

Thermal Processing of Fishery Products

- Objectives of canning:
 1. Preservation – prevent food spoilage
 2. Product safety – spoiled foods cause health hazard
 3. Profitability – higher price for convenience of longer shelf life

- Thermal processing operations – designed – nature of food and type of contaminant likely to be present
- Risks in canning:
 1. Health hazard to consumers
 2. Product failure
 3. Economic loss

Raw material Quality

- Thermal process requirements – depend on variable raw material quality
- Time and temp. schedule specified in a process schedule – based on known microbial loadings
- Incoming raw material quality control - deciding factor
- Process schedule – sufficient to ensure commercial sterility with worst quality raw material

Unknown raw material quality



Unknown end product quality



Commercial and health risks

- Raw material preservation – prevent surface contamination
- Foods with protective coating – less spoilage compared to fish (loins, chunks, fillet)
- Adequate refrigeration before processing

Heat transfer mechanism

- Rate of heating of a product in a container – function of
 - Geometry of container/product
 - Physical properties
 - Heat transfer characteristics of container/product

- Depends on
 - Nature/consistency of foods – whether fluid, solid, or solids and liquid
 - Presence of particles
 - Use of thickening agents and sugars
- 2 types:
 1. Conduction
 2. Convection
- Cold point determination

- Conduction

- Solid foods – thick soups, creamed corn, meat balls in gravy, fish
- Slow process
- Heat transferred by molecular activity from one substance to another
- Rate of heat transfer decreases as difference between retort temperature and can centre is lesser

- Solid packs – cold point – at geometric centre of can
- Slow destruction of microorganisms – solid product insulates bacteria in centre of can

- Convection

- Liquid foods/ solids in brine/syrup/thin soups
- Heating - change in density of fluids – set up convection current
- Thin liquids - rapid convection heating
- Dissolved substance – increases viscosity - decrease in heat transfer
- Cold point – 1-1.5cm above bottom (10% of can's height from bottom)

- Mixed conduction-convection heating
 - Products with high solids to liquid ratio or larger pieces of solid food in thin liquid
 - Simultaneous heating by conduction and convection
 - Sudden clumping of solid food together forming large pieces
 - Slow rate of heat transfer
 - Under-processing and consequent product spoilage

- Broken heating
 - Sequential combination of conduction and convection or convection and conduction
 - Distinct change/break in rate of heat penetration
 - Initial period of rapid heat transfer – ceases abruptly – followed by slower rate of heating
 - Sol-gel transformation – starches

- Rapid heating of canned product to lethal temperatures – quick destruction of microbial contaminants
- Cold point – least sterilization effect
- Heating of cold point – ensures sufficient heating of every other point in the container

Factors affecting thermal processing requirements for canned foods

1. Product acidity
2. Raw material quality
3. Method of heat transfer
4. Container size
 - Larger containers – higher initial loads – more heating and longer time to heat compared to smaller ones

Sources of contamination and control measures

- Higher the degree of contamination, the greater extent of heat treatment required for commercial sterility
- Fish – ideal substrate for support and multiplication of bacteria
- Prolonged exposure to heat – adverse effect on quality
- Process schedule – appropriate design

- Sources of contamination in canned foods:
 - Raw materials
 - Plant – equipment, machinery, utensils and other installations
 - Containers
 - Cooling water

- Raw materials
 - Ideally non-infected with spoilage organisms
 - Fish – source of bacteria – gut, slime, gills
 - Contamination from soil – unhygienic landing – pre-process handling
 - Fishing area, gear used, duration of exposed keeping without ice, fish holds and decks, poor quality water
 - Faecal coliforms, *Bacillus*, *Clostridium*

Control measures

- Conduct fishing in unpolluted grounds
- Wash fish with clean, chlorinated water immediately after catch
- Prevent contamination with sand/soil
- Sorting – species-wise and size-wise
- Immediate icing, RSW/CSW storage, etc
- Use bacteriologically good quality ice – preservation and processing
- Clean, disinfected handling deck, equipments, containers

- Raw material other than fish – potential sources of contamination
- Common salt – contaminated with carbonates
- Carbonates in acid medium – CO_2 – swelling of cans – bursting during thermal processing
- Spices, sugars
- Heat treatment of spices – loss of volatile essential oils
- Tomato puree – potential carrier of thermophiles

- Preliminary heat treatment of ingredients – practical method to control contamination
- Pre-cooking / hot blanching – reduces bacterial load
- Ultra-filtration – eliminates contamination from soluble ingredients – sugar and meat extracts

Plant and equipment

- Canning plant, utensils, equipment
- Source of thermophilic organisms – ‘flat sour’ spoilage – fillers, blanchers
- Control of contamination within plant:
 - Correct design and operation of equipments
 - Efficient cleaning schedule
 - Maintenance of good hygiene

- Design, construction and lay out of plant:
 - Equipment
 - Non-porous material
 - No chemical contamination of food
 - Withstand corrosion from foodstuffs and chemicals used for cleaning
 - Lay out and alignment of process line – unidirectional, straight-through flow of material – eliminate stagnant pockets where spoilage organisms may develop
 - Pipelines – easy dismantling and cleaning

- Equipment surface – smooth, allow for easy cleaning, free from recesses, dents and ledges
- Chutes, conveyors, storage vessels – rounded bottom, corners free from rough, pitted areas
- Equipment installation – sufficiently raised from floor and removed from walls – easy cleaning from all sides, repair and maintenance

- Plant and equipment – thoroughly cleaned after each operation – detergents and disinfectants
- Regular chlorination after cleaning with detergent
- Cleaning schedule – all utensils and accessories

- Chlorine – low cost, high bactericidal property – most popular disinfectant
- NaOCl or $\text{Ca}(\text{OCl})_2$ – dissociate in water – HCl and HOCl
- HOCl – destroys vegetative cells and spores
- 15-20 ppm – water for cleaning operations
- 5-10 ppm – application on conveyor belts, elevators
- 5 ppm – washing fish and other raw materials

- Plant and equipment – maintained in sanitary condition
- Thorough cleaning – bacteria multiply on left over food – source of contamination of food which passes through subsequently
- Cleaning – plant in operation

- Accumulation of waste, spillage etc on floors and equipment – regular cleaning
- Washing cans after seaming with hot alkaline solution – prevents passage of waste sticking to can surface into retort – contaminate subsequent batches of cans
- High standard of cleanliness:
 - Plant
 - Processing and handling equipment
 - Material being handled
 - Processing operations

Containers

- Potential source of contamination
- Improper storage in unclean atmosphere – dust accumulation
- *C.botulinum* type A
- Can washing before filling – water jets
- Hot detergent wash – followed by clean water
- Dry cleaning methods – residual water not desirable

Cooling water

- Contaminated cooling water – risk of microbial contamination and subsequent spoilage
- Post-process spoilage – faulty seam – permits access to bacteria
- Leaker spoilage in perfect seams – minute droplets of water sucked in through expanded seams – high internal pressure suddenly changes into vacuum on contact with cooling water

- Water of low bacterial quality – contaminate processed sterile food
- Potable water quality - < 100 per ml
- Chlorination – 4-5 ppm
- Maintain adequate contact time between chlorine and bacteria – satisfactory cooling water hygiene