



THERMAL PROCESSING OF FISHERY PRODUCTS



Unit Operations in Canning

1. Selection, handling and preparation of raw material
2. Salting/blanching/pre-cooking
3. Filling the container
4. Exhausting
5. Sealing the container
6. Washing the sealed container
7. Thermal processing
8. Cooling the container and contents, drying, labeling and storing

- International canned fish market – can contents should leave no ‘plate-waste’ from consumer
- Raw material – subjected to pre-processing – finished product
- Separation of parts – inedible even after prolonged heat treatment – pre-retorting
- De-heading/knobbing, evisceration, de-scaling, trimming of fins

Selection, handling and preparation of

raw material

- Sardine, Mackerel, Tuna, Seer fish
- Shrimp, clam, oyster, mussel, crab
- Raw material quality – prime importance – determines canned product quality
- Thermal processing – standardized wrt known level of microbial population – excess number – failure of destruction
- High bacterial load – longer exposure to high temperature – adverse effect on product quality

- High bacterial load – contamination/unhygienic post-harvest handling/unhygienic habitat
- Fresh fish – prime quality, low bacterial load - proper dressing , thorough washing in potable water, proper icing
- Temporary storage before canning:
 - Sprinkling salt over fish
 - CSW or RSW storage
 - Ice storage
 - Frozen storage

- Dressing – type of fish and type of end product
 - Sardine – de-scaling, beheading, de-gutting, removal of fins, tail
 - Tuna – bleeding on board
 - Shrimp – beheading, peeling , de-veining
 - Bivalves – depuration
 - Crabs – carapace, body flap, gills, legs removed
- Skinning – tuna, mackerel – better presentation
- Chemical skinning process
 - Fish immersed in 70-80°C NaOH at pH 14 – loosened skin removed by water-jet sprays – immersion in HCl at pH 1 – neutralises residual alkali

- Filleting – not done – bones soften after retorting – edible
- Deviate from traditional presentation, weaken structure of fish – break up during retorting
- Oily fish fillets – damage during filling
- Mackerel – pre-cooked at 90°C until flesh separated in 2 halves from spine without breaking up

- Automatic knobbing and packing machines
- Dressed fish – washed – remove blood, adhering dirt, slime etc
- Cleanses and reduces bulk of fish – easy handling
- Pre-process operations – modify sensory aspects and cause denaturation of proteins and loss of water
- Size-cutting – as per can size

- **Salting/Brining** – mixing with solid salt/immersion in brine

- Firmness of meat – improved texture, easier handling
- Removal of blood and slime
- Stabilization/enhancement of flavour – characteristic taste of fish

- Insignificant denaturation of sarcoplasmic proteins – solubilize and conveyed to surface – water evaporates in post-brining stage
- Form shiny, attractive gloss – permits further moisture loss and inward diffusion of volatile components (smoking)
- Brines also carry colours, smoke flavour or acetic acid – toughens skin/epidermis – prevents sticking to can sides on retorting

- Inward migration of salt during brining depends on:
 - Thickness of pieces
 - Fat content – layers of fat – barriers for salt entry
 - Concentration of brine

- **Dry salting** – large fish canned as ‘cuts’ or ‘steaks’
- **Marinating** – subsequent to being sold in chilled form
 - Preservation of shellfish meats in glass jars prior to pasteurization or sterilization
- **Smoking** – hot or cold –imparts characteristic flavor and succulent taste to fatty fish
- Drying during smoking – denatures and sets proteins – reduces exudation into surrounding liquor during retorting
- Precooking and antibacterial effect

- Initial composition of fatty fish for smoking and canning – affects end-product quality
- Low fat fish – lose more water during smoking – firm and easy handling during filling – tough-textured after sterilization
- High fat fish – break up easily during filling – too soft finished product
- Smoke flavour – incorporated in brine

- **Blanching/Pre-cooking**

- Releases 15-30% of body water - Controls drained weight :
 - Under-blanching – under-weight of product
- Water-oil emulsion/cloudiness, internal can corrosion during thermal processing – dissolved proteins
- Eliminates possibility of further release of water from fish into can during thermal processing
- Minimises 'curd' – proteinaceous exudate (unsightly curd) in surrounding liquor during processing

- **Blanching/Pre-cooking:**
 - Shrinkage of fish – adequate and easy filling of cans
 - Imparts firm and proper texture to fish
 - Cleanses fish and reduces bacterial load
 - Inhibits enzymatic action
 - Retains nutritive value – reduces browning reaction
 - Expels respiratory gases from tissue – improves vacuum
 - Removes raw flavour and imparts colour
- Over-blanching – excessive drained weight, affects colour, texture and flavour and distortion

- Cold blanching –
 - Immersing fish pieces in salt solution – concentration and dipping time depends on species and type of fish – sardine, mackerel etc
- Hot blanching – 5-6% brine
 - Boiling brine – shrimps – characteristic red colour, curls and shrinks – adequate filling
 - Substantial reduction in enzymes and microbial load
 - Leaching of soluble proteins and other nutrients
 - Stabilization of solid weight

- Objectives of pre-cooking:
 - to partially dehydrate the flesh and prevent release of those fluids during retorting which would otherwise collect; in the container;
 - to remove natural oils, some of which have a strong flavour;
 - to coagulate fish protein and loosen meat from the frame;
 - to develop desirable textural and flavour properties; and
 - to make the flesh of crustacean firm and aid their release from the shell

- **Pre-cooking** – in steam with or without pressure – till no further water exudes during heat processing - minimizes loss of proteins
- 20-25% moisture loss from fish
- Lean fish – longer time than fatty fish
- Sardine – pre-cooked in steam after packing in cans (after cold blanching)
- Exuded water (exudate) – decanted at the end
- During precooking – cans kept inverted over grid – water drains away as it is formed
- Tuna – pre-cooked in steam under pressure (before packing in cans) – solid salt added to pre-cooked fish after filling in cans

- Heating during pre-cooking – done till all exudate is removed – core temperature reaches 80°C
- No loss of proteins, minerals, flavour
- Pre-cooking of clam – exudate collected, added back for taste retention

Filling into container

- Manual or automated
- Style of packing – type of can – affects heat transfer to cold spot
 - Round can – axial packing
 - Rectangular can – lengthwise or breadth wise packing
- Tuna – chunks/flakes
- Crab – flakes
- Prawn, clam meat – random arrangement

- Thorough washing of cans – removal of dust, grit, traces of chemical salts *viz* $ZnCl_2$
- Correct weight – influences other operations
- Heat processing of sealed cans – generates internal pressure:
 - Expansion of can contents
 - Increase in water vapour pressure
 - Expansion of air and other gases in food

- Internal pressure – balanced by expansion of cans and bulging of can ends
- Completely filled can – excessive strain – distortion of seam
- **Headspace** left over food – influences exhausting and act as reservoir of gases - liberated during heat processing
- Careful filling – no air pocket occluded in the pack which cannot be expelled during exhausting

- Uniform headspace of 6-9mm
 - Less headspace – bulging of can ends
 - Excess product – change in heat processing schedule – economic loss
 - More headspace – affects vacuum and accelerates product deterioration and container corrosion
- solid-liquid ratio – constant – change affects rate of heat penetration
- Filling area – clean – free of flies, dust, dirt and other sources of contamination

- Criteria for ideal container:
 - Strong enough to protect contents during transportation and handling
 - Light enough for economic handling
 - Impervious to air, moisture, dust and disease germs after sealing
 - Pleasing and sanitary appearance
 - Non-toxic internal lacquer
 - Withstand sterilization temperature and pressure
 - Inexpensive - cheap enough to discard after use
 - Capable of sealing at high speed

- OTS cans – tin plate – 98% steel and 2% tin coating
- Canning fish – internally coated with sulphur resistant lacquer to prevent black discolouration
- Sulphide blackening – Sulphur from sulphur containing amino acids in fish + iron in tin can – black iron sulphide
- Oleoresinous C-enamel lacquer – Zinc oxide + sulphur – Zinc sulphide (white)

- Size of cans
 - Trade name followed by dimensions of diameter and height expressed as a 3 digit number
 - 1st digit – diameter in inches
 - Next 2 digits – in sixteenth of an inch

Common cans in fish canning industry

Trade name	Dimensions
4 $\frac{1}{2}$ oz prawn can	301x203
8 oz prawn can	301x206
1 lb jam can	301x309
No.1 tall can	301x409
8 oz tuna can	307x113
$\frac{1}{4}$ dingley	404x302x014 (LxWxH)



OTS can



EOE can

Addition of liquid medium/additives

- Liquid medium –
 - Constituent of product – improves taste, texture, flavour
 - Facilitates rapid heat penetration – enhances sterilization
 - Avoids overcooking at points closest to can walls
- Liquid-solid ratio
- Brine – common – fatty fishes – **Brine pack**
- Oil – double refined and de-odourised vegetable oil – **oil pack**
 - Should not undergo any change during thermal processing

- Tomato sauce – Sauce pack– mackerel, oyster
 - Concentrated tomato pulp with additives
 - Prepared from good quality tomato without any decomposition by mould, yeast or bacteria
 - Colour – red – with a faint tinge of yellow, but never brownish - should not deteriorate during heat processing and storage
 - Odour and taste – pure and natural
 - Sauce - heterogeneous ; not contain too much seeds or skin
 - Consistency of sauce – 28-30% solid content; sugar - < 40%
 - No extraneous matter (carrot pieces)
 - No artificial colour and preservatives
 - Slow heating – conduction

- Curry pack – recipe
- Natural style/salmon style – no packing medium
 - Raw fish pieces with salt
 - No pre-cooking
 - Exudate produced during retorting – acts as medium
- Dry pack
 - No packing medium
 - Fish – pre-cooked and drained
 - Tuna flakes, fish spread
- Additives – CMC, MSG, sugar, vegetables,

Additives used in canned foods

- Additives - suitable for human consumption and be free from abnormal taste, flavour and odour
- Salt:
 - Flavour
 - Brining, blanching, packing medium
 - Pure
 - Should not contain appreciable quantities of magnesium chloride – bitter taste and struvite formation increases – form crystals resembling glass in canned fish
 - Calcium salts – toughening of musculature
 - Salt should comply with the "Codex Alimentarius Specifications for Food Grade Salt"

- Oil:

- Double refined and de-odourised vegetable oil
- Flavouring substance, packing medium
- Olive oil, soyabean oil
- Clear, free from mucilage/turbidity , mould or other impurities
- Free from moisture, rancid odour
- Colour - yellow to golden with only a slight tinge of green
- Odour and taste – pure , good and natural, not acrid, bitter or too strong
- Resistant to cold

- Spices/seasonings
 - Flavour enhancement
 - Curry, formulated products
 - Powder, concentrate or small pieces
 - Pepper, cardamom, ginger, onion, mustard
- Taste enhancers – MSG
- Preservatives
 - Antimicrobial
 - Chemical preservatives – sulphite, metabisulphite, benzoate – acid foods – active at low pH
 - Antibiotics – nisin – heat resistant, active at neutral

- Acids
 - Dip treatment
 - Citric acid – controls sulphur blackening
 - Acetic acid – firming up skin and flesh
- Cane sugar/sucrose
 - Fruit products – syrup, jam
 - Condensed milk
- Vegetables
 - Adjuncts for formulated products
- Chelating agents