
5-methylchrysene	5MeCh	242	
Benzo[c]fluorene	BcF	216	

CONTROL MEASURES

- The PAH contamination in smoked products can be significantly reduced by using indirect smoking process instead of direct smoking of the fish.
- In indirect smoking, the smoke generated in an external smoking kiln, under controlled conditions, is used for smoking process.
- The smoke produced can be even, washed before coming into contact with the food material processed.
- In addition to that, use of lean fish for smoking, and cooking at lower temperature for longer time can also reduce the PAH contamination significantly.

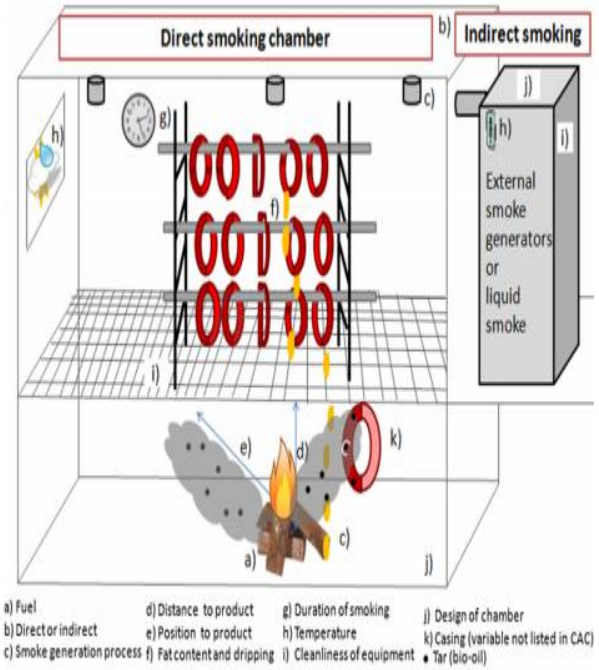


Fig. 2. Smoking chamber: Representation of CAC/RCP 68/2009 variables to control polycyclic aromatic hydrocarbons (PAH) contamination of meat products in direct and indirect smoking processes.

CONT..

- The formation of PAH in smoked fish can be minimised by following Code of Practice for the Reduction of Contamination of Food with Polycyclic Hydrocarbons (PAH) from Smoking and Direct Drying Processes (CAC/RCP 68-2009) given by Codex Alimentarius Commission.
- EU No.835/2011 specifies that maximum level of benzopyrene, and PAH4 (benzo[a]pyrene + chrysene+ benz[a]anthracene+benzo[b]fluoranthene) should be 2µg/Kg wet weight and 12µg/Kg in meat of smoked fish and fishery products
- 5µg/Kg and 30µg/Kg in smoked sprats
- 6µg/Kg and 35µg/Kg in smoked bivalve mollusc respectively.

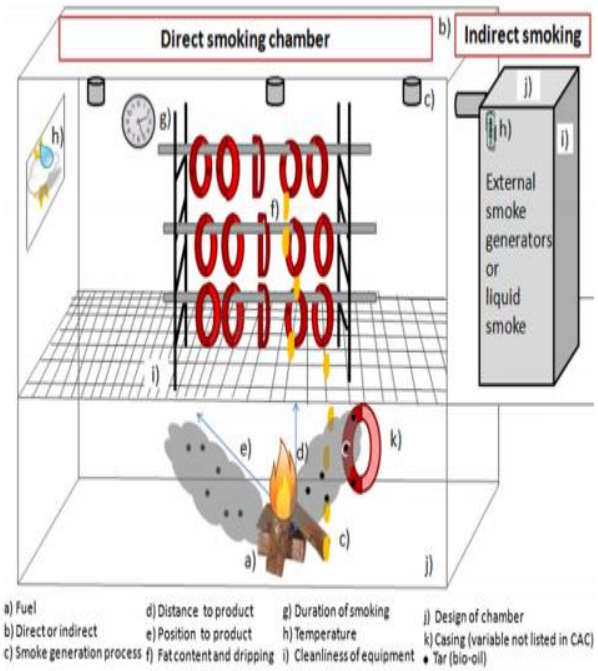
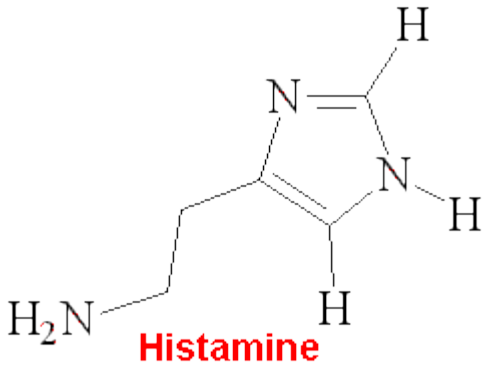


Fig. 2. Smoking chamber: Representation of CAC/RCP 68/2009 variables to control polycyclic aromatic hydrocarbons (PAH) contamination of meat products in direct and indirect smoking processes.

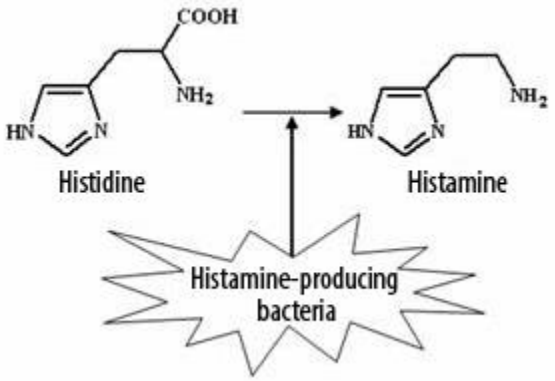
CHEMICAL HAZARDS

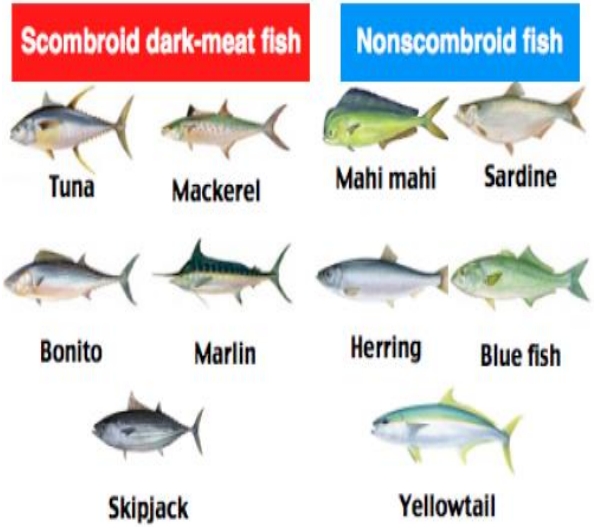
Histamine:

- Histamine poisoning is associated with Scombroid fishes and other dark meat fishes.
- The fishes showing potential treats of histamine poisoning are tunas, bonitos, mackerel, mahi mahi, carangids, herring etc.
- These fishes having high content of free histidine, which during spoilage are converted to histamine by bacteria like *Morganella morgani, Klebsiella pnuemoniae* and *Hafnia alvei*.
- Histamine is heat stable, even cooking or canning cannot destroy it.
- As per Codex standards, the maximum allowable histamine content in smoked fishes is 200 mg/Kg for species like *Scombridae, Clupeidae, Engraulidae, Coryphaenidae, Pomatomidae,* and *Scomberesocidae.*
- Low temperature storage of fishes right from catch can effectively reduce the production of histamine in fishes.



Histamine



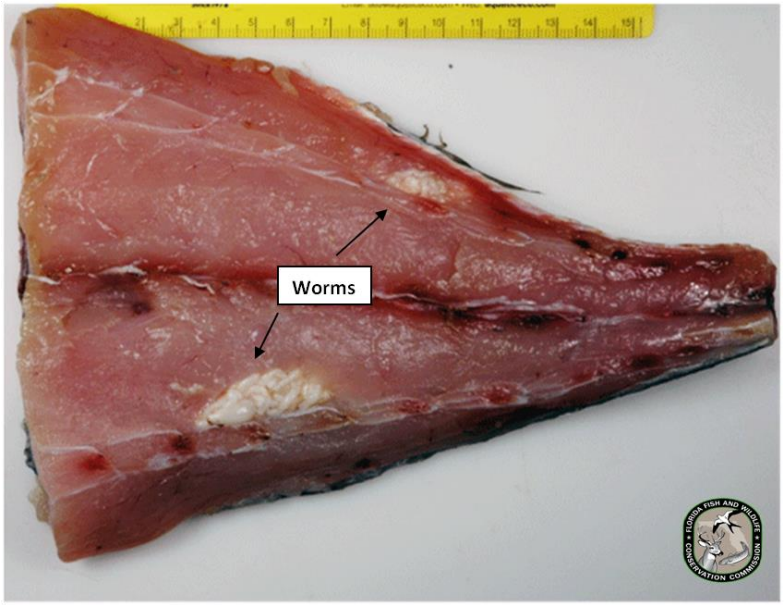


CHEMICAL HAZARDS

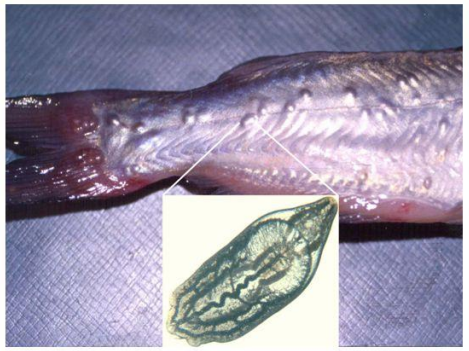
- Biotoxins
  - Biotoxins causing a number of food borne diseases.
  - The poisoning due to biotoxins are caused by consuming finfish/shell fish containing poisonous tissues with accumulated toxins from plankton they consumed.
  - Paralytic shellfish poisoning (PSP), diarrheic shellfish poisoning (DSP), amnesic shellfish poisoning (ASP), and neurotoxic shellfish poisoning (NSP) are mostly associated with shellfish species such as oysters, clam and mussels.
  - The control of biotoxin is very difficult. They cannot be destroyed by any of the processing methods like cooking, smoking, drying or salting.
  - Environmental monitoring of plankton and proper depuration process of the bivalves only can reduce the occurrence significantly.

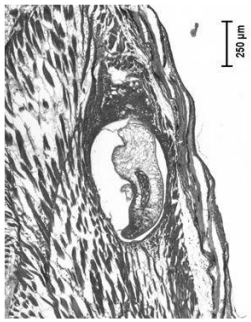
PHYSICAL HAZARDS

- Presence of parasites like nematodes, cestodes, trematodes and any other extraneous matter can be considered as physical hazards.
- Particular attention needs to be paid to cold smoked or smoke-flavoured products, which should be frozen before or after smoking if a parasite hazard is present.



Trematodes





RECENT TECHNOLOGICAL INNOVATIONS

- Fish smoking process have included the use of more complex mixtures of salts and other ingredients to impart specific flavours
- Pepper corns, wines and spice blends as curry, paprika and pepper
- Orange peels, lemon peels or juniper berries may be added to the sawdust to modify the flavour of the smoke
- Prevention of carcinogens,
  1. Smoke generation is a two-part process consisting of pyrolysis and oxidation. It has been suggested that, by maintaining the temperature at 425 & 200° C respectively, the production of carcinogens can be kept minimum.
  2. Electrostatic filtration – solid and liquid particles are trapped and only the gas phase is used for smoking (produce a certain adverse effect on colour and flavour of the product, but reduce the carcinogens level upto 2%.
  3. Steam smoke method – smoke generated by the action of superheated steam, with a temperature of 280-380° C, on a compressed sawdust mixture. The product is then infused with the vapours in a special ventless unit.
  4. Liquid smoking

NEW TECHNOLOGY FROM FAO

- FAO to invent a new technology that is especially designed to help small-scale fish processors prepare and market safe and high-quality food.
- Called the FAO-Thiaroye Processing Technique, or FTT, the technology consists of a dual functioning oven and mechanical drier, which also act as a storage unit.
- 12 countries adopted in africa

NEW TECHNOLOGY FROM FAO

- Since 2008 FAO has worked on developing the FTT-Thiaroye, an improved fish smoking and drying oven technology.
- The oven can be purpose built, or the smoke-capturing chimney, oil-catching trays and other elements can be added to an existing oven.
- It is designed to improve fuel-efficiency in fish-smoking by encapsulating heat and smoke.
- It also addresses health hazards suffered by small-scale fish dryers - the vast majority of whom are women.

FISH SMOKING KILN

- Nigerian Institute for Oceanography and Marine Research (NIOMR) is helping transform the lives of West Africans who depend on fishing for their livelihoods.
- Comprised of a smoking chamber, a fan to distribute heat, a thermometer to control temperature, and a chimney to filter air,
- NIOMR's fish smoking kiln reduces cooking and smoking time from four days to just four hours.

FISH SMOKING KILN

- Eliminates many challenges West African fisheries typically encounter with traditional smoking methods
  - lack of control over the drying process,
  - exposure to dirt and dust,
  - insect infestation,
  - exposure to contaminants, and low capacity.
- According to NIOMR, using the fish smoking kiln can reduce post-harvest losses by 70% and rapidly increase incomes for the 5 % of people depending entirely on the fisheries sector for their livelihoods in West Africa.

AT CIFT

Indigenous smoking Kilns

AT CIFT..

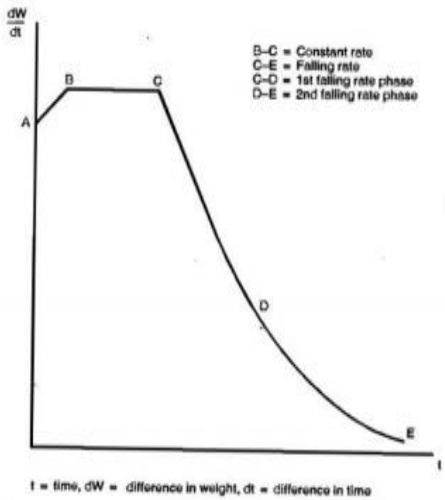
Liquid smoking Kiln, Mechanical Fish smokers

3. DRYING

- In general, the term term 'drying' implies the removal of water by evaporation.
- In fish, water constitutes about 70-80% and since water is essential for the activity of all living organisms, its removal will facilitate retardation of microbial and autolytic activity as well as oxidative changes and hence can be used as a method of preservation.
- In any process of drying, the removal of water requires an input of thermal energy.
- The thermal energy required to drive off the water can be obtained from a variety of sources, e.g., the sun or the controlled burning of oil, gas or wood, electrical heating etc.
- The thermal energy can also be supplied directly to the fish tissue by microwave electromagnetic radiation or ultrasonic heating

DRYING PHASES

- Drying takes place in two distinct phases.
- In the first phase,
  - whilst the surface of the fish is wet, the rate of drying depends on the condition (velocity, relative humidity etc.) of the air around the fish.
  - If the surrounding air conditions remain constant, the rate of drying will remain constant; this phase is called the 'constant rate period'.
- Once all the surface moisture has been carried away, the second phase of drying begins and this depends on the rate at which moisture can be brought to the surface of the fish.
- As the concentration of moisture in the fish falls, the rate of movement of moisture to the surface is reduced and the drying rate becomes slower; this phase is called the 'falling rate period'.



Drying rate curve.

Source: Redrawn from *FAO Fisheries Report*, No. 279. Food and Agriculture Organization of the United Nations, Rome. 1983.

RATE OF DRYING IS DEPENDENT ON SEVERAL FACTORS:

- Constant rate drying phase
  - Air temperature
  - Relative humidity of the air
  - Air velocity
  - Surface area of the fish
- Falling rate drying phase
  - Nature of the fish
  - Thickness of the fish
  - Temperature of the fish
  - Water content

METHODS OF DRYING

Natural or sun drying

- The common and traditional method being sun drying which is done by utilizing the atmospheric conditions viz., temperature, humidity and airflow.
  - Drying on the ground
  - Rack Drying
  - Solar drying using Solar tent dryers, Solar cabinet dryers

Artificial / Mechanical Dryers

- In recent times, the controlled artificial dehydration of fish has been developed so that fish drying can be carried out under controlled conditions, regardless of weather conditions.
- Hot air dryers
  - Cabinet dryer
  - Tunnel dryer
  - Multi deck tunnel
- Contact Dryers
  - Vacuum dryers
  - Rotary dryers
  - Drum dryers

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Solar drier with electrical backup

AT CIFT

Solar drier

AT CIFT

Solar-LPG Hybrid drier

AT CIFT

Solar Tunnel drier

STATUS OF CURING IN INDIA

Salting Area

STATUS OF CURING IN INDIA

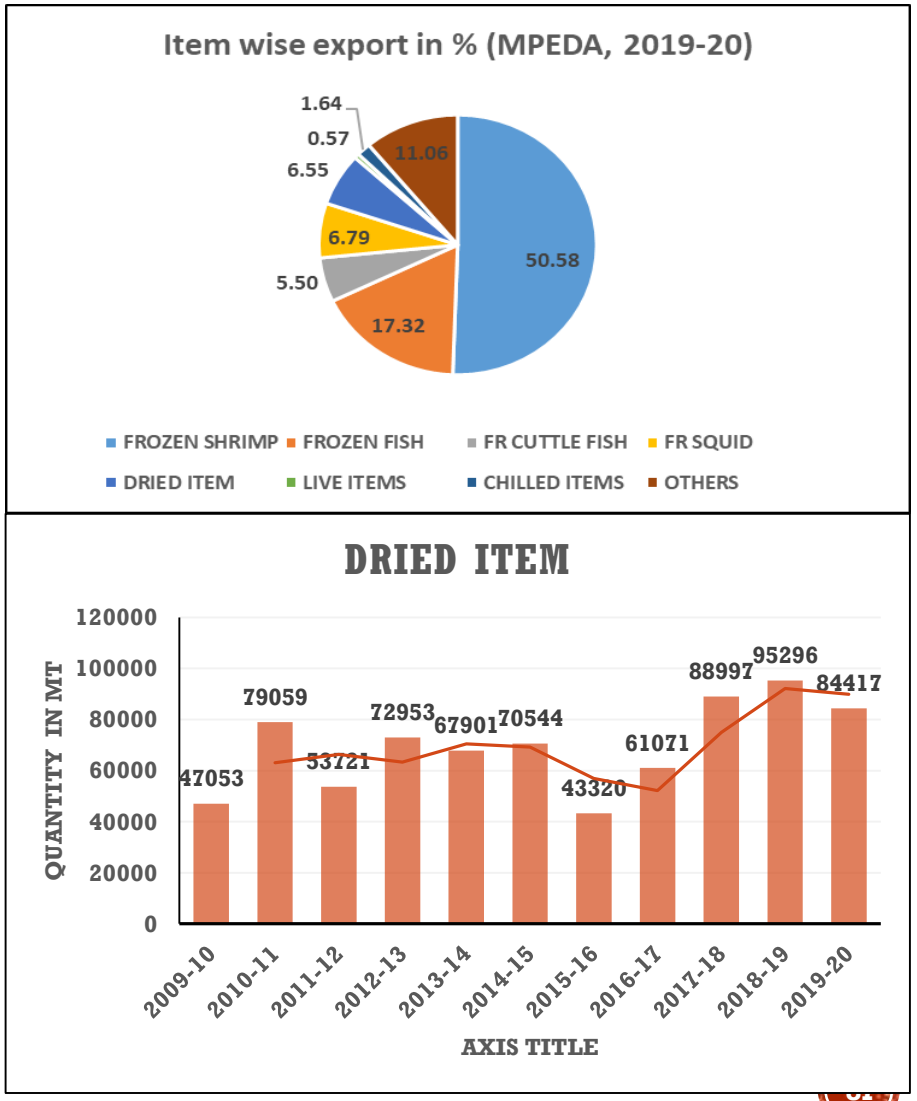
STATUS OF CURING IN INDIA

Drying conditions

SELLING POINT

STATUS OF CURING IN INDIA

- Dried items – 6.55%
- However a major drawback with this traditional processing is the lack of standard operating procedures being followed which affects the quality of cured products.
- Lack of infrastructure and knowledge
- Moreover, there is a general conception that drying/salting is a secondary method for preservation applicable for low value as well as inferior quality varieties.



CONCLUSION

- As scientific communities will need to take more responsibility for solving local problems.
- Efforts towards effective and hygienic handling practices in the process chain, popularization of improved drying technologies and packaging practices, and adequate extension services can facilitate better adoption of cured fishery products in the seafood sector.
- SOP for traditional fishery products, which will improve the quality and increase the socio-economic status of fisher folks in terms of additional revenue.


THANK YOU…

EQUIPMENTS AND MACHINERIES USED IN FISH AND MARINE PRODUCTS PROCESSING

IMPORTANCE OF EQUIPMENTS AND MACHINERIES IN FISH PROCESSING

1. **Inevitable for the large-scale processing and manufacturing of fishery products**
2. **Minimum human handling : Less risk of contamination**
3. **Preservation of fish by various methods**
4. **Value addition by machines**

EQUIPMENTS USED IN UNIT OPERATIONS OF FISH AND MARINE PRODUCTS PROCESSING

- **IMPORTANT UNIT OPERATIONS**

1. Drying
2. Salting
3. Smoking
4. Chilling
5. Freezing
6. Cutlet production
7. Fish powder production
8. Fish pickle production
9. Surimi production
10. Surimi products production
11. Canning
12. Fermented fish production

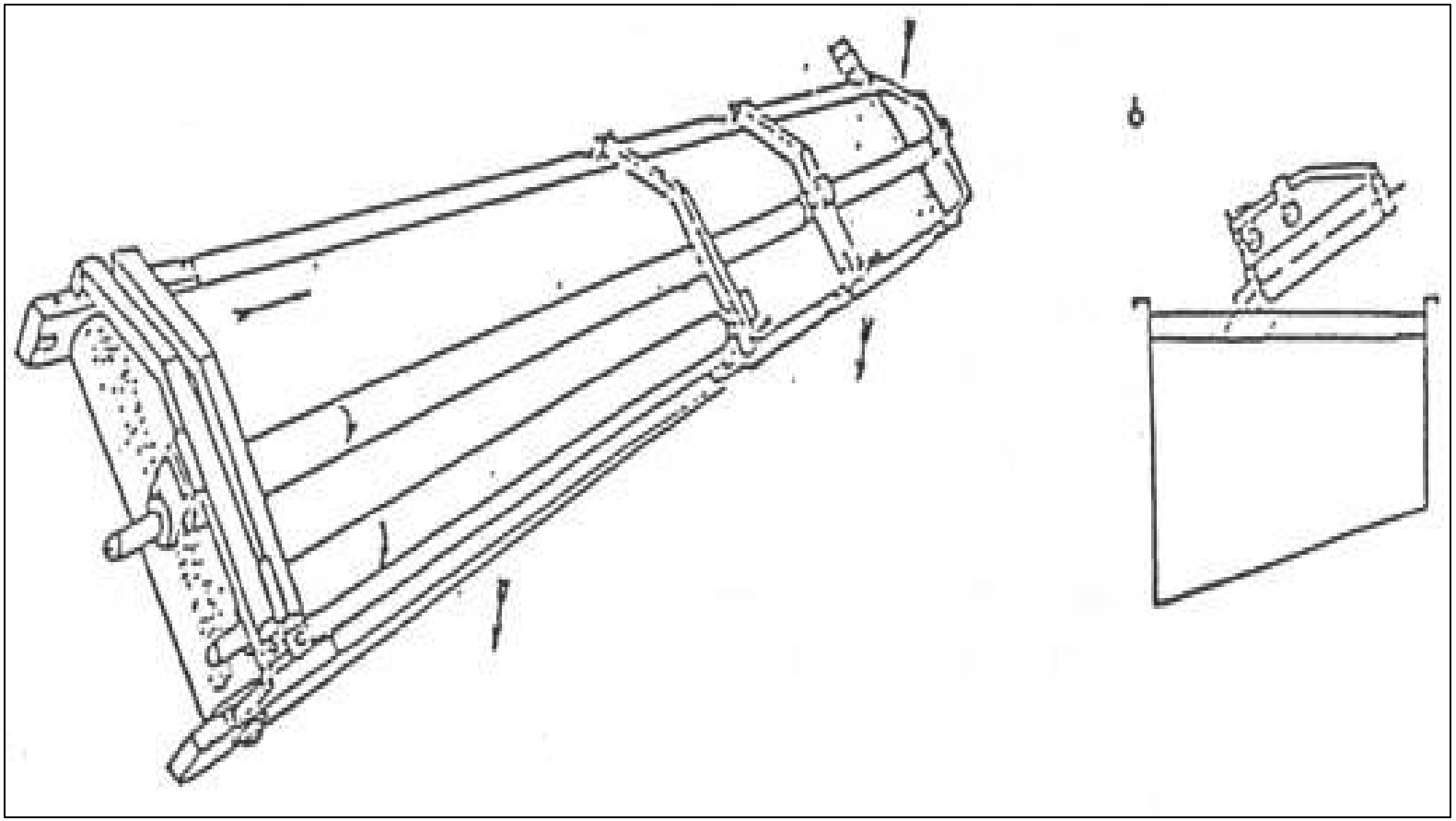
Equipments can be used in the following categories

A. Pre-processing
B. Machineries for coated products
C. Freezers
D. Ice making machines
E. Fish dryers
F. Fish canning machines
G. Packaging machines

A. EQUIPMENTS USED IN PRE-PROCESSING

1. FISH SIZE GRADING MACHINE (FISH GRADING MACHINE)

- Divides a batch of fish into different size groups
- There are rollers with increasing distance among them

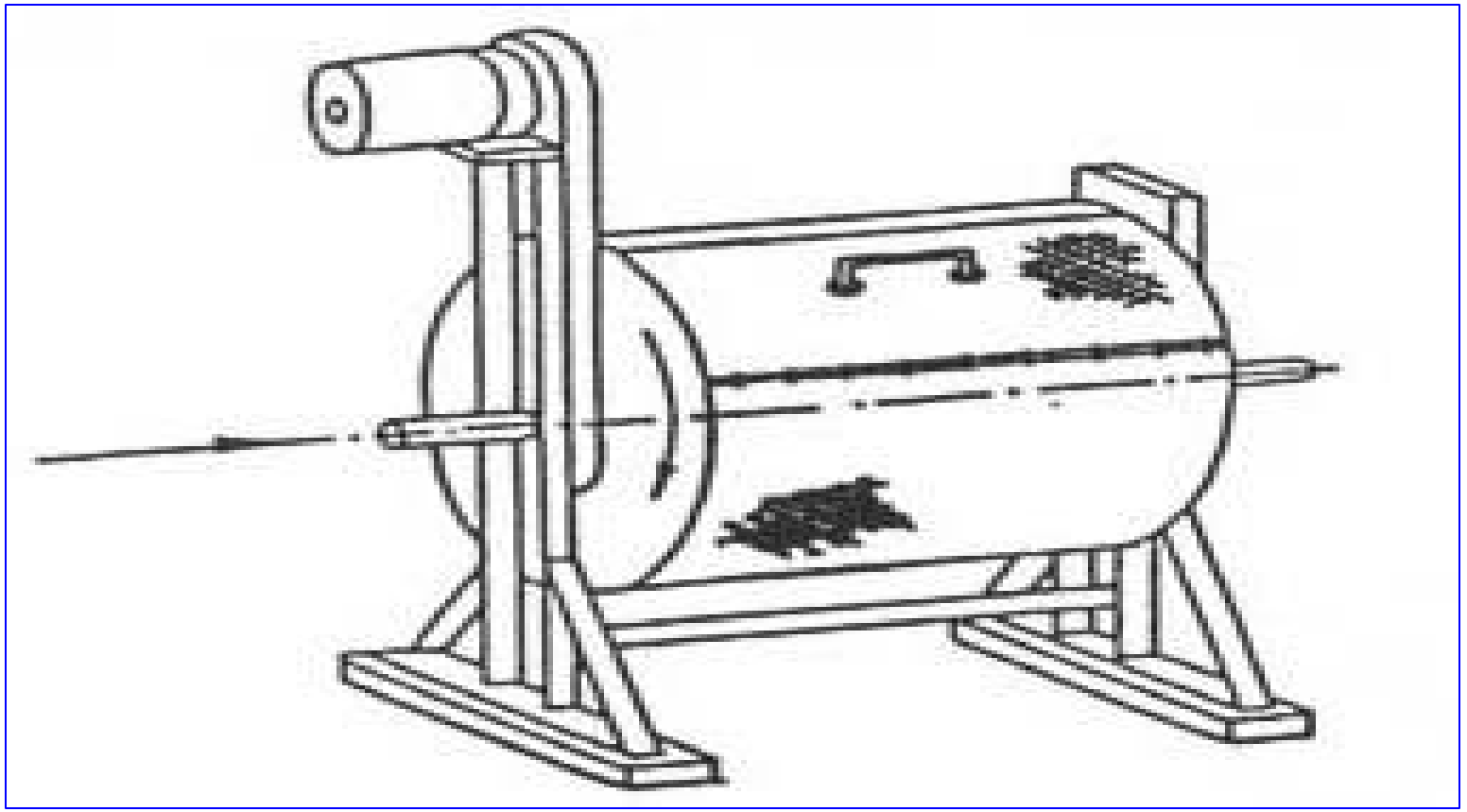


Shrimp grading machine

Shrimp grading machine

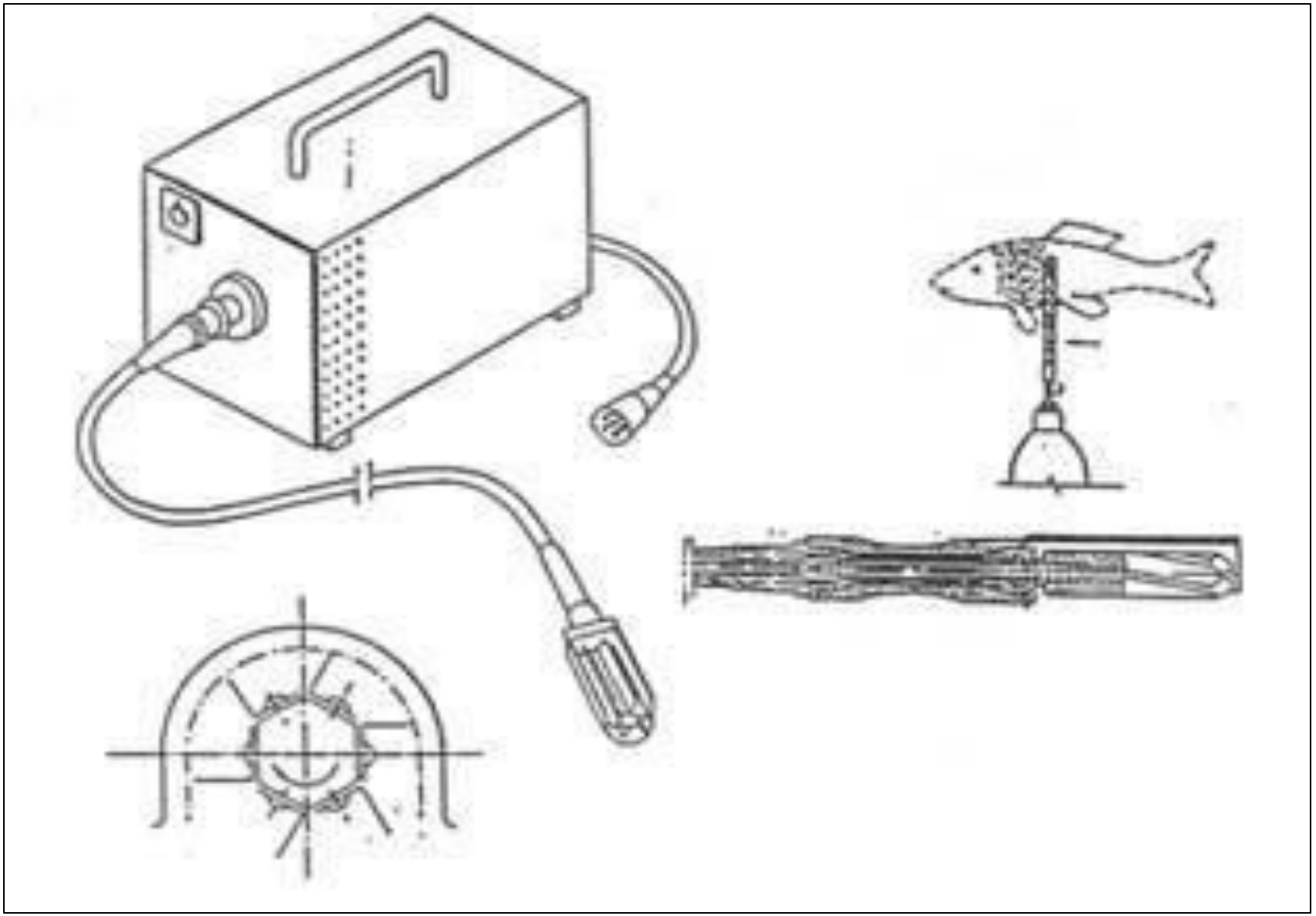
2. FISH DESCALING MACHINE (FISH DESCALER)

Uproots the scales by rubbing against a rough surface



Drum type fish descaler

Drum type fish descaler



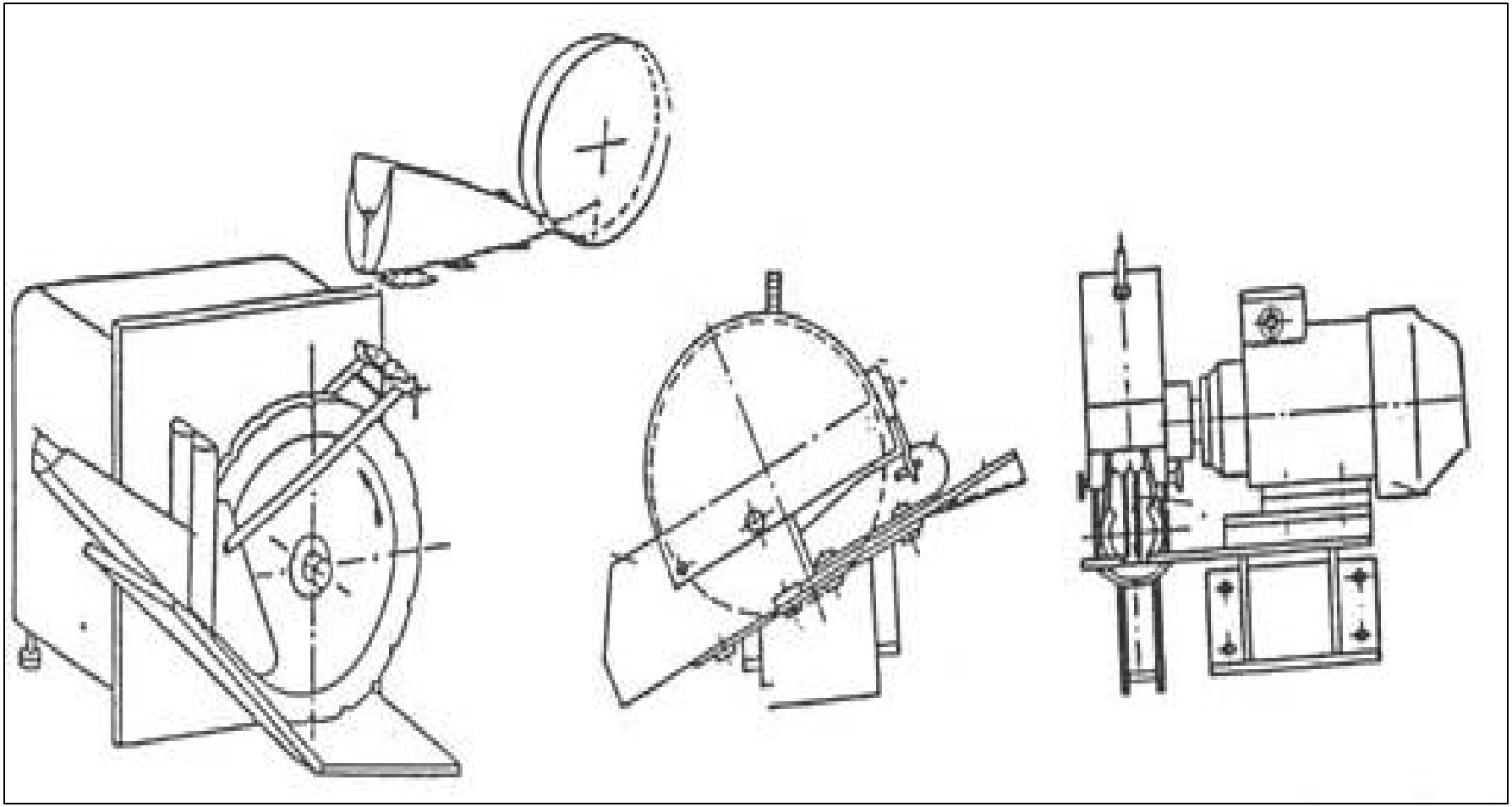
Scrubber type table to fish descaler

Scrubber type table top fish descaler

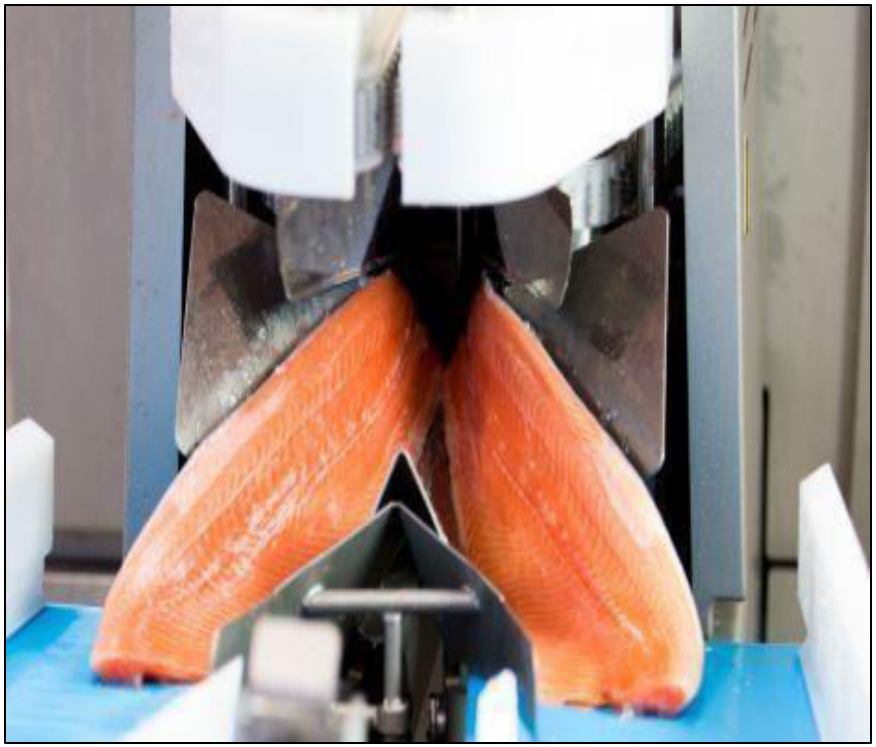
Scrubber type hand held battery operated fish descaler

3. FISH FILLETING MACHINE

Cuts the fish along back bone by rotating circular blades



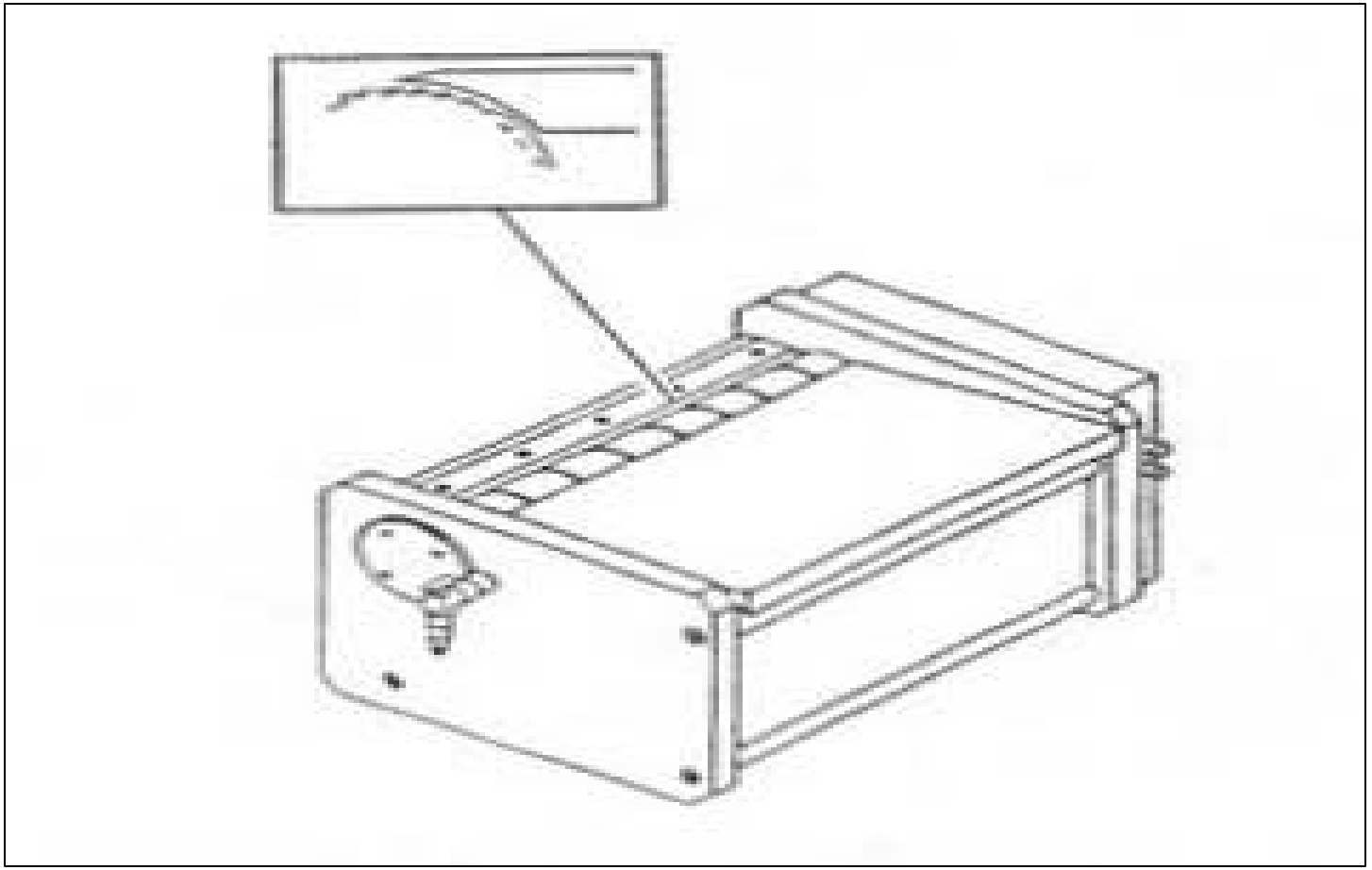
Fish filleting machine



Filleting operation in a filleting machine

4. FISH SKINNER (FISH DESKINNING MACHINE)

Removes skin by cutting it from flesh with a sharp knife



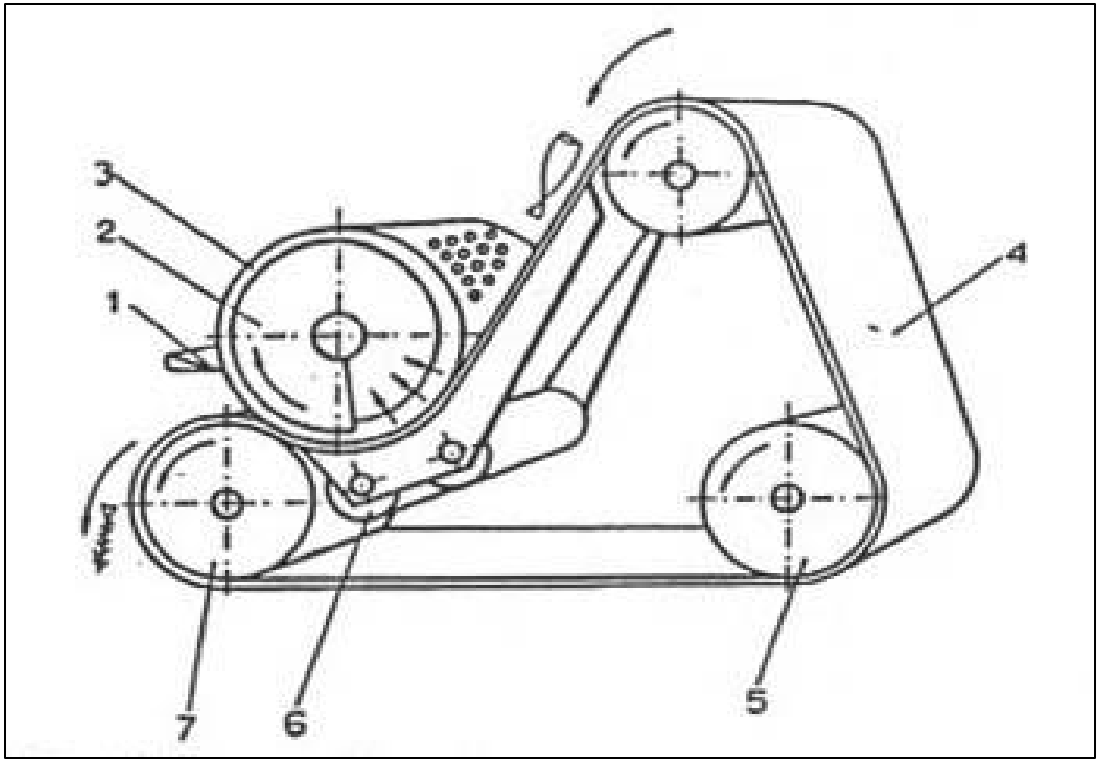
Fish deskinning machine

Deskinning operation in a deskinning machine

B. EQUIPMENTS USED FOR COATED PRODUCTS

1. MEAT-BONE SEPARATOR

- Separates meat from bones and skin
- Fish is pressed against a perforated drum. Only the meat passes into the drum through the perforations



Meat-bone separator

Meat-bone separator in operation

2. FISH MEAT STRAINER

Pure meat passes out through the perforation of a perforated drum while other skin and bone are retained and forced forward to be removed periodically

Fish meat strainer

3. FORMING MACHINE

Forms the dough into cutlet shape or any other defined shape

Forming machine

4. BATTERING AND BREADING MACHINE

Coats the formed shape with a liquid batter followed by covering it with bread crumbs

Battering and breading machine

Forming machine integrated with battering and breading machine

4. FRYER MACHINE

Continuously fries the battered and breaded products

Continuous frying machine

C. FREEZERS

1. PLATE FREEZERS

Freezes fish between cooled metallic plates

Horizontal plate freezer (Land based plants)

Vertical plate freezer (Onboard fishing vessels)

2. AIR BLAST FREEZERS

Freezes in a chamber with blast of cold air

Air blast freezer

3. TUNNEL FREEZER

A conveyor belt takes the fish into a cooled tunnel where cold air blasted on the product freezes it.

Tunnel freezer

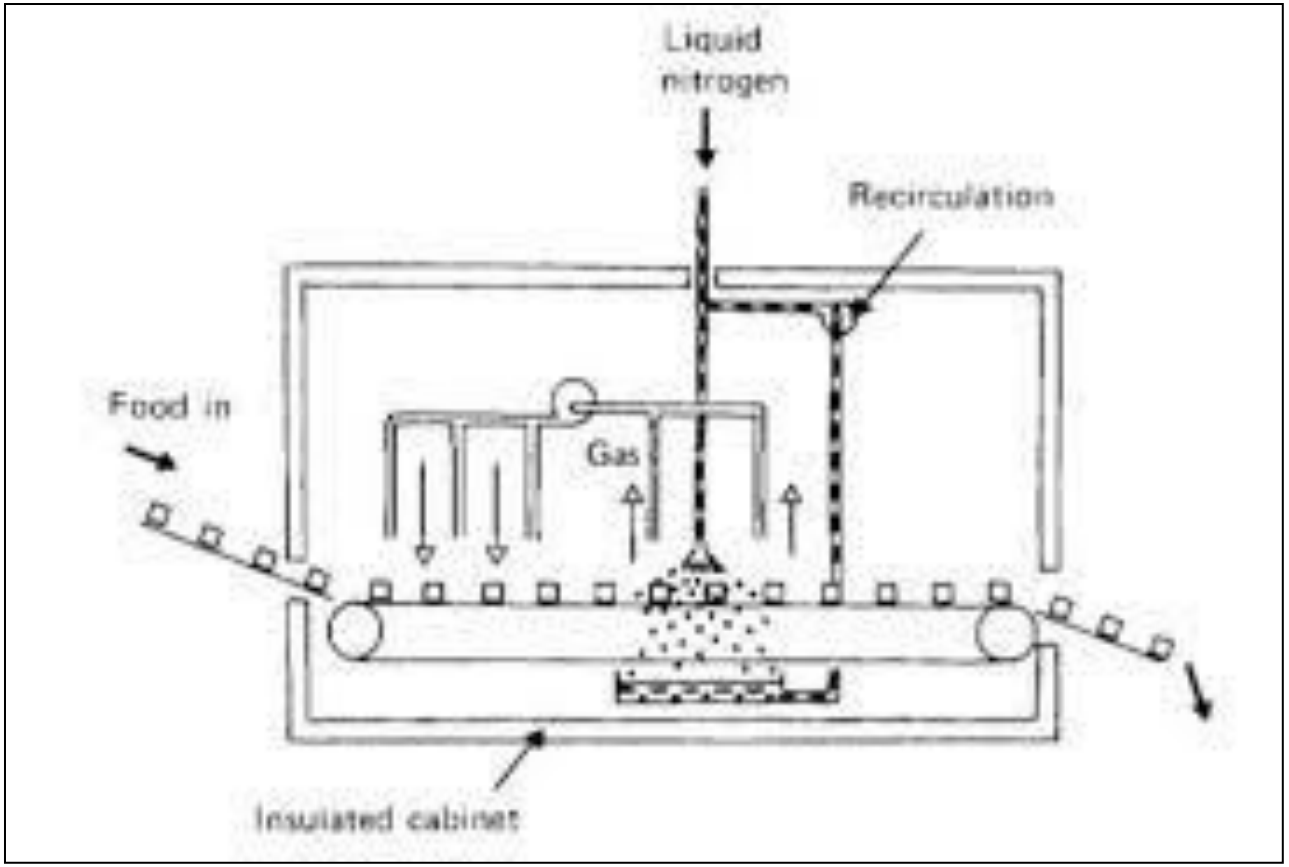
4. SPIRAL BELT FREEZER

Fish moves on a spiral conveyor belt and cold air is blasted on it

Spiral belt freezer

5. CRYOGENIC FREEZER

Liquid nitrogen at very low temperature (-196 C) is sprayed on the fish to freeze it.



Cryogenic freezer

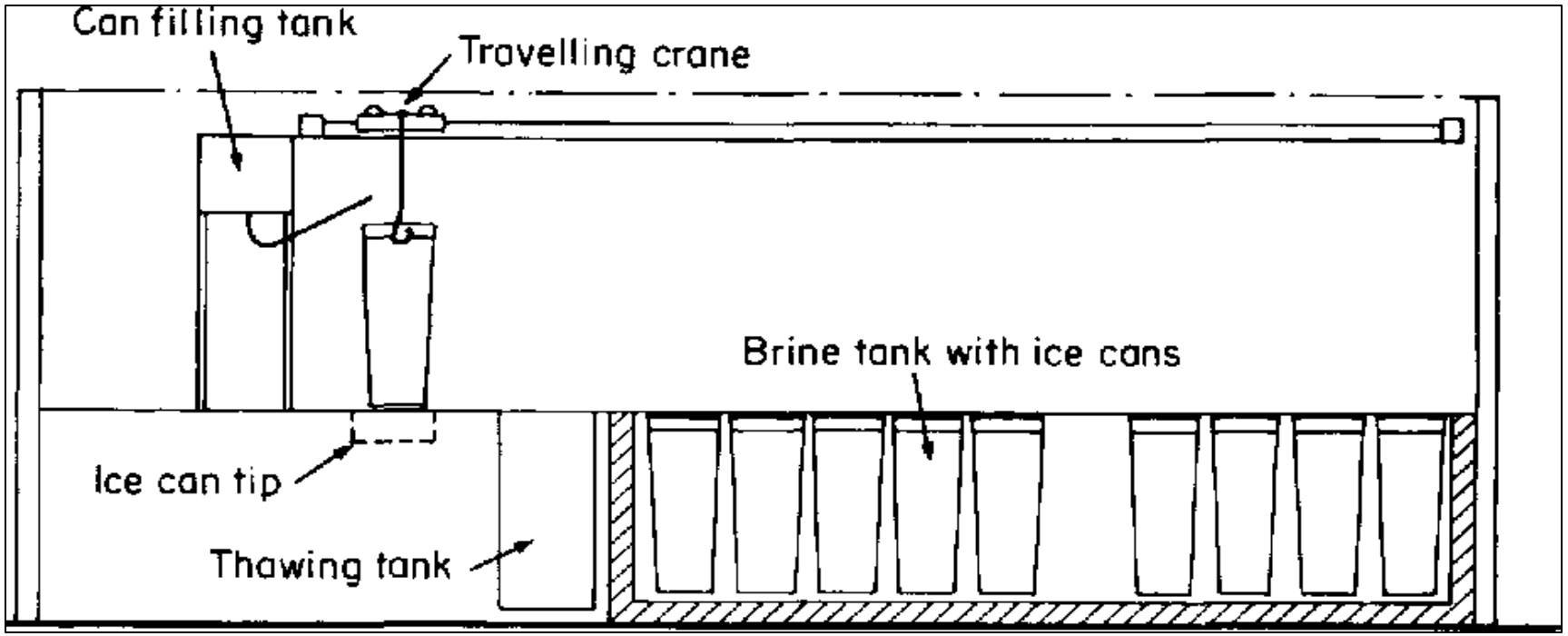
Cryogenic freezer

D. ICE MAKING MACHINES

1. BLOCK ICE MACHINE / PLANT

Produces large blocks of ice which are crushed into small pieces for use

Ice blocks are produced by cooling water in cans submerged in cooled brine tank.



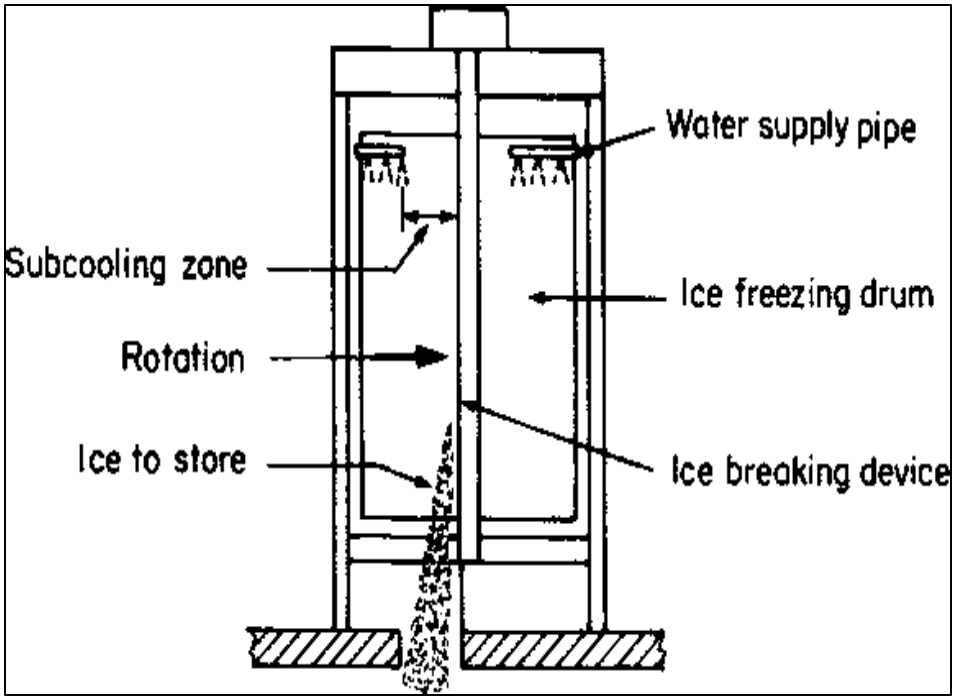
Block ice plant

Blocks of ice

2. FLAKE ICE MACHINE

Produces small flakes of ice which need no crushing before use.

It is produced by spraying water on a cooled drum which solidifies to ice immediately. Then the thin layer of ice is scraped off.



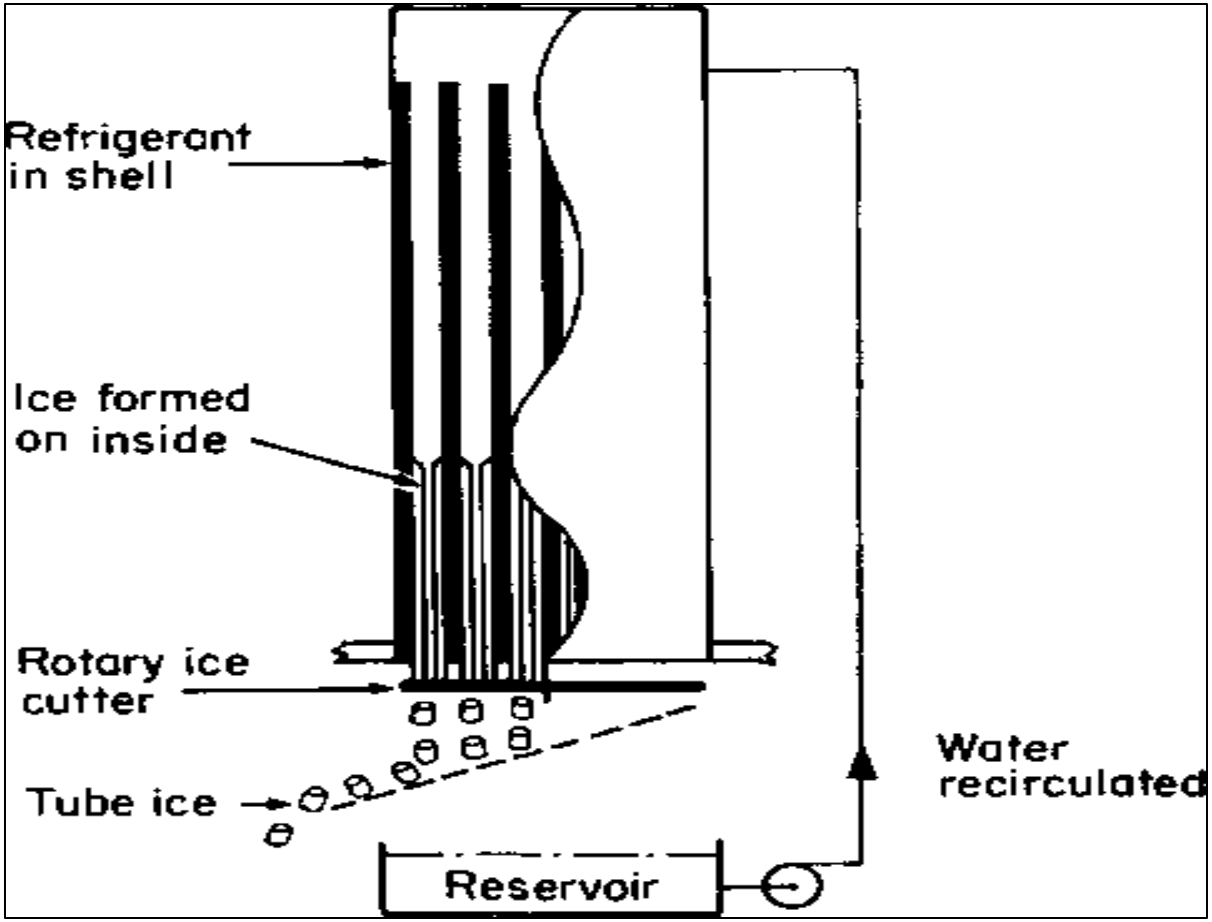
Flake ice machine

Flake ice machine with flake ice

3. TUBE ICE MACHINE

Ice is produced by cooling water in cooled tubes.

The tubular ice formed is cut into small pieces



Tube ice machine

Tube ice machine with tube ice

4. PLATE ICE MACHINE

Ice is produced by cooling water on cooled plates.

The plates of ice formed is broken into small pieces by an ice crusher

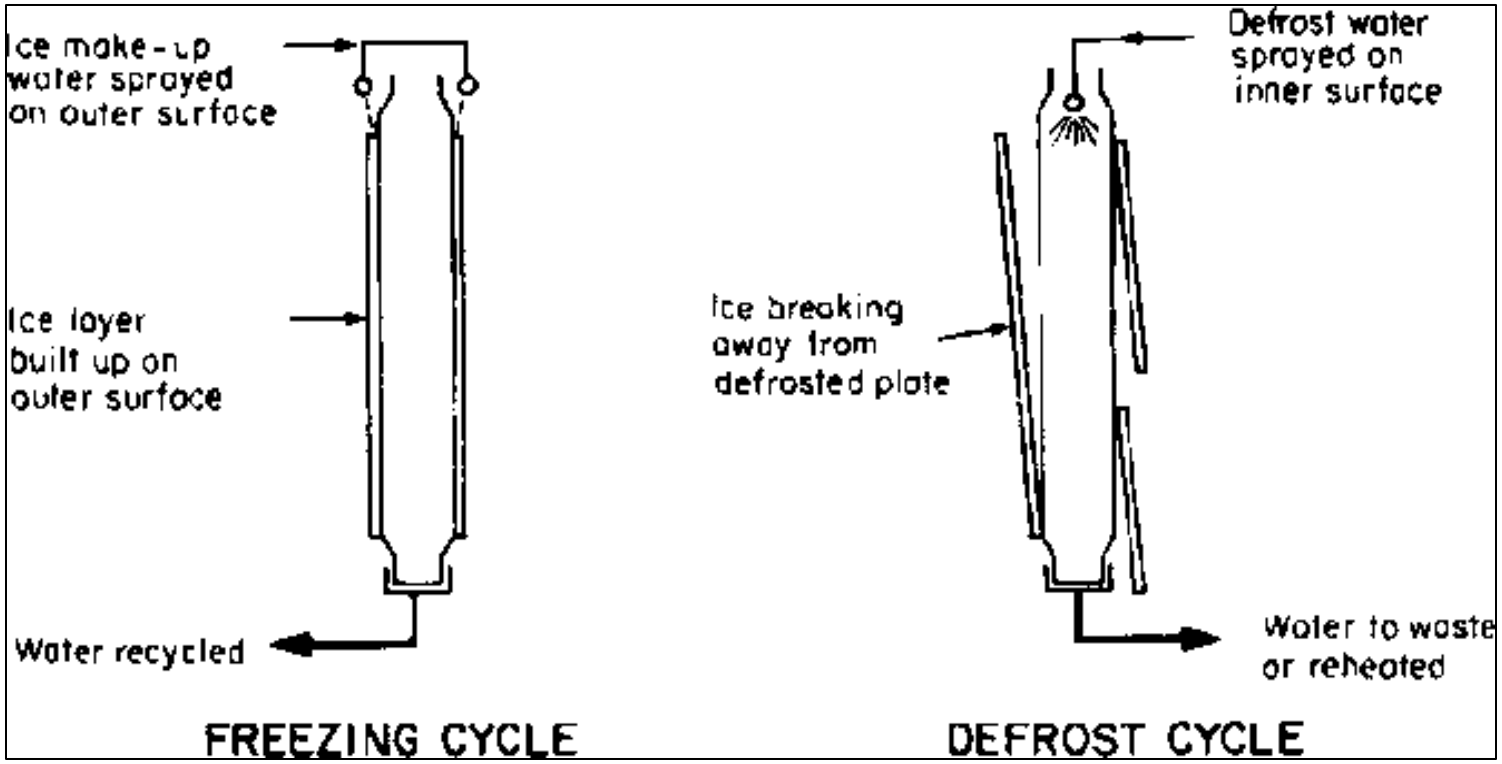


Plate ice machine

Plate ice machine

E. FISH DRYERS

1. ELECTRICAL CABINET DRYER

Dries fish in an insulated cabinet by blowing hot air produced by electric heaters

Electrical cabinet dryer

2. SOLAR CABINET DRYER

Dries fish in an insulated cabinet by blowing hot air produced by absorbing solar radiation

Solar cabinet dryer

F. FISH CANNING MACHINES

1. CAN DOUBLE SEAMER

Fixes can lids to the can body to produce hermetic seal.

Can double seamer

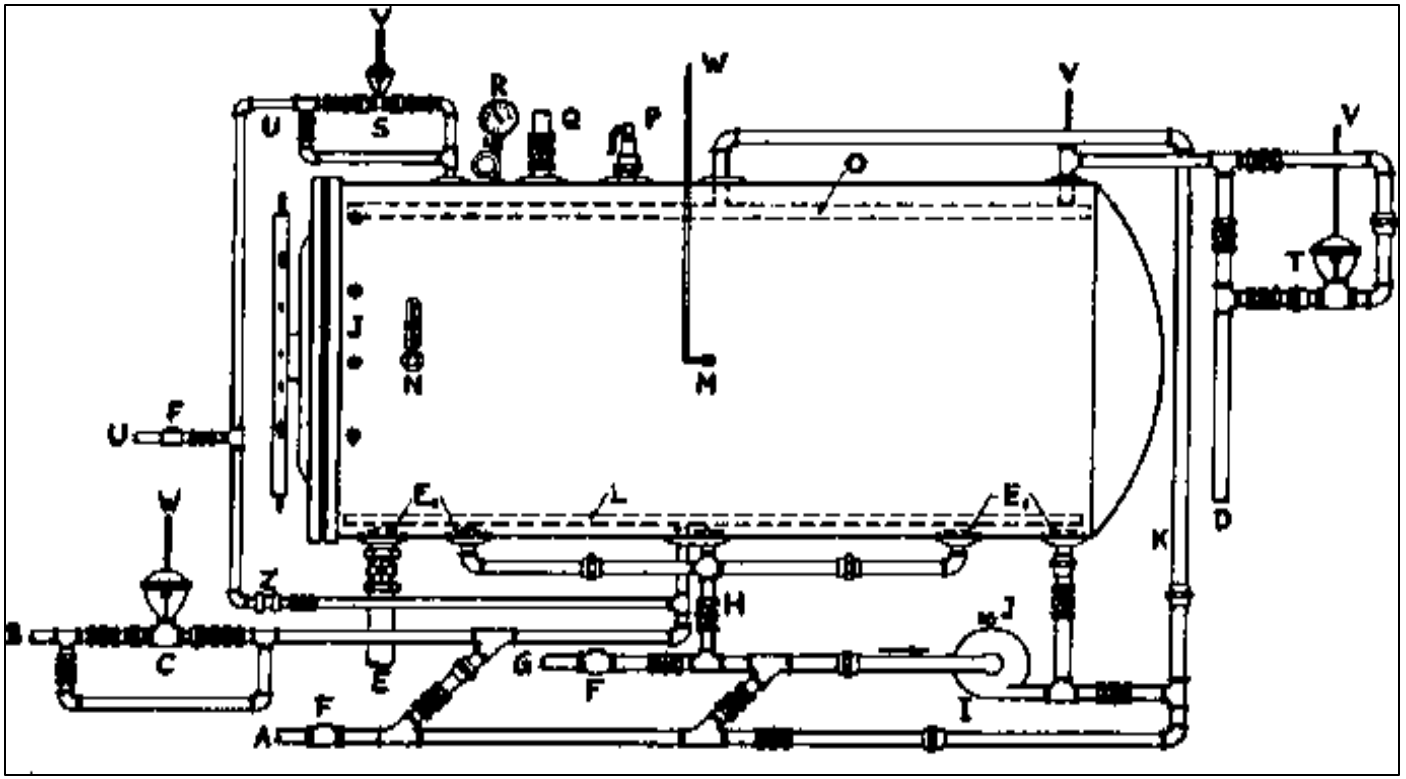
2. EXHAUST BOX

Removes air from within the cans after filling with fish. It is done by moving the filled cans by a conveyor into a steam chamber where the can and the contents get heated and displaces all the air.

Exhaust box

3. RETORTS

Heats the can and the fish contained in it with the help of super saturated steam inside a chamber to sterilize it so as to make it shelf stable



Retort

A series of horizontal retorts

F. PACKAGING MACHINES

1. HAND SEALER

Seals by heated jaws pressed manually

Hand sealer

2. BAND SEALER

Seals continuously

Band sealer

3. TRAY SEALING MACHINE

Seals trays with plastic film

Tray sealing machine

3. LABELLING AND CODING MACHINE

Labels and codes the packages

Labeling and coding machine

4. STRAPPING AND BUNDLING MACHINES

Strapping and bundling machine

SANITIZATION OF PROCESSING EQUIPMENTS

1. The equipments should be arranged in the processing hall sequentially so as to allow linear product flow rather than zig-zag product flow.
2. The sequential arrangement of the equipments should be done to get the desired flow patterns. Generally, in fish processing plants, the I-flow pattern is recommended.
3. Fish cutting implements like knives, blades as well as the cutting edges of fish cutting equipments like band saw and circular saw should be sharpened regularly by scrubbing their edges on a honing stone in an appropriate manner.
4. The equipments should be designed for maximum efficiency.

5. The fish contact surfaces should be made of high grade stainless steel such as AISI SS 316 (L). Even, those surfaces which do not come in direct contact of fish, but have more or less chance of coming in contact with fish during its processing, should also be made of stainless steel, but it can be of slightly lower grade such as AISI SS 304 (L). Fish contact surface can also be made of aluminium (trays for a plate freezer), rubber (belt of fish deboner) or plastic (crates fro keeping fish) depending upon the specific purposes.
6. The design of the equipments should be such that they can be easily dismantled and assembled. This makes it easy to wash the dismantled components thoroughly.
7. The equipments should not be kept very close to the walls.
8. The electrically operated equipments should be provided with electric connection through hanging cables from the ceiling.

9. In case of ‘processing lines’, the operation of the equipments are controlled from a central ‘control panel’ which has starter switches for all the equipment in the line. However, in case of stand-alone equipments, each one should have its starter on its body at an easily approachable height so that it can be operated by a single person easily.
10. All the equipments should be provided with proper electrical earthing.
11. The equipments should be maintained regularly following the instruction manual of each equipment provided by its manufacturer.
12. At the beginning and end of each shift of processing, The equipments to be used should be dismantled, washed thoroughly and assembled for use.

THANK YOU

Packaging of Fishery Products

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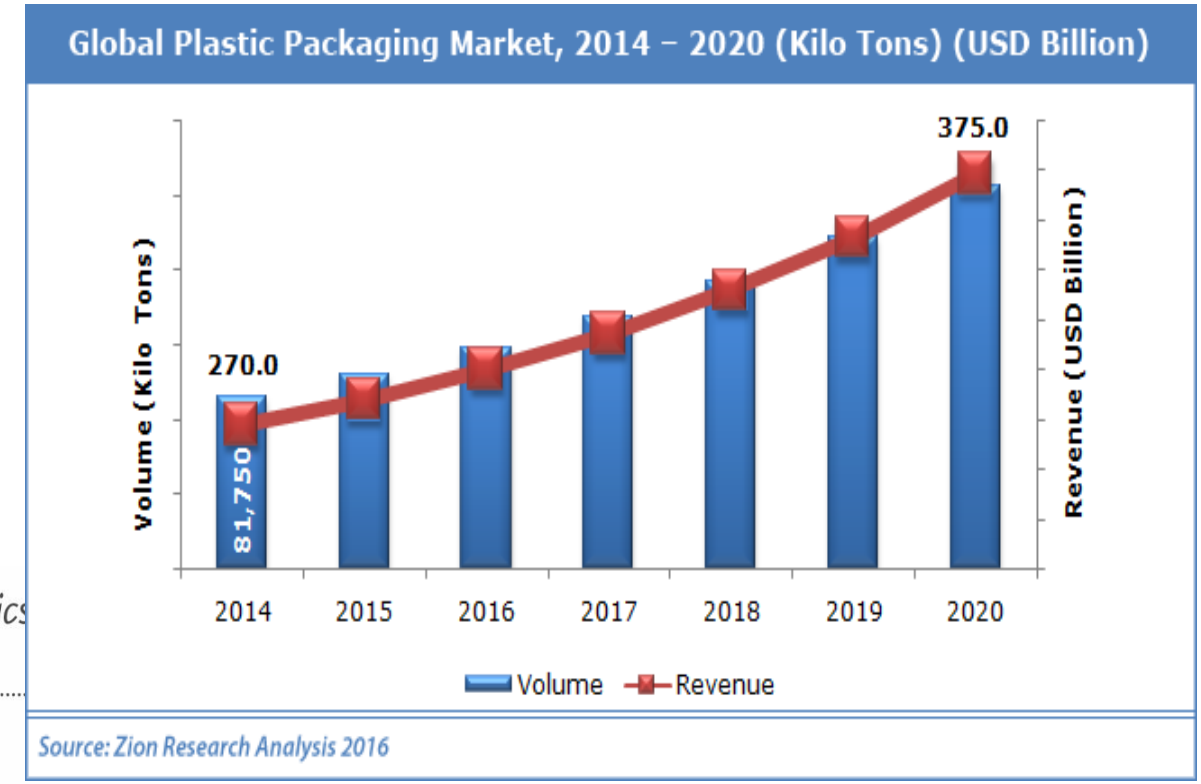
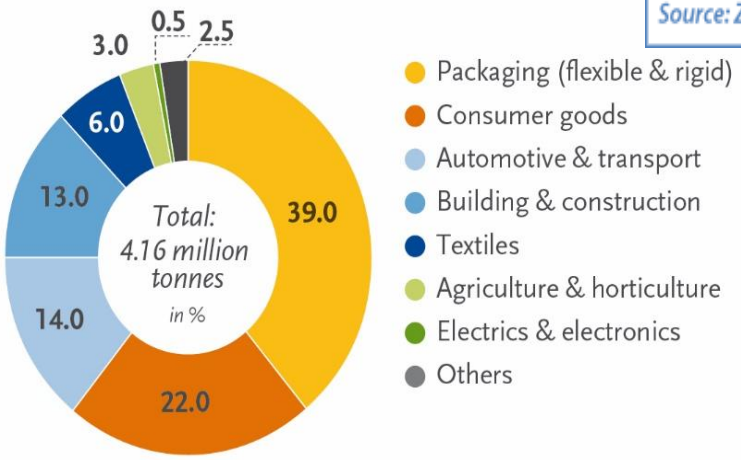
ICAR- Central Institute of Fisheries Technology
Kochi -682029

Global demand for plastic packaging is expected to reach $375 billion in 2020, growing at a CAGR of 4.8% between 2015 and 2020.



Global production capacities of bioplastics in 2016 (by market segment)



Source: European Bioplastics, nova-Institute (2016). More information: ***www.bio-based.eu/markets*** *and* ***www.european-bioplastics.org/market***

Bioplastics market is growing faster than the plastics market at an annual growth rate of 19.5%

Overview of Indian Packaging Industry

- India is the sixth largest packaging market in the world
- With a turnover of $24.6 billion and a growth rate of 13% to 15% annually, the Indian packaging industry is expected to reach $32 billion by 2020
- Expenditure on packaged food products has doubled in the last five years and is expected to increase by 14 % annually
- The per-capita consumption of packaged beverages and food in India is still very low compared to other regions (4.3 kg compared to 6 and 19 kg in China and Taiwan, respectively)

Why Packaging

- Protection
- Containment
- Presentation
- Identification / Information
- Convenience / Compliance

during

- **Storage**
- **Transport**
- **Display and use**

Development of Packaging

- Shortage of Labour
- Need for pre-packaging of goods
- Departmental stores
- Self- service super markets
- Vending machines
- Higher standard of living
- Need for speciality packaging
- Frozen items
- New packaging systems for conversion
- Development of automatic packing machines
- Govt. recognition of packaging as an industry

Rigid plastic containers

- Made by PVC, HDPE, LDPE etc
- It can be made in any shape like bottle, tray, cans, jars, cups, tubes tec
- Used for packing variety of food products

Advantages

- Both transparent and non-transparent containers
- Very cheap, good rigidity and recyclable

Dis advantages

- Low heat stability than glass
- May react with high acidic foods

Flexible plastic packaging

- A variety of films with different properties are in use

Advantages:

- Light in weight, requires less storage space
- Easy to use, seal and open
- Easy to dispose

Disadvantages:

- Consumes much packaging time
- Causes environmental problems

Why Plastics

- Reduce material use
- Weight
- Maintain freshness
- Reduce breakage
- Reduce transportation costs
- Economical

PACKAGING MATERIAL FOR FISH PRODUCTS

FOOD CATEGORIES	PACKAGING MATERIAL
Fresh chilled	HDPE, PP, HM-HDPE
Fresh frozen	Laminates or co-extruded pouches, LDPE, BOPP
Dried	HDPE woven gusseted sack, laminates
MAP	Nylon/suryln laminates, PVC moulded trays laminated with polyethylene, polyester/LDPE film, EVOH
Thermal processed	Metal cans, retort pouches, HIPP trays
Surimi	LDPE/ LLDPE/ HMHDPE with waxed duplex carton & 5/7 ply CFB
Sausage	PVDC or natural casings
Breaded & battered products	Thermoformed trays of PVC, HIPP & HDPE
Pickles	Glass bottles or PEST / LDPE-HDPE co-extruded film

Packaging of Fresh fish

Most perishable of all foods

- Post harvest losses more than 20 % due to improper handling, packaging and preservation
- Containers -made of timber, bamboo, rattan, reeds, HDPE, PUF insulated, PP baskets

Problems

- Porous surface –
- absorb water & accumulate slime, Id ground for spoilage bacteria

Use of plastic box made of HDPE & PUF insulated containers

- They are durable
- Ease of cleaning
- Resist impact, moisture and chemicals
- Improved drainage of melt water
- Recyclability

Fresh fish

- Most perishable of all foods
- Post harvest losses more than 20 % due to improper handling, packaging and preservation
- Icing and storing in good containers is the best way to prevent losses

Dried fish


SOLAR DEHYDRATED FOOD PRODUCTS


DryFish
Taste Yourself
Vacuum Packed
No Wastage
Ready to cook


Ready to cook Shell-on prawns (prepared as per GMP developed in CIFT)


CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY
(Indian council of Agricultural Research)

Packaging materials

Type	Merits	Demerits
250 gauge low density polyethylene film	Cheap, readily available, good bursting and tearing strength and heat sealability	High WVTR and GTR rate, easy to puncture sharp spine, smell comes out. Shelf life limited.
250 gauge polypropylene film	Cheap, readily available, good bursting and tearing strength and heat sealability	Same as above
300MXXT Cellophane/150 gauge LDPE	Very low WVTR and GTR transparent, good bursting and tearing strength , heat sealability and long shelf life.	Prone to easy attack by insects, costly.

Type	Merits
12 micron plain polyester/150 g low density polyethylene	Very low water vapour and gas transmission rate, transparent, good bursting strength, puncture resistance & heat sealability. No insect penetration
20 micron Nylon laminated with 150 gauge polyethylene	Very low water vapour and gas transmission rate, transparent, good bursting strength, puncture resistance & heat sealability. No insect penetration

Accelerated freeze dried products

- ✓Moisture content very less
- ✓Fragile and can easily undergo oxidation, deterioration of color etc
- ✓Generally packed under a inert gas
- ✓Low OTR & WVTR to protect from rancidity & absorption of moisture
- ✓Sufficient mechanical strength to protect from shock are essential
- ✓Laminates of Paper/ Al foil/ PE or metallised PEST/PE are recommended
- ✓Metal containers are required for very brittle products

Extruded fish product -

Fish Kure

Packaging of Frozen fish

•Frozen fish products are the important items of export

•Conventionally they are frozen as blocks and as IQF products

•IQF products fetches higher unit value compared to block frozen products

•Packaging requirements for IQF products vary from those of block frozen

•In Block Frozen the risk of moisture loss or oxidative reaction leading to flavor changes are minimal

✓Some of the essential packaging requirements for IQF products are

- Low WVTR to reduce the risk of dehydration
- Low OTR to reduce the oxidation & subsequent changes in odour and flavour
- Flexibility to fix the contours of the product
- Resistance to puncture, brittleness & deterioration at low temperatures

- IQF products are normally packed in a primary container along with code slip

- Bar coding is nowadays adopted instead of code slip

Block Froz


8/12
FAO ZONE 51
PRODUCT OF INDIA


U/3
WT. 2 Kg
PRODUCT OF INDIA


FS
PUD
PVN
KKD
300/500
NET WT: 2 Kgs

Duplex cartons

IQF shrimps in flexible films

Master cartons

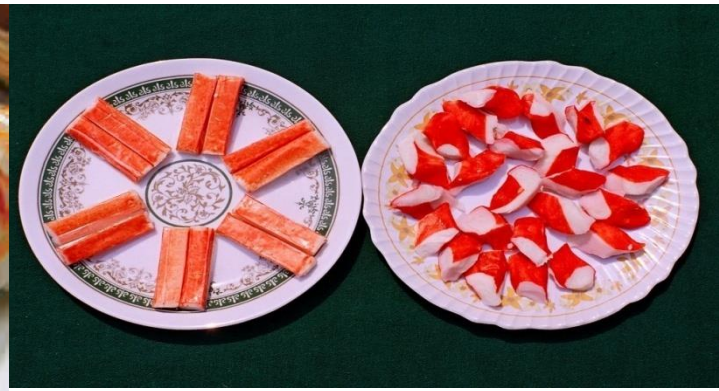
Surimi

•Deboned fish mince from lean fish, which is washed, refined & mixed with cryoprotectants.

•Surimi is generally frozen as rectangular blocks. Materials used should have low WVTR & OTR

•Materials should be strong & durable to withstand stress during handling, storage & distribution

•Inner wrap of LDPE/ LLDPE/ HMHDPE with waxed duplex carton & 5/7 ply CFB is ideal for surimi



Battered and Breaded products

Coated products are also known as battered & breaded products.

The production of battered and breaded fish products in most cases involves seven steps- portioning/forming, pre-dusting, battering, breading, pre-frying, freezing and, packaging and cold storage.

Desiccation, discoloration, rancidity
Flexible plastic films not suitable - mechanical protection to the products.

- Thermoformed trays of PVC, HIP & HDPE
- These trays are unaffected by low temperature & protects the contents even during prolonged storage.

Breaded shrimp & cutlets in thermoformed containers

Thermal processed products

To prevent metallic taste and avoid discoloration
Maintain high vacuum

Packaging materials used

❖Cylindrical/ Dingley SR/AR lacquered tin cans

Developments

❖Aluminium cans

❖Tin free steel cans

Retort pouch

12 µ PE / 12 µ Al foil / 70 µ Cast PP


SARDINES
ANCHOR

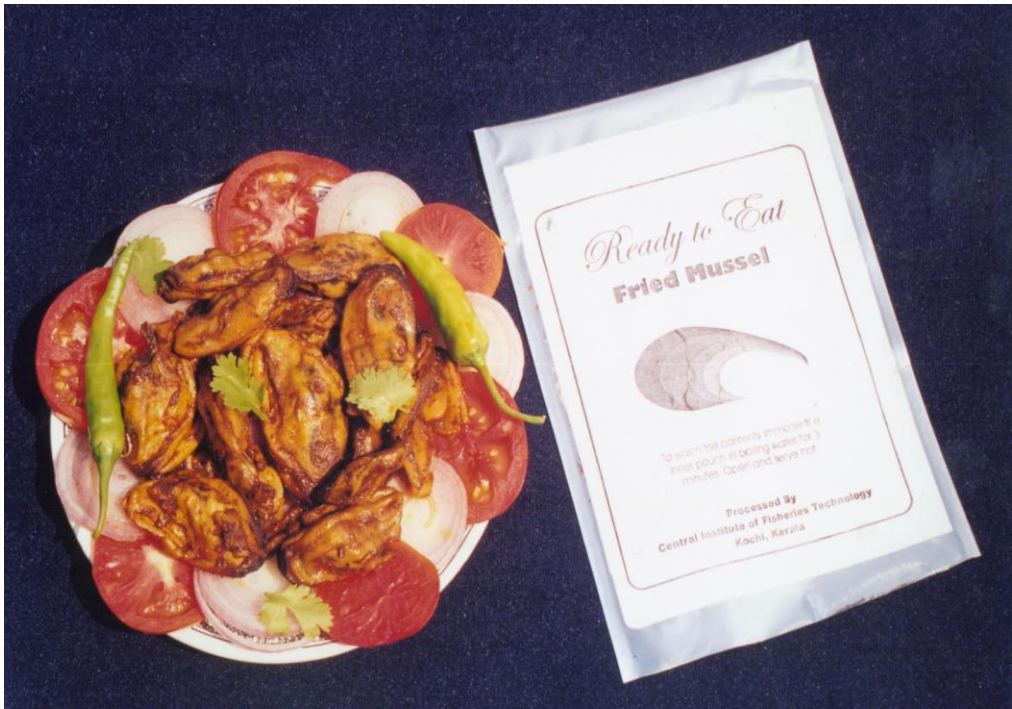

TUNA
MACKEREL
CURRY


CREVETTES


TUNA
TUNA
TUNA

Retort Pouches

Fish Curry in Retort pouch



Fish Sausage

- Conventionally sausages are processed in animal intestine and frozen
- The shelf life in natural casings is limited
- Synthetic casings made of PVDC or polyamide/nylon
- Polypropylene casings can be used for heat processed sausages
- Casings made of collagen /cellulose can also be used but should be packed in a secondary pouch made of PEST/PP

Fish pickles

Conventionally glass bottles are used, which offer properties like inertness, non toxicity, durability, non- permeability to gases, moisture etc.

But they are heavy, prone to break, voluminous & expensive.

New flexible packaging materials developed for fish pickles are plain PEST / LDPE-HDPE co-extruded film

These are inert to the product, can be attractively fabricated as stand up packs & can be printed

Fish soup powder

•Fish soup powder is a specialty product containing partially hydrolyzed fish, protein, carbohydrate, fat & several other seasonings including salt

•The product is hygroscopic & hence the selection of packaging material assumes great significance

•Appropriate packaging materials for such products are;
• 12 micron metallised polyester laminated with LDPE-HDPE co-extruded film or multi layer film with high barrier .

Chitin/Chitosan

✓Chitin and chitosan are exported commodities

✓ The packaging should protect this product against moisture as well as microbial and insect attacks

✓The packaging developed for chitin/ chitosan & now extensively being used in the industry is a HDPE woven gusseted bag laminated with 100 gauge LDPE

Thank You

FSSAI REGULATIONS ON PACKAGING AND LABELLING REQUIREMENTS

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Introduction

Food packaging

- Proper packaging plays a crucial role in preservation of quality and delivery of safe, wholesome food products to the end user

- Packaging has been with humans for thousands of years in one form or the other





Purpose of packaging

Packaging: Art and science of encasing food products to safeguard them during distribution, sale, and storage

1. Product containment
2. Preservation by maintaining quality
3. Presentation and convenience
4. Protection during distribution and processing
5. Provide storage history

Types of Packaging Materials

- **Flexible materials**: Plastic film, foil, paper and textiles
- **Rigid materials**: Wood, glass, metals and hard plastics

Food Labelling

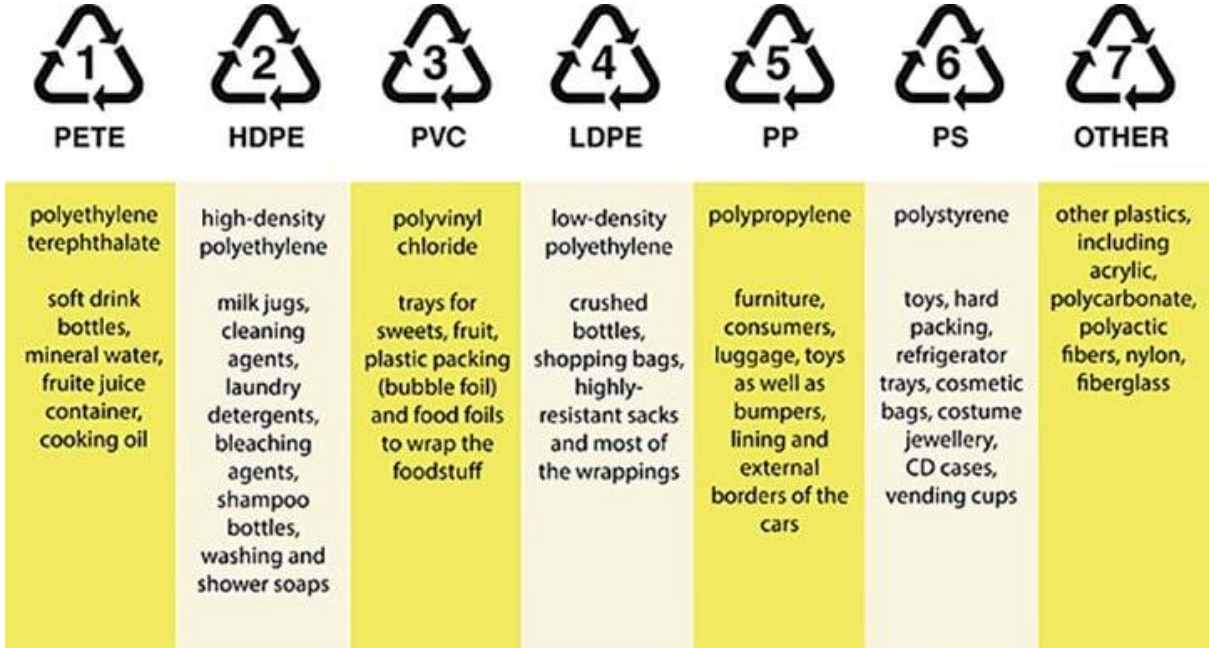
- Food label: Displays information regarding the product
- Piece of paper, polymer, cloth, metal, or other material affixed to a container or article.
- A label may also be printed directly on the container or article
- Primary link of communication between the manufacturer and consumer
- Covers both food safety and information of consumer interest

Food Packaging Symbols

Product is suitable for food use.

Product can be recycled

Plastic used in the packaging can be recycled



Food Packaging Symbols

Packaging is certified to be compostable

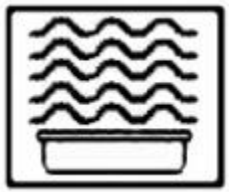
Suitable for vegetarians
Alternative logo uses a tick rather than leaves

Contain ingredients that are common allergies

Food Packaging Symbols

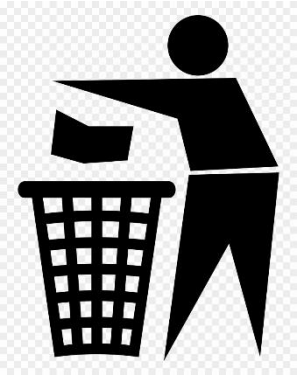
GLUTEN free

Does not contain gluten/any other wheat extracts



Suitable for use in a microwave

Product suitable for freezing



Keep your city clean

Food Safety and Standards Authority of India (FSSAI)

- Autonomous body established by the Government of India under the Ministry of Health & Family Welfare

- Usually sets standards for food so that there is no chaos in the minds of consumers, traders, manufacturers and investors

Food safety and standards (packaging and labelling) regulations, 2011

Packaging: General Requirements

1. A utensil or container made of the following materials or metals, when used in the preparation, packaging and storing of food shall be deemed to render it unfit for human consumption: —

a. containers, which are rusty;
b. enameled containers, which have become chipped and rusty;
c. copper or brass containers which are not properly tinned
d. containers made of aluminium not conforming in chemical composition to IS:20 specification for Cast Aluminium & Aluminium Alloy for utensils or IS:21 specification for Wrought Aluminium and Aluminium Alloy for utensils.

Packaging: General Requirements

- **Containers made of plastic materials should conform to the following Indian Standards Specification, used as appliances or receptacles for packing or storing whether partly or wholly, food articles namely: —**

(i) IS: 10146 (Specification for Polyethylene in contact with foodstuffs);

(ii) IS: 10142 (Specification for Styrene Polymers in contact with foodstuffs);

(iii) IS: 10151 (Specification for Polyvinyl Chloride (PVC), in contact with foodstuffs);

(iv) IS: 10910 (Specification for Polypropylene in contact with foodstuffs);

(v) IS: 11434 (Specification for Ionomer Resins in contact with foodstuffs);

(vi) IS: 11704 Specification for Ethylene Acrylic Acid (EAA) copolymer;

(vii) IS: 12252 - Specification for Poly alkylene terephthalates (PET);

(viii) IS: 12247 - Specification for Nylon 6 Polymer;

(ix) IS: 13601 - Ethylene Vinyl Acetate (EVA);

(x) IS: 13576 - Ethylene Metha Acrylic Acid (EMAA);

(xi) Tin and plastic containers once used, shall not be re-used for packaging of edible oils and fats; Provided that utensils or containers made of copper though not properly tinned, may be used for the preparation of sugar confectionery or essential oils and mere use of such utensils or containers shall not be deemed to render sugar confectionery or essential oils unfit for human consumption.

Packaging: General Requirements

3. General packaging requirements for Canned products,

I. All containers shall be securely packed and sealed.

II. The exterior of the cans shall be free from major dents, rust, perforations and seam distortions.

III. Cans shall be free from leaks.

Labelling: General Requirements

1. Every pre-packaged food shall carry a label containing information
2. The particulars of declaration required under these Regulations to be specified on the label shall be in English or Hindi in Devnagri script
3. Pre-packaged food shall not be described or presented on any label or in any labelling manner that is false, misleading or deceptive or is likely to create an erroneous impression regarding its character in any respect
4. Label in pre-packaged foods shall be applied in such a manner that they will not become separated from the container

Labelling: General Requirements

5. Contents on the label shall be clear, prominent, indelible and readily legible by the consumer under normal conditions of purchase and use;

6. Where the container is covered by a wrapper, the wrapper shall carry the necessary information or the label on the container shall be readily legible through the outer wrapper and not obscured by it;

7. License number shall be displayed on the principal display panel in the following format, namely: -

Labelling of pre-packaged foods

1. The Name of Food
2. List of Ingredients
3. Nutritional information
4. Declaration regarding Veg or Non veg –
5. Declaration regarding Food Additives-
6. Name and complete address of the manufacturer
7. Net quantity
8. Lot/Code/Batch identification
9. Date of manufacture or packing
10. Best Before and Use By Date
11. Country of origin for imported food
12. Instructions for use

Labelling of pre-packaged foods

- **The Name of Food:** The name of the food shall include trade name or description of food contained in the package

- **List of Ingredients:** Except for single ingredient foods, a list of ingredients shall be declared on the label in the following manner

(a) The list of ingredients shall contain an appropriate title, such as the term "Ingredients";

(b) The name of Ingredients used in the product shall be listed in descending order of their composition by weight or volume, as the case may be, at the time of its manufacture;

(c) A specific name shall be used for ingredients in the list of Ingredients;

Labelling of pre-packaged foods

(d) Where an ingredient itself is the product of two or more ingredients, such a compound ingredient shall be declared in the list of ingredients, and shall be accompanied by a list, in brackets, of its ingredients in descending order of weight or volume, as the case may be: Provided that where a compound ingredient, constitutes less than five percent of the food, the list of ingredients of the compound ingredient, other than food additive, need not to be declared;

(e) Added water shall be declared in the list of ingredients

(f) Every package of food sold as a mixture or combination shall disclose the percentage of the ingredient used at the time of the manufacture of the food

Labelling of pre-packaged foods

Nutritional information

(i) energy value in kcal;
(ii) the amounts of protein, carbohydrate (specify quantity of sugar) and fat in gram (g);
(iii) the amount of any other nutrient for which a nutrition or health claim is made:
amount or type of fatty acids or the amount of cholesterol, the amount of saturated fatty acids, monounsaturated fatty acids and polyunsaturated fatty acids in gram (g) and cholesterol in milligram (mg) shall be declared, and the amount of trans fatty acid in gram (g)
(iv) Wherever, numerical information on vitamins and minerals is declared, it shall be expressed in metric units;
(v) Where the nutrition declaration is made per serving, the amount in gram (g) or millilitre (ml) shall be included for reference beside the serving measure;

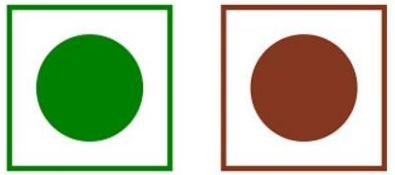
Labelling of pre-packaged foods

Declaration regarding Veg or Non veg –

- **Non veg:** The symbol shall consist of a brown colour filled circle having a diameter not less than the minimum size specified in the regulation, inside a square with brown outline having sides double the diameter of the circle.

- Where any article of food contains egg only as Non-Vegetarian ingredient, the manufacturer, or packer or seller may give declaration to this effect in addition to the said symbol.

- **Veg:** Green colour filled circle, having a diameter not less than the minimum size specified, inside the square with green outline having size double the diameter of the circle.



Food Safety and Standards (Packaging and Labelling) Regulations, 2011

- Food Safety and Standards (Packaging) Regulations, 2018
- Food Safety and Standards (Labelling and Display) Regulations, 2019

Food Safety and Standards (Packaging) Regulations, 2018

General Requirements

- Every food business operator shall ensure that the packaging material used shall be in accordance with these regulations: Provided where Indian Standards are not available, then relevant International Standards may be complied with.

- Any material which comes in direct contact with food or likely to come in contact with food used for packaging, preparation, storing, wrapping, transportation and sale or service of food shall be of food grade quality.

Food Safety and Standards (Packaging) Regulations, 2018

- Packaging materials shall be suitable for the type of product, the conditions provided for storage and the equipment for filling, sealing and packaging of food as well as transportation conditions.

- Packaging materials shall be able to withstand mechanical, chemical or thermal stresses encountered during normal transportation. In case of flexible or semi-rigid containers, an overwrap packaging may be necessary.

- Food products shall be packed in clean, hygienic and tamper-proof package or container.

Food Safety and Standards (Packaging) Regulations, 2018

- The sealing material shall be compatible with the product and the containers as well as the closure systems used for the containers
- Tin containers once used, shall not be re-used for packaging of food
- Plastic containers of capacity 5 liter and above and Glass bottles, which are reused for packaging of food, shall be suitably durable, easy to clean or disinfect
- Printing inks for use on food packages shall conform to IS: 15495

Food Safety and Standards (Packaging) Regulations, 2018

- Printed surface of packaging material shall not come into direct contact with food products

- Newspaper or any such material shall not be used for storing and wrapping of food

- In case of multilayer packaging, the layer which comes in direct contact with food or layers likely to come in contact with food shall meet the requirements of packaging materials specified in Schedule I, II and III of these regulations

Food Safety and Standards (Packaging) Regulations, 2018

- The materials listed in Schedule I, II and III of these regulations shall be compatible with their intended use as a packaging material so as not to alter the quality and safety of the food product.

- Every food business operator shall obtain the certificate of conformity issued by NABL accredited laboratory against these regulations, for the packaging material, which comes in direct contact with food or layers likely to come in contact with food to be used.

Specific Requirements for Primary food packaging

- **Paper and board materials** intended to come in contact with food products
- **Glass containers** intended to come in contact with food products
- **Metal and Metal Alloys** intended to come in contact with food products
- **Plastic materials** intended to come in contact with food products

Plastic materials intended to come in contact with food products

Migration

All packaging materials of plastic origin shall pass the prescribed overall migration limit of 60 mg/kg or 10 mg/dm^2 when tested as per IS 9845 with no visible color migration

Plastic materials and articles shall not release the substances in quantities exceeding the specific migration limits (mg/Kg)

Barium 1.0
Cobalt 0.05
Copper 5.0
Iron 48.0
Lithium 0.6
Manganese 0.6
Zinc 25.0

Schedule – IV: List of suggestive packaging materials

Fish and fish products or Seafood

- Glass jars with plastic (PP or High-density polyethylene (HDPE) caps
- Metal Containers with metal lid (lacquered tin containers)
- Polyethylene terephthalate (PET) punnets or containers with plastic caps
- Plastic-based multi-layered flexible laminates heat sealed pouches
- Plastic tray with overwrap

FOOD SAFETY AND STANDARDS (LABELLING AND DISPLAY) REGULATIONS, 2020

Labelling Requirements

(1) **The Name of Food**: Every package of food shall carry name of the food, which indicate the true nature of the food contained in the package, on the Front of Pack

(2) List of Ingredients

(3) Nutritional information

Nutritional Information per 100 g or 100 ml or per single consumption pack of the product and per serve percentage (%) contribution to Recommended Dietary Allowance calculated on the basis of 2000 kcal energy, 67 g total fat, 22 g saturated fat, 2 g trans fat, 50 g added sugar and 2000 mg of sodium (5 g salt) requirement for average adult per day, shall be given on the label.

FOOD SAFETY AND STANDARDS (LABELLING AND DISPLAY) REGULATIONS, 2020

Labelling Requirements

(4) Declaration regarding Veg or Non veg

Non-Vegetarian Food: The symbol shall consist of a brown colour filled triangle inside a square with brown outline

(c) Size of the Vegetarian/Non-vegetarian logo:

SI. No.	Area of principal display panel in cm. square	Minimum size of diameters of circle in mm	Minimum size of each side of triangle in mm	Minimum size of each side of square in mm
1.	Upto 100	3	2.5	6
2.	Above 100 to 500	4	3.5	8
3.	Above 500 to 2500	6	5	12
4.	Above 2500	8	7	16

Labelling Requirements

(6) Declaration of name and complete address

(7) FSSAI logo and license number

fssai

Lic. No. XXXXXXXXXXXXXX

Fortified food & Organic food

Fortified with....
SAMPOORNA POSHAN
SWASTHA JEEVAN

.... से फोर्टिफाइड

सम्पूर्ण पोषण स्वस्थ जीवन

Jaivik Bharat

भाकृअनुप
ICAR

Labelling Requirements

(8) Net quantity, Retail Sale Price and Consumer Care details

(9) Lot/Code/Batch identification

(10) Date Marking

(11) Labelling of Imported Foods

(12) Country of Origin for Imported Foods

Labelling Requirements

(13) Instructions for use: Example- 'Refrigerate after opening'

(14) Declaration regarding Food allergen

Crustacean and their products (To be declared as Crustacean)

Fish and fish products (To be declared as Fish)

(15) Every package of food material sold in retail but which is not meant for human consumption shall bear a declaration to this effect by a symbol- A black colour cross inside a square with black outline

Schedule-II -Mandatory Declarations

- Refined (name of the Oil) Oil
- CRUSH THE BOTTLE AFTER USE

DISPOSE THE BOTTLE RESPONSIBLY

- **NOT TO BE USED FOR INFANTS BELOW SIX MONTHS**
- **“Gluten Free”**

Principal display panel

- **Part of the container/package which is intended or likely to be displayed or presented or shown or examined by the customer under normal and customary conditions of display, sale or purchase of the food article contained therein**

TABLE I

SI. No.	Area of Principal Display Panel	Minimum Height of numeral and letter in mm	
		Normal Case	When Blown, formed Moulded, or perforated on container
1.	Upto 100 cm^2	1	2
2.	Above 100 cm^2 upto 500 cm^2	2	4
3.	Above 500 cm^2 upto 2500 cm^2	4	6
4.	Above 2500 cm^2	6	8

Thank You All