FISH CANNING TECHNOLOGY
Practical Manual
CC-FSP 437

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FOREWORD

Canning is an important method of preserving perishable food commodity. Canning of fish and fishery products date back to 150 Years and the first canning industry in India was established in the year 1911. Following a major set back in 1980's, the canning industry has now revived and gaining popularity due to the recent developments in the retortable pouch packaging. Ready-to-eat value added fishery products prepared in retortable pouches with shelf life more than one year meet the needs of the institutional caterers, fast food trades and departmental store.

Fisheries colleges of India are offering a course on "Fish Canning Technology" for the students. During the course work, it was felt to have an exclusive teaching manual on Canning Technology for the benefits of the students and researchers. This manual exhaustively covers the principles of canning, heat process calculations, types of containers and their manufacture, spoilage and quality defects associated with canned fishery products in addition to the recent developments in the canning technologies. With the introduction of retortable pouch packaging for fishery products, it is highly mandatory for the food manufactures and processors to develop process formulations in relation to the heat resistance and heat process to produce economically viable fishery products with good nutritional quality.

I am happy to record that a teaching manual on "Fish Canning Technology" is brought out by Dr. Siddhnath of the Department of Fishery, The Neotia University, Kolkata. He has done an excellent job in this compilation and deserve congratulations. I have great pleasure in presenting this manual to the benefits of fisheries students, researchers and fish processors.

Vice-Chancellor

LIST OF EXPERIMENTS

1. TYPES OF CAN

Containers for heat processed foods are made of steel and aluminium. Steel cans are more common than the aluminium for the reason of cost and performance.

1. STEEL

Steel is usually in the form of tinplate (misnomer, tin cans) is the most common metal used. Tin plate refers to a sheet of steel plate coated on either side with tin, giving a final composition of 98% steel and 2% tin. The gauge (thickness) and the level of tin coating vary considerably with container size and the product to be packed. Typical ranges are:

Nominal gauge	:	0.15 – 0.30 mm
Tin coating weight	:	0.5 – 15 gsm

Can making quality (CMQ) steel is used to make the base plate and should have the following qualities

i. Capable of being rolled into thin plate and able to take thin coating of tin
ii. Coating of tin should be uniform to reduce the porosity to the minimum
iii. Strong enough to withstand rough handling

The chemical composition of the CMQ steel is

Carbon	-	0.04 – 0.12%
Phosphorus	-	0.02%
Manganese	-	0.05 – 0.6%
Sulfur	-	0.05%
Silicon	-	0.01%
Copper	-	0.08%

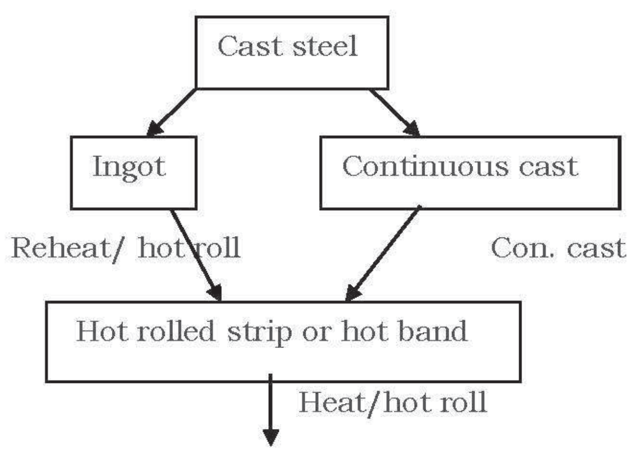
If copper and phosphorus are more, corrosiveness is greater

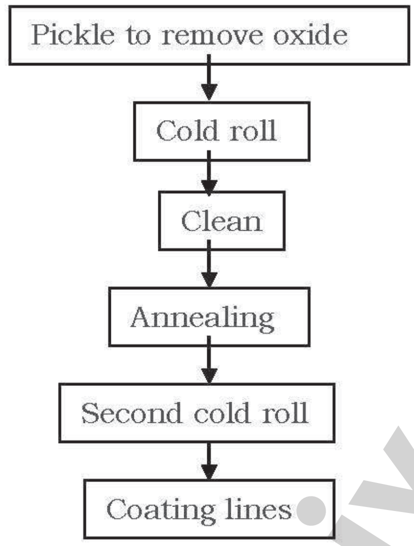
Manufacture of tin plate:

Steel (pig iron) is manufactured by "**Bessemer process**" or "**Open hearth process**". In this process, impurities of pig iron are removed by oxidation. Then, it is partially deoxidized using ferromanganese. Then, once again it is deoxidized using reducing agents, silicon and aluminum. This process is known as '**KILLING**'.

Refined low carbon steel is cast to ingot or continuously cast into a slab. Ingot steel is continuously heated and rolled into a slab. In slab form the steel is passed through heating furnace and then through rollers to get strips of steel. To remove the scale like portion on the strips, '**roughing**' process is done by treating the surface with high pressure water spray (900-1200 psi). Then, to remove the oxide film over the steel surface, '**pickling**', a purification process is done by dipping them in dilute H_2SO_4 acid or by electrolysis. **'Oiling'** process is done to facilitate subsequent rolling. The next stage is '**Cold reduction process',** in which sheets are passed through cold rollers a number of times to get a required thickness. Typical cold reduction can result in 10-fold reduction in thickness. The next stage is the '**annealing**' process (**Hot reduction process**), in which the coils of sheets are held at elevated temperature (580-600oC) in an inert atmosphere for long time (60h) incorporating 8-10 h at peak temperature. Continuous annealing process is carried out in a coil and requires less time. Annealed products are then either light-temper rolled or subjected to further cold reduction process. (Flow chart)

Tin Mill Products Manufacture





The strip is now ready for final finishing.

1. Oiling in case of Black Plate
2. Electrolytic tinning in case of Tin Plate
3. Electrolytic deposition of chrome/ chromium oxide layer in case of Tin free Plate (TFP) or Electrolyte chrome coated steel (ECCS)

i. **Black Plate**: Is defined as uncoated mild steel. Suitable for only a very limited range of products even when fully lacquered. Corrosive and poor chemical resistance

ii. **Tin-free steel (TFS)**: Fairly wide usage. Draw-redraw containers and fixed ends for processed food cans. The abrasive surface necessitates overall lacquering prior to fabrication of containers.

iii. **Tin plate**: Tinning performed by two ways. Hot dipping and electrolytic process.

I. Hot dipping: Steel sheets immersed in water and passed through molten tin bath. Then, they pass through the rollers, which remove the excess tin coating. Then, they pass through a deep layer of palm oil (squeezing action). Temperature brought down during this process to reduce oxidation. Then, tin plates are cleaned using a hot solution of soda ash and polished by rollers covered with sheep's skin. Tin required for this process is 2%.

II. Electrolytic process: Base plate given a light electrolytic pickling in dilute H_2SO_4 acid. Then, it is passed through electrolytic cells, containing dilute acid. Pure tin is used as anode. Direct current of required voltage applied and this causes the tin from anode to dissolve slowly and deposit on the cathode (moving steel plate). To prevent oxidation, tin plate is subjected to chromic acid treatment. After rinsing and drying, very thin coating of oil is given. Tin required for this process is ¼ - ¾ %.

Differential coating: Tin requirement is different for exterior and interior surfaces of the can. Internal surface have contact with food and hence, require heavier coating than outer surface. When coating thickness is different on two sides it is called **Differential coating**. If coating thickness is same on both sides it is **Even coating.**

ISI specification for fish can is D 11.5/ 5.6. Tin requirement is < ½ %.

Units for expressing tin coating thickness:

Earlier, Pounds per Basis Box is used.

Basis Box = Area of 112 sheets of size 20" x 14" or 31,360 sq.inches.

For tin cans, one pound/basis box is sufficient.

Now, Grams per sq.m (GSM) is used.

Tin coating thickness depends on the characteristic of the product and on whether the can is lacquered or not.

Grades of tin containers:

1. **Prime**: High quality tin plate. Without any defect. Right size and weight.
2. **Mender**: Slight defect in tin coating. Reheated, defect rectified and considered as prime.
3. **Waste**r: Defective tins. Not suitable for packing food. Used for paints.
4. **Waste waste** : Very defective tins. Cannot be used for any material and has to be scrapped

Lacquering:

Reaction between the food stuff and metal due to corrosion, ultimately leads to perforation of cans. Covering the inside of the can with an inert material film prevent the contact of food with metal. This process is known as 'Lacquering'.

Two types of lacquers are generally used in food cans.

1. Acid resistant lacquer (ARL) e.g. Fruits
2. Sulfur resistant lacquer (SRL) e.g. Meat, Milk, Fish

1. **Acid resistant lacquered cans:** Fruits with red anthocyanin pigment react with tin causing the fruit to turn purple and the syrup becomes cloudy. Oleoresin lacquers are most commonly used.

2. **Sulfur resistant lacquered cans:** Products containing sulfur bearing proteins yield low molecular sulfur bearing compounds during processing which on reaction with tin or iron produce black colour due to iron sulfide formation. The most common lacquer for fish cans are oleoresins C enamels. C enamel contains zinc oxide, which react with sulfur compounds and produce zinc sulfate, which is white in colour.

Majority of the lacquers in use are either oil based (oleoresins) or synthetic. Oil based lacquers contain natural fossil gums and drying oils and they are thinned with white spirit. Synthetic lacquers used for food cans are phenolic, epoxy, vinyl or polyester lacquers. Recent introductions are polybutadienes and diphenolic acid.

Lacquers should have the following qualities:

i. Should not impart flavour or color
ii. Should be able to withstand high temperature for longer period
iii. Should not degrade the color of the product
iv. Should not absorb any color from the product.

Oleoresinous lacquers:

Combinations of an oil or an oil derivative and a resin. Drying oils used are tung, linseed and castor oil. Resins used vary from naturally occurring resins, polymerization product of unsaturated hydrocarbon, phenolic resins etc. Oleoresinous lacquers have widest application in canning industry. They yield a gold coloured coating on can. When used without added pigment, they are called 'R' or 'F' enamels. When used along with 10-20% zinc oxide and 90-80% oleoresin, the coating is 'C' enamel. Zinc oxide is added to induce sulfur resistant properties.

Advantages: Lower cost and general applicability for food containers

Disadvantages: Limited flexibility and failure to withstand many products

Open Top Sanitary Cans (OTS):

Tin plate cans in common use are the OTS cans. They can be 'three piece cans' and 'two piece cans'.

Three piece cans: Consists of a cylindrical body with soldered side and two can ends attached to the cylinder by the method of double seaming.

Two piece cans: Shallow cans made of tin plate or aluminium and are popular in packing fish. They are mainly drawn cans made by cutting, drawing and flanging in one operation.

2. ALUMINIUM

The most important and extensively used alternate to tin plate container is the aluminium can. They are used for packing meat and fish products as early in 1918. Aluminium used in can making is often reinforced by alloying with manganese, magnesium or chromium. Aluminium alloyed with manganese mostly used.

Advantages over tin plate cans:

i. Light weight (1/3 the weight of tin plate)
ii. Do not produce corrosion
iii. Do not impart metallic taste
iv. Easy to open

v. Good scrap value for the container after use

Disadvantages:

i. Not highly resistant to corrosion by acid fruits and vegetables
ii. Must be handled with extreme care, as it is soft
iii. Difficulty in closing body seams by soldering
iv. Precaution required during heat processing to avoid distortion
v. Severely bleaches some products
vi. Service life less than tin plate

Methods employed in the manufacture of aluminum cans:

i. Build up
ii. Shallow formed
iii. Deep drawn
iv. Impact extruded container

For fish canning, 'shallow forming process' is widely used. They are made by a single pressing process. Maximum height is half is diameter and maximum diameter is 150 mm. Alloyed aluminium is first given anticorrosive treatment in dilute H_2SO_4. Then, it is further coated with a lacquer suitable for the product.

Size of the cans:

The cans are generally denoted by the trade name followed by their dimensions denoted by a 3 digit symbol. First represents diameter of the can and the second, the height. The first number in the digital symbol represents integral inches and the next two digits indicate the measurement in sixteenth of an inch. This an A1 can is $3^1/_{16}$" in diameter and 2 $^{11}/_{16}$" in height is shown as 301 x 211. Now-a-days the dimensions are given in millimeters.

Trade name	Trade dimensions	Over seam dimension
4 ½ oz Prawn	301 x 203	77 x 56 mm
8 oz Prawn	301 x 206	77 x 60 mm
1 lb Jam	301 x 309	77 x 90 mm
No. 1. Tall	301 x 409	77 x 116 mm
8 oz Tuna	307 x 113	87 x 43 mm
¼ Dingly	404 x 302 x 014	-

2. Canning machineries and fabrication of can

Open Top Sanitary cans (OTS) made of tin are very familiar packages in the fish canning industry. They can be 'three piece' or 'two piece' cans. Three piece can consists of a cylindrical body with soldered side and two can ends attached to the cylinder by the method of double seaming.

A. Cutting body blanks:

Tin plate sheets fed to a 'Slitter' or 'Trimmer' machine, which cut the sheets to required dimensions to form the body of the can.

B. Body making:

Body blanks are passed through a 'flexing' unit, which removes any irregularity and hardens the sheet. The corners of the blanks are then 'notched'. The blanks are then 'edged', by which a 'hook' is formed at the two shorter edged of the blank, by bending one edge downwards and the other upwards. Hooks are then coated with 'flux' and blank is formed into a cylindrical body with the hooks locking together. Locked hook is hammered flat to form 'side lock' or 'lap seam'. To make it water tight, soldering done in a 'solder mill' by means of longitudinal rollers, which revolves and apply soldering material (flux) over the side seam. Excess solder removed by rotating brush ie. buffing wheel. The solder is solidified by a blast of cold air. The container body is flattened to occupy less volume and to avoid damage during transportation.

C. Can body reformer:

This form the cylindrical cans from the flattened cans

D. Flanging machine:

The cylindrical can body is next flanged. The flanger consists of two flanging punches, which fit into both ends of the can. Punches move slightly towards each other and force the edges of the body outwards thus forming flanges.

E. Can Lids:

Both the can ends are identical and interchangeable. They are made of tin plates of same thickness and weight as body blanks. Tin sheets are fed into 'Scroll shears' which cut the sheets with required size and shape. They cut into strips of irregular shapes instead of square or rectangular to minimize wastage. Then sheets are fed to 'Press' or 'Curler', which have a combination of dye and punch. Dye will leave markings and can ends are cut from the sheet. Dye will also promote grooves at the edges or concentric expansion rings to receive the seaming compounds. Curler also bent the edges or periphery.

They are then fed to seaming compound applying machine, wherein sealing compound is poured inside the curl on the can edges, which is a rubber solution or emulsion with good resilient properties. The lids are then dried in an oven. The rubber solution in the groove forms a gasket and ensures air tight seal. Now-a-days aqueous emulsion of rubber is used. Sealing compound should not undergo decomposition, oxidation and impart any off flavour. It should not be damaged by heat or fat in foods.

D. Can seaming:

The can ends are attached to the body using a 'Double Seamer'. Double seam is defined as that part of the can formed by joining the body and end components, the hook of which interlock and form a strong mechanical structure. It consists of 5 thickness of metal, 3 thickness of the end (lid) and 2 thickness of the body.

Double seaming machine consists basically of three parts

1. Base plate
2. Chuck
3. Pair of seaming rolls or grooved wheels

Double seaming consists primarily of two operations. Double seam is formed with two seaming rolls. Of the seaming roll, one which comes in operation first has a deeper groove and the second, shallower. The base plate, raises the can body with the end in position causing the chuck to fit into the end of the can.

First operation: The first seaming roll comes into operation, it round the curled rim of the end, tucks it under the flange of the body to form the 'Cover hook'. The cross section will show a good overlap of body flange and end curl, but shape of the seam will not be distorted.

Second operation: The second roll, tightly presser and flatten together the hooked edge of the end and body against the chuck, thus forming hermetic seal, the 'Body hook'.

https://www.youtube.com/watch?v=ruSskEAzeXI

3. Examination of can double seam

Introduction:

The double seam of a can should be examined very carefully because successful canning largely depends on the degree of perfection achieved in sealing the container air tight. The finished seam should be judged in its entirety and not by individual measurements of its elements. Both external and internal conditions of the double seam should be visually inspected as also measurements taken, before arriving at any conclusion.

Materials required

1. Micrometer screw gauge
2. Seam cutting saw
3. Cutting pliers
4. Magnifying glass
5. Double-seamed cans

Procedure:

a. External examination:

I. ***Visual***: Observe carefully all round the seamed end, both on the body and lid sides. Note any peculiarities or presence of defects such as 'Vees', 'Lips', 'Cut overs', 'Lined seam' etc. Give special attention to the part of double seam over the side lap joint.

II. ***Measurements:*** Using the screw gauge, take measurements of seam length or width (W), seam thickness (T) and countersink (CS) at 3 points on can end separated radially by 120^{0} angle, avoiding the side seam (or at 4 points separated by 90^{0}). Record the measurements.

b. Internal Examination:

I. ***Visual*** : Strip one can end all round by means of the pliers and get a ring of the cover hook portion. Observe the wave-like 'wrinkles' on the inside surface of cover hook. Rate the wrinkles. In the other can, cut seam sections from the 3 or 4 points, where external measurements had been taken. Observe the cut sections for hooking, overlap and clearances, using the magnifying glass.

II. ***Measurements:*** Separate the body hook (BH) and the cover hook (CH) without straightening either, and measure their lengths. Taking average values for hook lengths and tin plate thickness (t), calculate the overlap percentage (OL %) of the double seam for each can tested, using the following formula:

$$OL\% = \frac{BH + CH + t - W}{W - 3t} \times 100$$

Where,

BH, CH = Body hook, coverhook.

T = Tin plate thickness.

W = Seam length or height

Compare the results with standard values.

Seam thickness: Maximum dimension across or perpendicular to the layers of the material in the seam.

Seam length: Maximum dimension of the seam measured parallel to the layers of metal and to some extent reflects the contour of the second roll.

Overlap: Degree of interlock between the body hook and the cover hook.

Some common defects with double seams: cock

i. **Cutovers:** Occur as a sharp fin at the top of the seam ,pointing inwards. It is caused by an excess of solder inside seam, a worn chuck, cocked can bodies, play in seaming roll, incorrect alignment etc.

ii. **False Seam:** Seams are formed but not hooked. Caused by knocked down flanges, damaged or bent covers.

iii. **Cut Seam**: Outer layer of seam is fractured. Caused due to too tight setting of seaming rolls, excess solder and excess sealing compound.

iv. **Body hook too long:** Base plate pressure is too high.

v. **Body hook too short**: Low base plate pressure, too tight first operation roll, too loose second operation.

vi. **Wrinkling:** When diameter of can is reduced during first operation puckers and pleats formed and second operation wrinkles appear.

vii. **Skidders:** Due to incomplete second operation rolling.

Observations:

The measurements of double seam elements may be tabulated in the following proforma:

Can No & End	**Seam cutting points**	**SEAM** **L**	**T**	**C S**	**Internal Measurements**			**Remarks**
	1 2 3							
	Average							

Internal defects:

External defects

Calculation:

Overlap % =

https://www.dixiecanner.com/pages/can-seam-inspection

4. Test for leakage of cans using hand seam tester

Materials required

- Hand can seam tester
- Cans to be tested
- Water in a vessel

Description of Hand Can seam tester:

This instrument is used for testing the leakage as well as pressure tolerance of the double seam of cans. This consists of the following parts.

a. Hand pump
b. Pressure gauge
c. Drilling point

The can seam tester has a pressure gauge at one end and a sharp drill bit at the other end. Just above the drilling bit, a rubber washer held by a metal holder is provided with a lever with which the washer can be raised or lowered. This arrangement aids in fixing the tester firmly on any canby piercing with the drill bit. The tester has a hollow body, which extends from pressure gauge to the drilling point, and there is a provision for attaching the hose of a hand pump. On fixing over a can, air can be pumped into the can through the hole at the drilling point and the corresponding pressure that develops inside the can is shown by the pressure gauge.

Procedure

1. Seam a few test cans using double seamer
2. Pierce the can using the sharp drilling point of the tester and turn it to 30^0 and firmly fix the can seam tester by raising the lever provided above the drilling point.
3. Using the hand pump, pump air into the can so that the pressure inside the can reaches to 15 psi.
4. Immerse the can in water kept in a vessel.
5. Observe for air bubbles along the seams (leakage is indicated by bubbling of air through incorrect or weak seams)
6. If there is leakage, the double seamer has to be corrected to obtain a perfect seal.

https://www.youtube.com/watch?v=Dr0OYvr13Pk

5. Determination of the Dimensions and Water holding capacity of a can

Introduction

According to certain specifications, the net contents as well as the drained weight of canned foods are fixed with reference to the water capacity of the container used. e.g. the I.S.I. specification for prawns canned in brine mentions that the drained weight of solids should not be less than 64% of the water capacity of the container. Hence it is necessary to know the dimensions and water capacity of the cans that are commonly used.

Materials and Equipments:

1. Cans of different sizes (4 – 6 cans each),
2. Water for filling (cooled to 20ºC),
3. Double seaming machine,
4. Balance, scale, Vernier calipers etc.

Procedure

1. Close the empty cans by double seaming. Measure external diameter and can height using calipers.
2. Cut open the lids completely without altering the height of the can
3. Wash, dry and weigh the cans.
4. Fill them with water at 20ºC, up to a head-space of 4 mm. (I.S.I) or 5 mm (F.D.A).
5. Wipe outside and weigh again.
6. From the difference calculate the weight of water required to fill the can up to the specified head-space
7. Take average values for each can size and express the result as water capacity (ml.)

Observations:

Tabulate the data as follows:

Can size	Can dimensions Dia X Height	No. of cans	Empty can wt. (g)	Can + water weight (g)	Wt. of water (g)	Can capacity (ml.)

Average water holding capacity of the cans:

https://en.wikipedia.org/wiki/Steel_and_tin_cans

6. Types of Retorts and Its Installation

Retort is a chamber in which canned food are processed under super imposed steam pressure. There are two basic types of retorts. Still and agitating. Retorts may be either batch or continuous. Majority of fishery products are processed in still, batch type horizontal or vertical retorts. Depending on the application, the size, design and capacity varying. There are several types of retort like vertical / horizontal; still/ agitating types; continuous/ batch types. In all cases, steam under pressure is used for processing.

Open type retorts:

Processing at less than 100ºC and without pressure. Fruits are processed in this type retort. Fruits are high acid foods and do not support growth of spore forming bacteria. Therefore, nutritive value is preserved. Vegetables are specially treated to bring down its pH from medium acidic condition and then processed at 100ºC .

Batch retort

I. Vertical retorts:

A retort having an upright cylinder made of heavy steel construction. eg. Gun metal. These retorts are mounted in wells. Materials must be loaded by block and tackle.

Advantages:

a. Saves labour
b. Economical and operated quite easily (short time)
c. Tends to favour more uniform internal steam distribution

Disadvantages:

d. Pose hygienic hazards as mounted in wells.
e. Repairs and adjustments holds problem.
f. Require overhead and traveling crane.

II. Horizontal retorts:

They are quite large and huge. They are 10 to 12 feet in length and 5 feet in diameter. They are made of heavy steel. Heavy doors are made to lock using hand operated wheel at center. No rack arrangements are provided; instead baskets with raw materials are fitted with wheels, which move through the rails inside the retorts i.e. materials are loaded in containers on trolleys. Steam is introduced through multi-orifice spurge pipes along the length of retort floor.

Disadvantage:

Spoilage may occur due to time lack between can preparation and loading time, as they are large.

III. Continuous retorts:

Have a special system for loading and unloading. Can pass through the conveyer belt and retained inside the autoclave for a sufficient time for heat processing. It is the best method for fish and meat canning, which requires lot of energy for keeping the retort in operation. Suitable for large output of uniform sized cans.

Agitating retorts:

Specially used for canning of fruits, vegetables, and fruit pulp and milk products. Generally in still (batch) type retorts, the heat processing is for a long time since it required a long time for heat penetration. In agitating retorts, cans are arranged in the wheels during heat processing and an end over end agitation will be experienced by the cans. Heat penetration is also very rapid and hence processing time is reduced. Since, the contents are in a liquid form, it mixes well enhancing heat penetration. This retort should be fitted with automatic control for temperature regulation.

Parts of the Retorts:

All retorts have the following parts.

1. ***Automatic controller*** – to accurately maintain processing temperatures.
2. ***Indicating thermometer*** – with corresponding pressure scale
3. ***Recording thermometer*** – for establishing accurate records of actual processing.

4. ***Pressure gauge*** – for accurate knowledge of internal retort pressure during processing and cooling. Separate pressure gauge also provides a mean for cross checking the thermometers.

5. ***Retort crates, baskets, trays are gondolas***: For holding stacked cans during processing. These crates are made of scrap iron or perforated metal and should be so designed as to allow uniform stream flow. It is also important that cans are stacked or jumble packed in to the crates so that free circulation of steam is possible; otherwise, low temperature regions or 'cold spots' will develop.

6. ***Vents:*** Large valve-controlled openings, necessary to eliminate air from the retort during the "come-up" period i.e. as the retort comes up to the desired processing temperature. The number and replacement of vents vary with retort size and design. Proper venting is of extreme importance in obtaining processing temperature. Retorts are normally vented until the retort temperature reaches 215 to 220°F, at which time the valves are closed and the processing cycle is begun.

8. ***Bleeders:*** Small valve opening in the retort usually 1/8 inch in size, left open during the entire process to assure steam flow.

9. ***Steam spreaders:*** To allow uniform distribution of steam throughout the retort

10. ***Drain valves:*** To allow rapid removal of water from the retort following cooling.

11. ***By-pass steam valve:*** To allow manual operation of retort during the come-up and cooling cycles and in case of failure of the automatic controller.

12. ***Safety or blow-off valve***: To prevent excessive pressure in the retort.

Retorts Installations

Steam supply:

Boiler capacity should be large to provide adequate steam for operation. The steam pressure in line should be not less that 90 psi. Supply line should have minimum bends and be large.

Basic Installations are

1. ***Steam controller or By pass:*** Steam-controller valve should be air-to-open type. Smaller than steam- in let pipe if bypass is used during the come-up period. Having controller, the same size as inlet pipe is desirable. By pass need to be installed around controller valves to permit hand operation.
2. ***Steam spreader:*** Steam admitted through a spreader in the bottom. In horizontal retort, this run the full length of the shell and in a vertical retort, a pipe cross is recommended. Spreader holes are along the top of the pipe to direct the steam. The number and size of holes should be such that there is a minimum of back pressure. If too many holes, poor distribution results. If holes are small, then clogging results.
3. ***Water supply and over flow line:*** If cooling is to be done in the retort, top and bottom water inlets are provided. In horizontal retort, water enters at the top through a spreader and at the bottom through one or two large opening. In vertical retort, the top inlet discharge water through a spray ring. Drain lines may be used us the bottom water inlets. Globe valves used instead of gate valves to prevent leak.
4. ***Drains:*** Drain should be large enough to remove water rapidly. In horizontal retort, door is an auxiliary drain.
5. ***Bleeders:*** A bleeder is a $^1/_8$ to ¼ inch petcock. Bleeders are essential to remove air admitted with the steam during the process and to provide circulation of steam in the retort and pass thermometer bulbs in wells. A horizontal retort has bleeder within one feet of each end and not more than 8 feet apart along the top. A vertical retort has one bleeder in the lid. Bleeders are installed on thermometer walls.
6. ***Safety valves:*** Is larger than steam inlet pipe. Should comply with local safety.
7. ***Pressure gauges***: Pressure gauges have a range of 0 to 30 lb and a dial 3 ½ inch or more in diameter. Purpose is to indicate the pressure during cooling. It is installed with a gauge siphon in the connecting pipe to the retort.

8. ***Indicating mercury-in glass thermometer***: Each equipped with at least one thermometer having a range of not more than 100ºF (170 – 270ºF) on a scale at least 7 inch in length. Should be checked for accuracy at least once a year. Bulbs of indicating thermometer installed within the retort shell or external wells. All external wells or pipes must be equipped with $^1/_8$-inch bleeders to provide full flow of steam.

9. ***Recording temperature indicator***: Recorder chart is easily readable to 1ºF and graduated in not to exceed 2ºF divisions within the range of ±10ºF of the process temperature. Bulb is installed within the retort shell or in a thermometer well.

10. ***Valve controlled vents:*** Large valve – controlled opening used for the elimination of air during the come-up period. Vent is controlled by plug-cock type valves, which should be fully opened during the come-up period to permit rapid discharge of air. Vent is located in the extreme opposite wall from that through which steam is admitted.

Retort operation:

I. Preparing for steam on

1. Close the door or lid and check if all lugs are fastened securely.
2. Check the temperature recorder.
3. Open the vents and bleeders
4. Close the drain and overflow.

II. Coming – up time:

1. Admit steam by gradual opening of controller as well as by pass lines.
2. When the correct temperature is reached for specified time, close the vents.
3. Gradually close the bypass just before the processing temperature is reached. (This prevents sudden drop in temperature)
4. When the retort has reached the processing temperature desired (250ºF), check the temperature indicated on the mercury and recording thermometers.

5. At the start of the process, enter on the production record, the time, mercury thermometer temperature, pressure and temperature of recording thermometer.
6. Keep a record of the coming-up time.

III. Processing period:

1. Maintain the retort temperature about 10°C above the recommended temperature.
2. As the process continues, check the temperature from time to time.
3. Leave all bleeders open during the entire process.
4. When the time required elapse, turn off steam and start the cool.

IV. Cooling

Various methods of cooling are:

1. Cooling in a canal
2. Cooling in retorts without pressure
3. Pressure cooling with steam and water
4. Pressure cooling with air and water
5. Pressure cooling with an ejector for supplying air

https://www.fda.gov/guide-inspections-low-acid-canned-

7. Layout of Cannery

Space Requirement:

1. Canning building must be constructed such that sufficient space is there to carryout different operations.
2. Sufficient space is required to install different machineries and equipments. Plan first and then construct. Avoid overcrowding of machineries and personnel's. For this, a through knowledge of the process flow sheet or flow diagrams for the different canning operations for the different types of packs is essential. Then, the machineries can be placed without any dislocation of work.
3. Sufficient room is required to install the boiler and storeroom is required to keep the finished product.
4. For installation of extra equipment used to prepare specialty products, adequate space need to the allotted.
5. Length of the cannery should be twice its width. Then, there is proper placement of machineries.

Division of Space:

Space should be proportionate to the requirement of each canning operations. Raw material treatment and cooking process should be carried out in a separate room. If no such partition is there, they should be at the opposite end of the same room. Otherwise, the hot environment will affect the quality of the raw material. The requirement of space will depend upon the type of operation

For eg,

d. Hand filling requires more space than machine filling.
e. Vacuum sealing requires less space than an exhaust box installed to create partial vacuum.
f. Incorporate frozen and cold storage facilities, in large canneries.
g. Boiler should be installed 50 feet away from the main building to prevent hazard or install in a separate room.
h. Provide adequate space for storage of finished products.

Type of construction:

Cannery must be single storeyed or easy installation of conveyors or automatic systems. Also, it prevent break in the flow of materials. Also, floors may sag, when machineries are installed in upper floor.

Floor:

a. Should be a concrete floor.
b. Should be water proof
c. Should not very smooth and polished
d. Should be sufficiently strengthened in places where machineries are installed
e. Provide adequate slope ¼” to 1’ in the floor.
f. Should have a central drainage.
g. No part of the floor should be more than 15 feet away from the center drain.
h. Use wooden trolleys, in places where the workers have to stand continuously for hours.

Wall:

a. Construction of walls, partitions and ceilings should be very smooth and coated with washable light colored paints.
b. Wall to wall and wall to floor functions should be smooth.

Ceilings and ventilations and lighting:

1. Ceiling should be very high and made up of reinforced cement concrete (RCC) roof than steel trusses or asbestos roofing. In former, there is less fire hazard and better sanitation
2. For best ventilation, saw tooth type ceiling is best.
3. Sky light arrangements can be made to give maximum available daylight.
4. Provide blowers fans and exhaust fans to provide good ventilation by circulation of air. This is essential particularly in warm and humid condition.

5. Good ventilation and lighting is essential to prevent growth of moulds in overhead structures.
6. Provide more windows preferably big and screened.
7. Provide fly proof or insect proof to doors and windows.
8. Use curtain of air at high speed to prevent entry of flies or insects.
9. Good lighting also improves the morale of the employers.

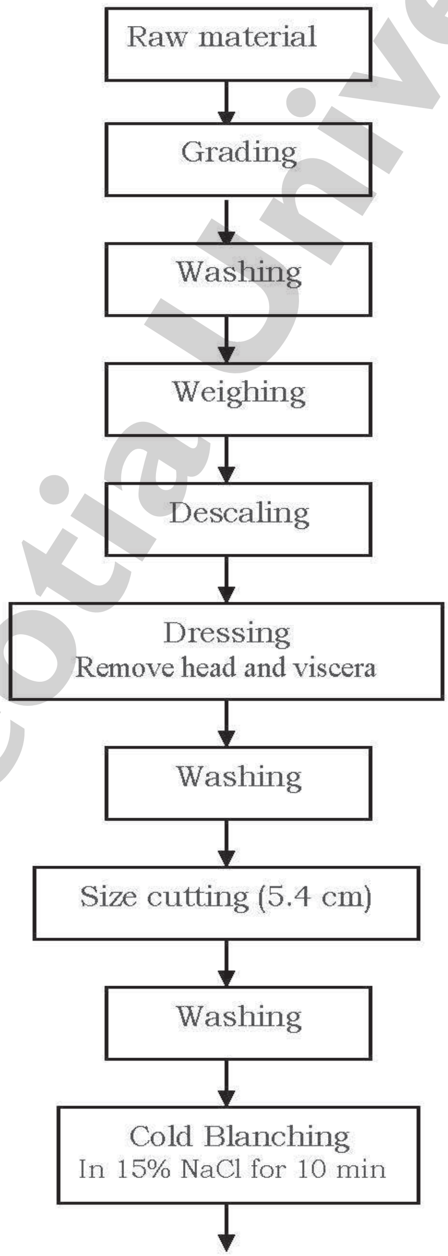
Draw the layout of a cannery

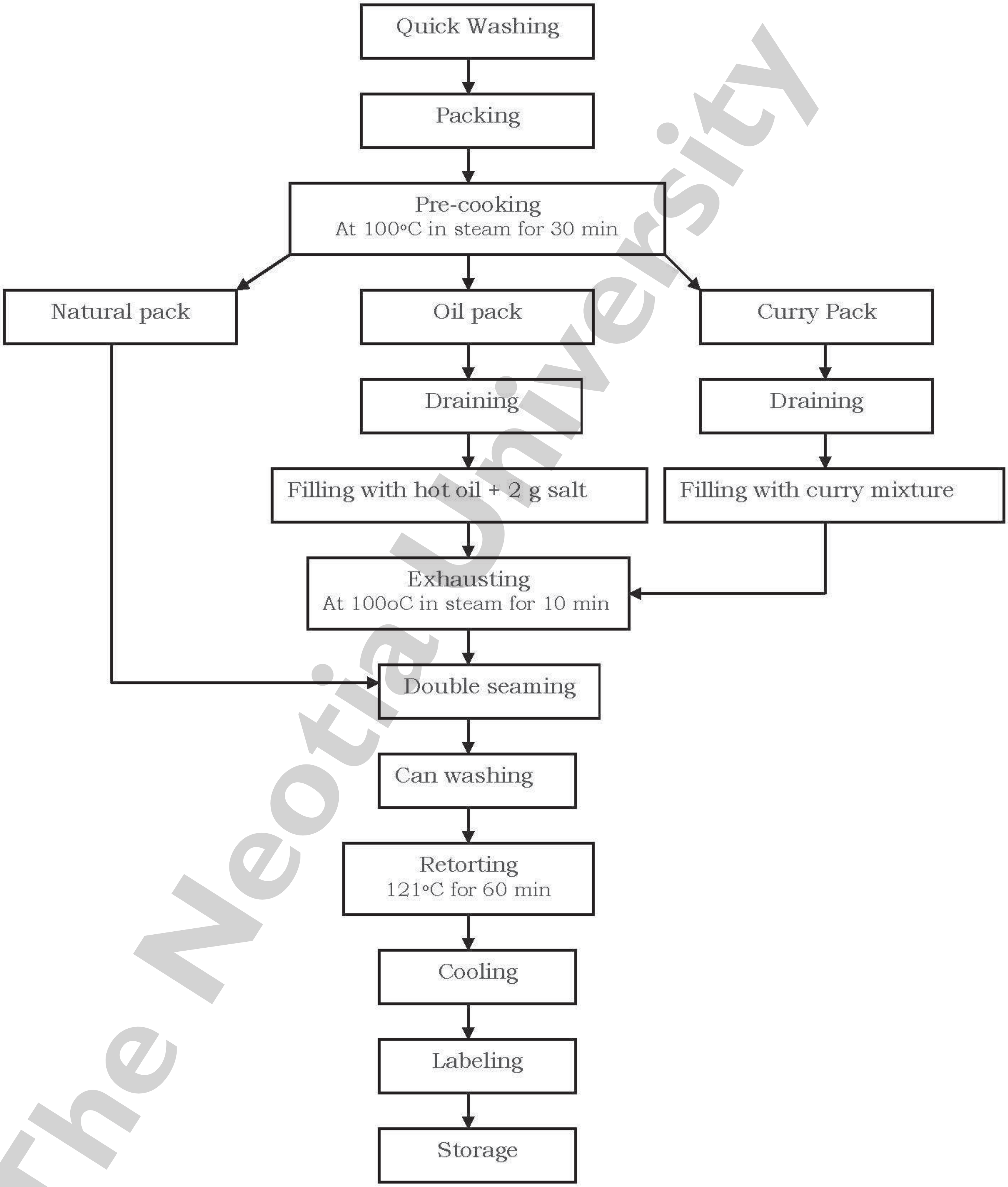
https://www.youtube.com/watch?v=9jiispK7yVw

8. Canning of sardines

Product code	:	SA 1 or SA 3 – Sardines in oil
		SA N – Sardines natural pack
		SA M – Sardines in curry/ masala pack
Standard net weight	:	190 g
Standard solid weight	:	70% of water holding capacity (WHC)

Flow chart:




Quick Washing
Packing
Pre-cooking
At 100°C in steam for 30 min
Natural pack
Oil pack
Curry Pack
Draining
Draining
Filling with hot oil + 2 g salt
Filling with curry mixture
Exhausting
At 100oC in steam for 10 min
Double seaming
Can washing
Retorting
121°C for 60 min
Cooling
Labeling
Storage

Recipe for curry preparation:

Sl. No.	INGREDIENTS	
1.	Chilli powder	50g
2.	Turmeric powder	1g
3.	Coriander powder	50g
4.	Pepper powder	10g
5.	Garlic	-
6.	Onion	1kg
7.	Tamarind	50g
8.	Tomato	250g
9.	Table salt	As required
10.	Refined oil	1/2l
11.	Water for grinding	As required

Method of curry preparation:

Fry spices in refined oil and grind them. Chop onions and garlic into small pieces, grind them into a slurry (not very fine). Prepare tomato pulp using a mixer. Soak tamarind in water and prepare the extract. Mix all into a paste and add the paste to refined oil and simmer the mixture for 10-15 min. If the curry became too thick, dilute it with tomato sauce/ juice.

Observations:

Weight of raw material :

Dressed weight :

Dressing yield $= \frac{\text{Dressed weight}}{\text{Weight of raw material}} \times 100$

=

=

Canning yield $= \frac{\text{Pack weight x No. of cans}}{\text{Weight of raw material}} \times 100$

=

=

Yield rate $= \frac{\text{weight of raw material}}{\text{No.of cans}} \times 48$

=

=

1. **Natural pack:**

Weight of raw materials	:
Cost of raw material	:
Cost of Ingredients	: -
Miscellaneous cost	: -
No. of cans	:
Cost of can	:
Canning Yield	: -
Yield Rate	: -
Cost of production	:
Cost per can	:

2. Oil pack:

Cost of raw material	:
Cost of raw material	:
Cost of Ingredients	:
Miscellaneous cost	: -
No. of cans	:
Cost of can	:
Dressing Yield	:
Canning Yield	:
Yield Rate	:

Cost of production	:	
Cost per can	:	

2. **Curry pack:**

Weight of raw material	:	
Cost of raw material	:	
Cost of Ingredients	:	
Miscellaneous cost	:	-
No. of cans	:	
Cost of can	:	
Dressing Yield	:	
Canning Yield	:	
Yield Rate	:	
Cost of production	:	
Cost per can	:	

https://www.youtube.com/watch?v=7plI3An_jts

9. Canning of tuna

Product code : TU1 or TU3

Product Name : Tuna in oil

Standard solid weight : 70% of water holding capacity (WHC)

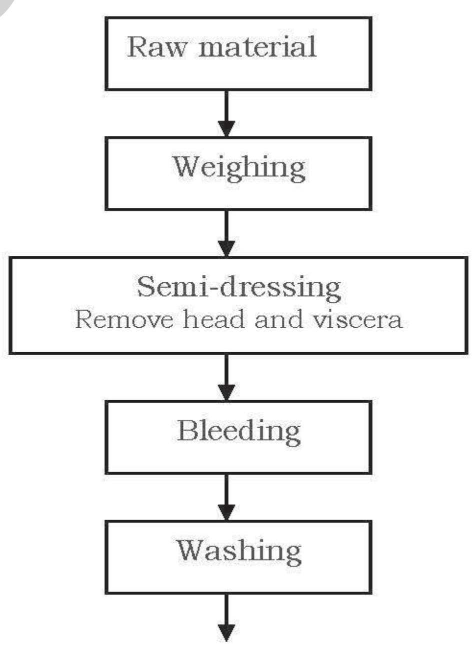
Grades of tuna:

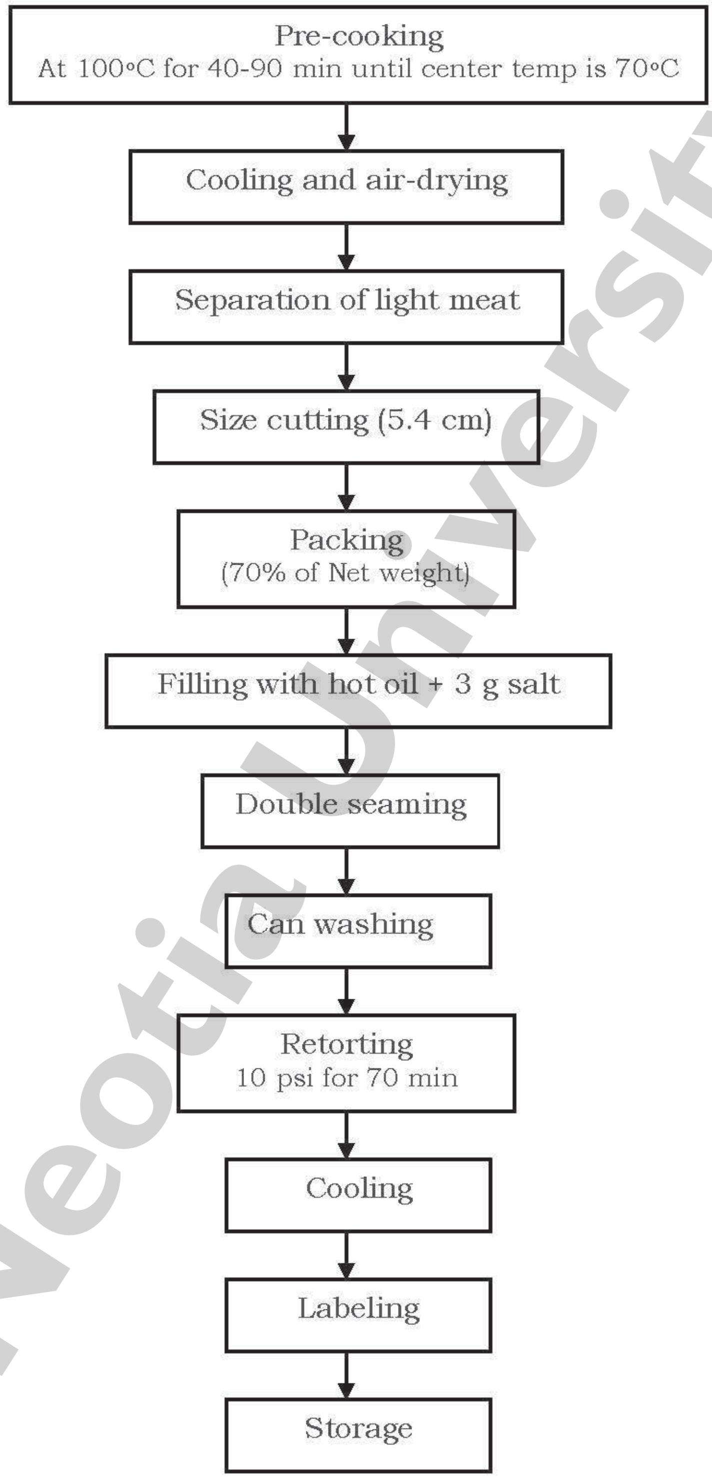
1. Fancy pack : Large pieces of solid meat packed without any fragments
2. Flakes : Small fragments packed in cans
3. Standard pack : Solid meat and fragments. Each pack contain 3 pieces of solid meat and remaining part of net weight is constituted by flakes

Specialty packs:

1. Tonno pack: Solid tuna meat packed in olive oil. Double quantity of salt added. Usually prepared from skipjack and also from blue fin tuna.
2. Creamed tuna: Cooked light meat are cut into cubes and filled into containers with cream sauce
3. Ventresca : Belly strips of large blue fin tuna cut into pieces without removing skin, cooked in boiling brine and after cooking, a single piece is packed with olive oil.
4. Garlic flavoured tuna: Pack of fancy yellow fin tuna with enough garlic added to give the meat a piquant but not obstructive flavour.

Flow chart:




Pre-cooking
At 100°C for 40-90 min until center temp is 70°C
Cooling and air-drying
Separation of light meat
Size cutting (5.4 cm)
Packing
(70% of Net weight)
Filling with hot oil + 3 g salt
Double seaming
Can washing
Retorting
10 psi for 70 min
Cooling
Labeling
Storage

Observations:

Weight of raw material :

Dressed weight :

Dressing yield :

Cost of raw material :

Cost of Ingredients :

Miscellaneous cost : -

No. of cans :

Cost of can :

Dressing Yield :

Canning Yield :

Yield Rate :

Cost of production :

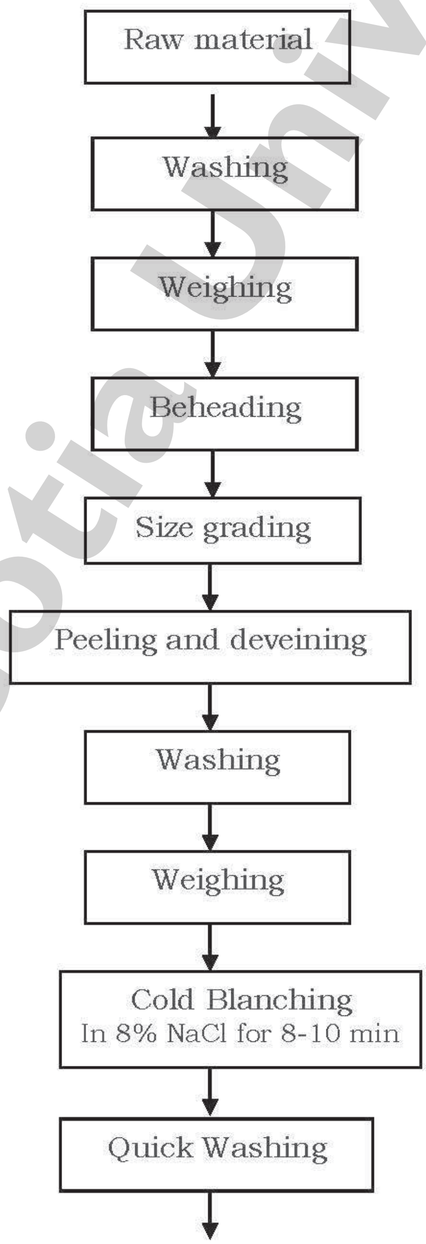
Cost per can :

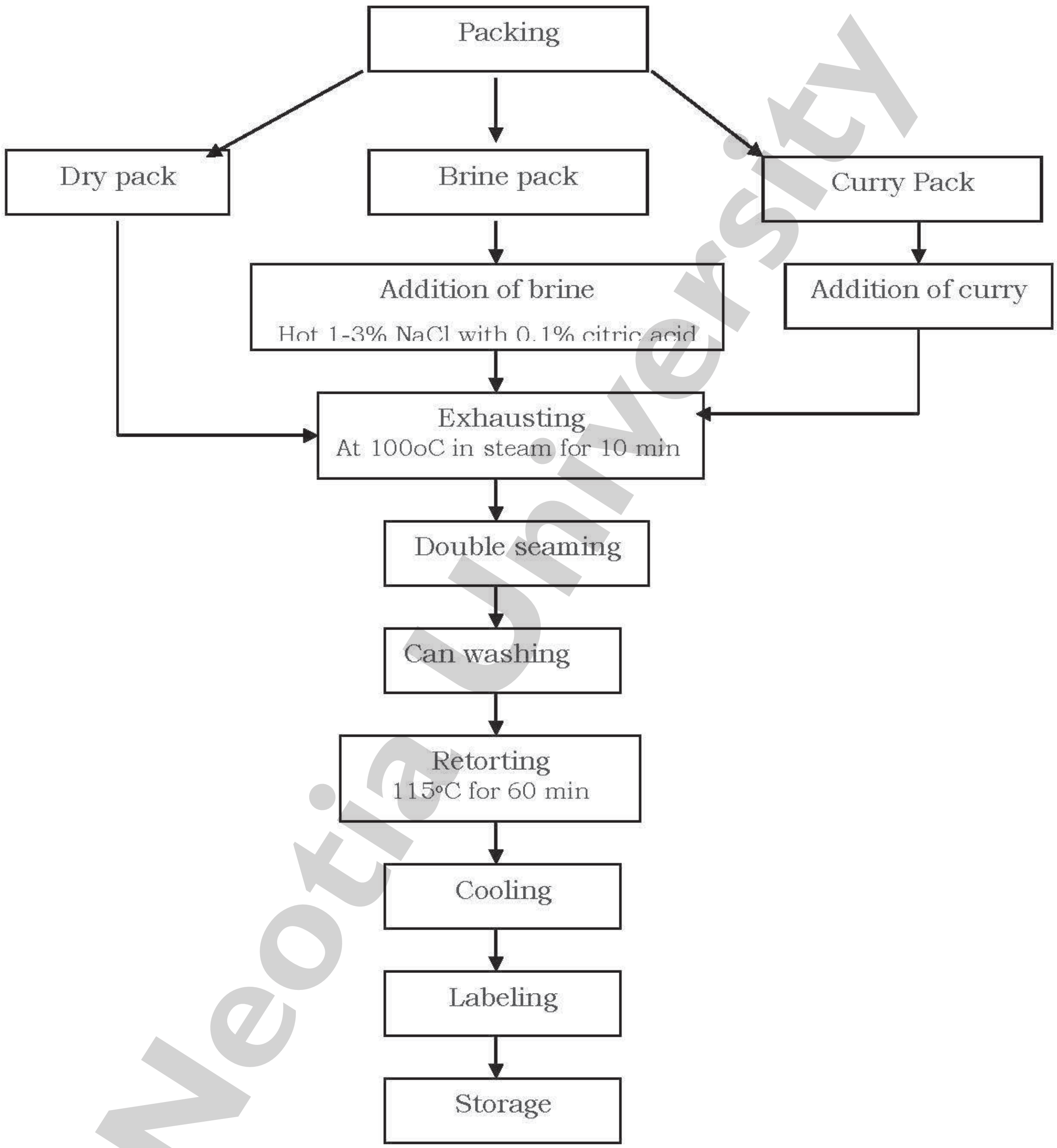
https://www.youtube.com/watch?v=luGivpgSEEQ

10. Canning of Shrimps

Product code	:	SR L – Shrimps in brine
		SR D – Shrimps Dry pack
		SR 7 – Shrimps in curry
Standard net weight	:	190 g
Standard solid weight	:	65% of water holding capacity (WHC)

Flowchart:





Recipe for curry preparation:

Sl. No.	INGREDIENTS	%
1.	Chilli powder	
2.	Turmeric powder	
3.	Coriander powder	
4.	Pepper powder	
5.	Garlic	
6.	Onion	
7.	Tamarind	
8.	Tomato	

9.	Table salt	
10.	Refined oil	
11.	Water for grinding	

Method of curry preparation:

Fry spices in refined oil and grind them. Chop onions and garlic into small pieces, grind them into a slurry (not very fine). Prepare tomato pulp using a mixer. Soak tamarind in water and prepare the extract. Mix all into a paste and add the paste to refined oil and simmer the mixture for 10-15 min. If the curry became too thick, dilute it with tomato sauce/ juice.

Dry Pack: The blanched meat are wrapped in parchment paper and canned without brine.

Observations:

Weight of raw material :

Dressed weight :

1. Dry pack:

Cost of raw material :

Cost of Ingredients :

Miscellaneous cost : -

No. of cans :

Cost of can :

Dressing Yield :

Canning Yield :

Yield Rate :

Cost of production :

Cost per can :

2. Brine pack:

Cost of raw material :

Cost of Ingredients	:	
Miscellaneous cost	:	
No. of cans	:	
Cost of can	:	
Dressing Yield	:	
Canning Yield	:	
Yield Rate	:	
Cost of production	:	
Cost per can	:	

3. Curry pack:

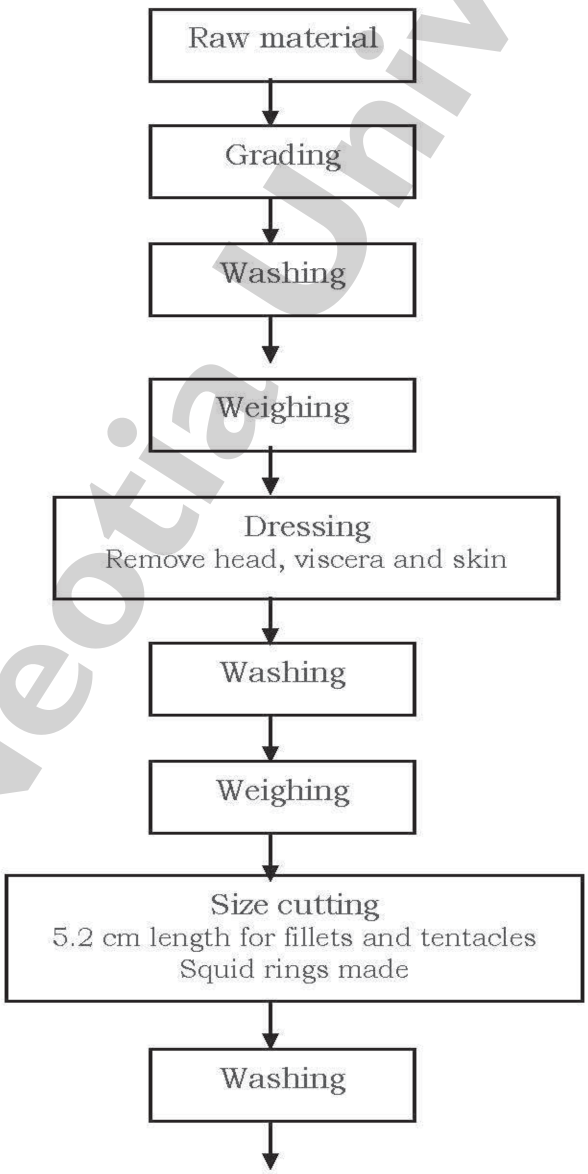
Cost of raw material	:	
Cost of Ingredients	:	
Miscellaneous cost	:	
No. of cans	:	
Cost of can	:	
Dressing Yield	:	
Canning Yield	:	
Yield Rate	:	
Cost of production	:	
Cost per can	:	

https://www.youtube.com/watch?v=ZBctF

11. Canning of squid and cuttlefish

Product code	:	SQR 1 - Squid rings in oil
		CFF 1 – Cuttlefish fillet in oil
		SQT 1 - Squid tentacles in oil
Standard net weight	:	190 g
Pack weight	:	65% of WHC

Flow chart:



Hot blanching
In 5% NaCl for 6-10 min

↓

Packing

↓

Filling additives
Hot oil

↓

Seaming

↓

Heat processing
At 115°C for 40 min

↓

Cooling

↓

Labeling

↓

Storage

Observations:

Weight of raw material :

Dressed weight :

Fillets :

Rings :

Tentacles :

Cost of raw material :

Cost of Ingredients :

Miscellaneous cost :

No. of cans :

Cost of can :

Dressing Yield :

Canning Yield :

Yield Rate :

Cost of production :

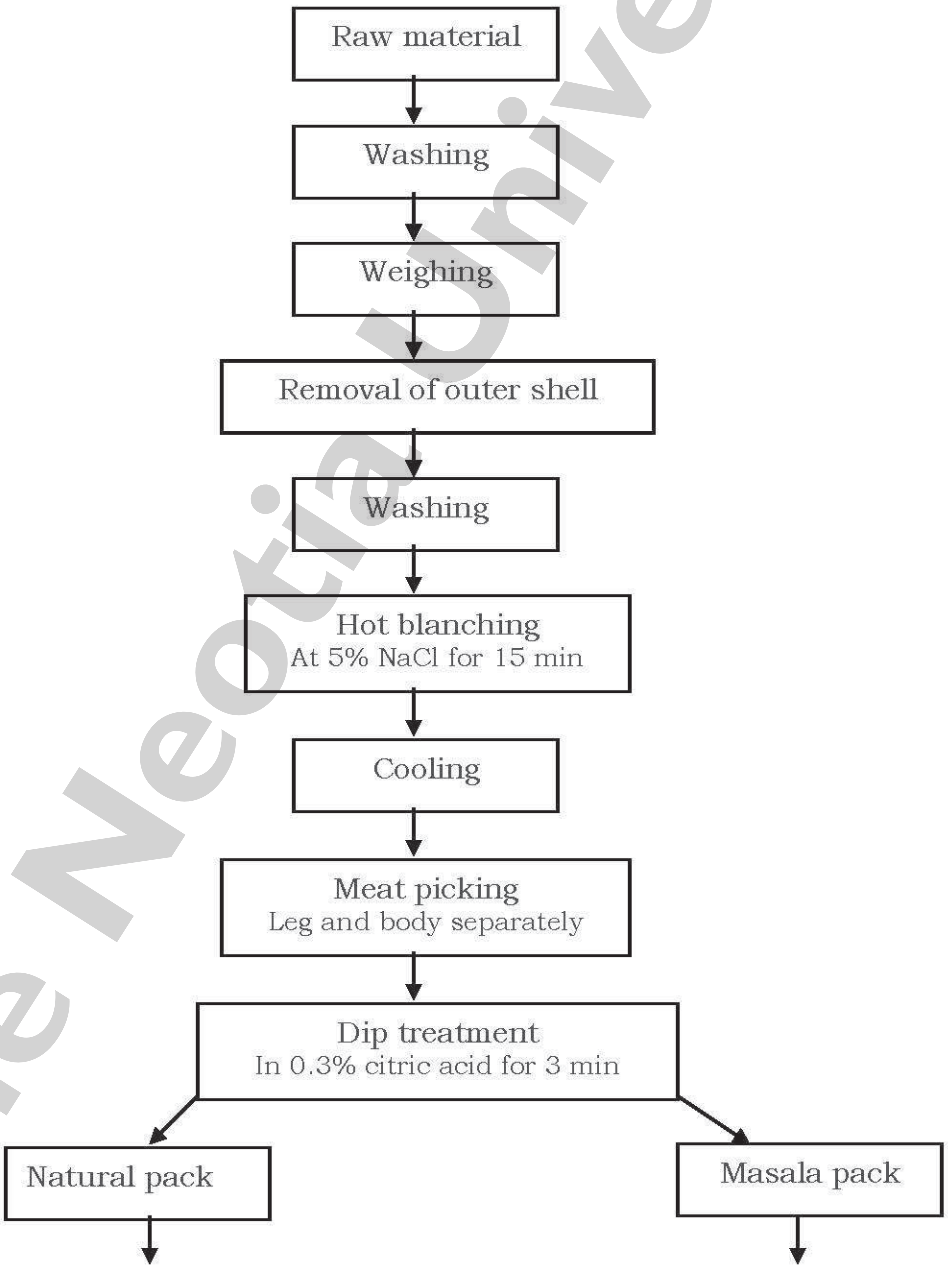
Cost per can :

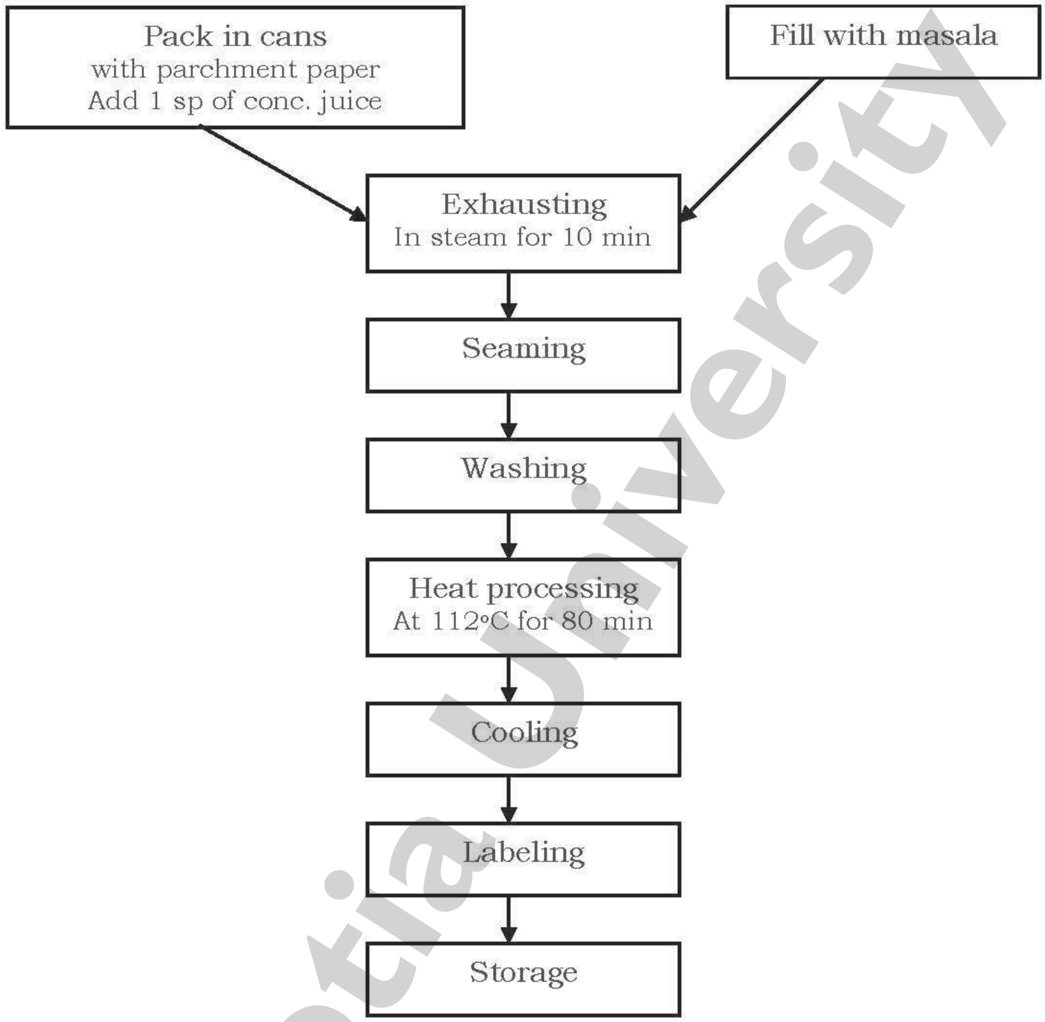
https://www.youtube.com/watch?v=-1jZAeCCzSk

12. Canning of Crab meat

Product code	:	CBN Natural pack
		CBM Masala pack
Standard net weight	:	190 g
Pack weight	:	65% of standard net weight (125g)

Flow chart:





Recipe for curry preparation:

Sl. No.	INGREDIENTS	%
1.	Onion	1 kg
2.	Tomato	250g
3.	Chilli powder	50 g
4.	Pepper powder	10 g
5.	Cumin	10 g
6.	Turmeric powder	1 g
7.	Tamarind	50.0
8.	Table salt	As required
9.	Refined oil	1/2l

Observations:

Weight of raw material :

Dressed weight :

Cost of raw material : $\dfrac{\text{Dressed weight}}{\text{Weight of raw material}} \times 100$

Cost of Ingredients :

Miscellaneous cost : -

No. of cans :

Cost of can :

Weight of leg meat :

Weight of body meat :

Dressing Yield :

Canning Yield : $\dfrac{\text{Pack weight x No of cans}}{\text{Weight of raw material}} \times 100$

=

Yield Rate : $\dfrac{\text{Wt of raw material}}{\text{No.of cans}} \times 48$

=

Body meat

No of cans :

Cost of cans :

Cost of production :

Cost per can :

Leg meat

No of cans :

Cost of cans :

Cost of production :

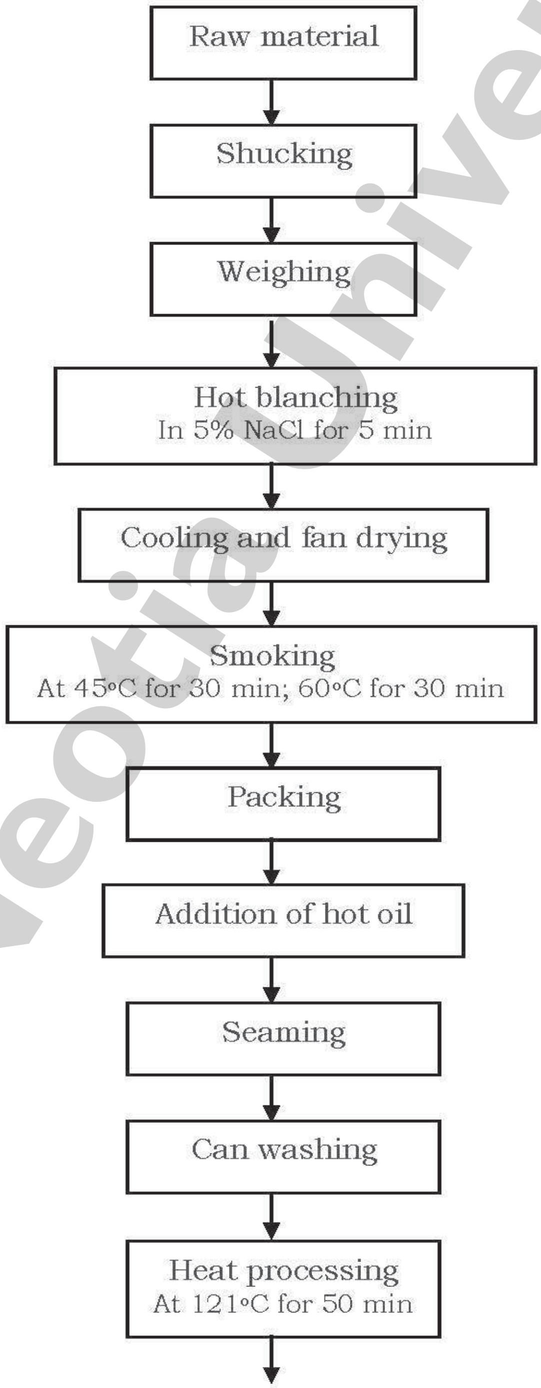
Cost per can :

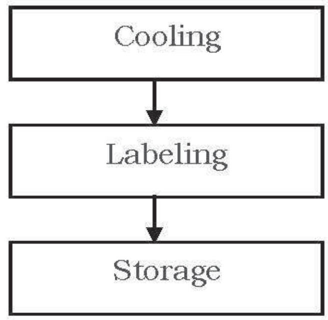
https://www.youtube.com/watch?v=87nH0xlxp00

13. Canning of smoked oysters in oil

Product code	:	OYS 1 – Smoked oyster in oil
Standard net weight	:	185 g
Pack weight	:	65% of WHC

Flow chart:





Observations:

Weight of raw material :

Dressed weight :

Cost of raw material :

Cost of Ingredients :

Miscellaneous cost :

No. of cans :

Cost of can :

Dressing Yield :

Canning Yield :

Yield Rate :

Cost of production :

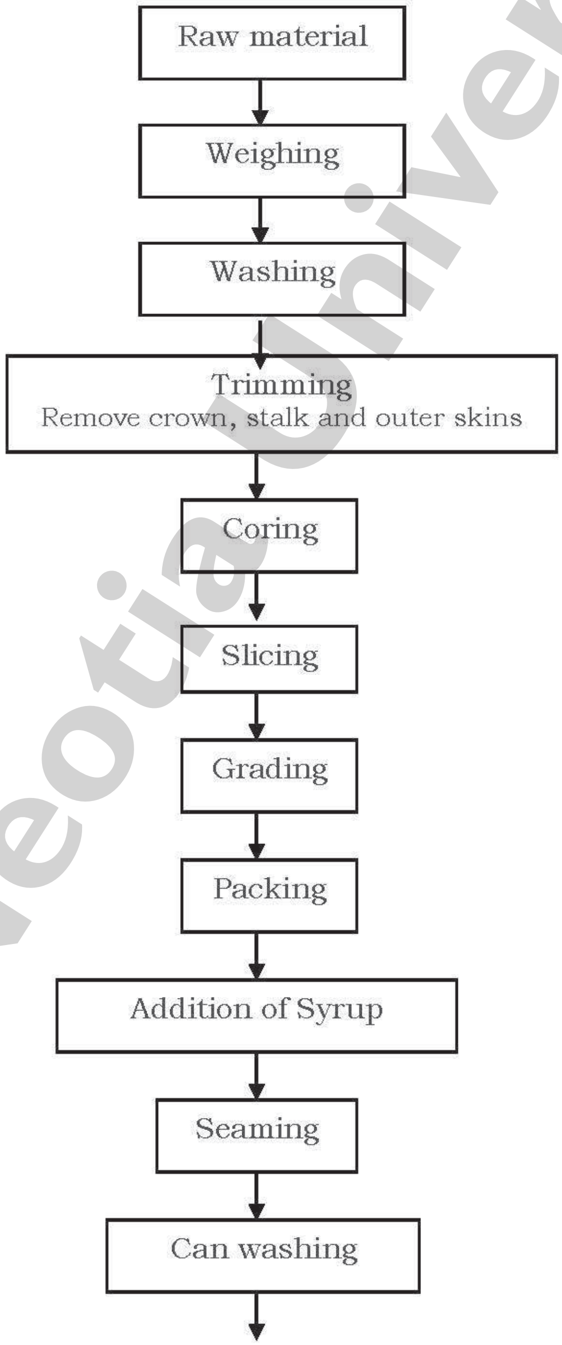
Cost per can :

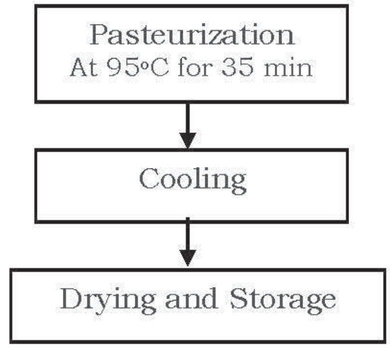
https://www.youtube.com/watch?v=RYcXwJTqk8A

14. Canning of pineapple in sugar syrup

Product code	:	RPY
Standard net weight	:	185 g
Pack weight	:	55% of WHC

Flow chart:





Observations:

Weight of raw material :

Dressed weight :

Cost of raw material :

Cost of Ingredients :

Miscellaneous cost : -

No. of cans :

Cost of can :

Dressing Yield :

Canning Yield : $\frac{\text{Pack wt x no of cans}}{\text{Cost of raw materials}} \times 100$
=

Yield Rate : $\frac{\text{wt of raw materials}}{\text{No of cans}} \times 48$

Cost of production :

Cost per can :

https://www.youtube.com/watch?v=qX1OpXpyy

15. Cut-Out test for canned fishery products

Cut-out test or can opening test is done to evaluate the general quality of canned food. In this test, the condition of the food contents, the external and internal conditions of the can and other characteristics of the products are examined. Assessment of the quality of canned fishery products is made by the organoleptic, physical, chemical and bacteriological evaluation.. Among these, physical and organoleptic evaluations of canned products are comparatively easy, fast and conclusive.

In organoleptic evaluation, the products are rated or graded according to their quality by a panel of judges. The judges should be well trained and must possess good experience in judging similar products and must be able to distinguish even the slightest defects. Products are graded into different classes or grades according to certain agreed categories, which are usually numbered.. The simplest one only two classes, which is acceptable and non-acceptable.

Generally accepted grades of the product:

I Numerical grades : Grade 1, 2, 3 ……….

II Lettered grades : Grade A, B, C……….

III Descriptive grades : Fancy standard (Good, Fair, Poor….)

Descriptive	Letter	Numerical Scoring
Excellent	A	9-10
Good	B	7-8
Fair	C	5-6
Poor	D	3-4
Very poor	E	1-2

The attributes to be tested vary from item to item .From the consumer point of view some attributes may be given more weightage than others. For overall score, panelists cannot judge a product as a whole at a time. Hence, the significant attributes of a product should be divided and each attribute should be judged independently and scores or grades are allotted accordingly. Always a numerical system of scoring is better when more judges are employed in a panel.

Aim:

To examine the physical and organoleptic quality parameters of canned fishery products.

Materials Required:

1. Canned foods
2. Physical balance
3. Vacuum gauge
4. Can opener
5. Scale
6. pH – paper (near neutral range)

Procedure:

- If the cans are labeled, note the particulars on the label.
- Observe the external condition of the cans, such as rusting, dents, seam defects etc.
- Test the tone and get an idea of the fill and vacuum.
- Determine the gross weight
- Measure the vacuum
- Cut the lid almost completely, open and observe the food surface and inside of the lid.
- Measure head-space
- Drain the contents for 5 minutes and collect the liquid in a measuring jar
- Note the volume, turbidity, color etc., of the drained liquid. Also note the volume of exudates and oil in oil pack.
- Note the weight of can + solids
- Transfer the solid to a white enamel dish and examine. Note the numbers of pieces, breakage, color, texture, flavour etc. Also look for foreign matter.

- Observe the bottom and inside of the can, look for settled curds, skin adhesion, lacquer peeling, blackening etc.
- Wash, dry and weigh the empty can

The physical parameters or characteristics are entered in the proforma given below:

Can Opening Test

Name of the Product: Code Mark:

Type and Size of Container:

Date of Examination: Examined By:

Particulars	Container Number			
	1	2	3	4
Appearance of the Can: External Internal				
Standard Nett weight (g)				
Standard solid weight(g)				
Gross weight (g)				
Vacuum (mm of Hg)				
Head space (mm)				
Fill-sufficient/insufficient				
Pack style				
Solid + can weight (g)				
Empty can weight (g)				
Solid weight (g)				
Liquid weight (g) vol. (ml)				
Drained weight (as % of water capacity of cans)				
Exudate v/v (as % of drained liquid)				

Number of pieces.... Broken of flakes				
Firm and wholesome				
Turbidity of the fill				
pH				
Curd formation				
Adhesion (of pieces along container)				

The organoleptic evaluation of can contents are entered using the proforma given below:

Sl. No	**Characteristics**	**Sample**			
		1	**2**	**3**	**4**
1	Appearance				
2	Color				
3	Odor				
4	Taste				
5	Texture				
6	Overall quality				
7	Remarks				

The average of the scores will indicate the overall quality. Under the remarks column indicate whether the product shows any rancid flavour or discoloration or any other description about the taste texture and appearance. The intensity of rancid flavour or any other off flavour or discoloration will be indicated as – (absent) + (very slight) ++ (slight) +++ (strong).

https://www.fda.gov/food/laboratory-methods-food/bam-chapter-21a-

16. Study of Heat penetration in canned foods

Aim:

To determine the rate of heat penetration in canned foods and to draw the 'Heating- cooling' curves.

Introduction:

The data of heat penetration at the slowest heating point in canned foods are used in the scientific evaluation of thermal processes and also in formulating sterilization processes for new products. The experiment, when conducted on low acid canned foods processed in retorts under pressure, requires special equipments. But in the case of fruit cans it can be simplified by the use of thermometers inserted into canned foods, heated in water. The method described in the experiments is a simple one, though subject to certain errors.

Material & Equipments:

1. Canned fruits (Mango slices or pineapple slices in syrup) with top lid containing holes.
2. Thermometer inserted tightly through one-holder stopper.
3. Kettle or vessel for processing
4. Additional thermometer and a stop-watch
5. Section paper and materials for drawing graphs.

Procedure:

1. Fix the thermometer in such a manner that the bulb is near or slightly below the geometric center of the can and embedded in a fruit slice. Make the stopper airtight.
2. Keep the water in the kettle boiling or at any steady temperature used for processing (86^{0} C or 90^{0}C) by adjusting the flame.
3. Dip the can so that it is completely under water, in a vertical position, with the thermometer stem out of water.

4. Keep the other thermometer in the water of the kettle.
5. Start the stop-watch as soon as the can is immersed, having noted the initial temperature (at 0 time).
6. Give the intended thermal process (say 15 min. at 90^{0}C) and go on noting the temperatures indicated at the point of greatest heat lag in the can, at intervals of every minute.
7. Quickly take out the can and immerse it in another vessel with cooling water, at the end of the process. Continue noting temperature during the cooling phase also. This may be stopped when the thermometer indicates a temperature of 40^{0}C or less.

Observations:

Tabulate the observations in the following proforma

Time (Min.)	**Temp. of water in kettle ^{0}C**	**Temp. at can center ^{0}C**
Heating		
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
Cooling		

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15		

Draw the 'Heating – Cooling curve' taking time horizontally and temperatures vertically. See for how many minutes the curve is above the 60ºC line.

Note:

1. The curve should be at least 9 min above the 60ºC line for products with pH 4.3 or below.
2. The experiments may be repeated with rotating cans.

https://inspection.canada.ca/food-safety-for-industry/packing-food/heat-penetration-studies/eng/1510068585993/1510068586390

17. Microbial examination of canned foods

The incidence of spoilage in canned foods is low, but when it occurs it is important to know how to proceed with an investigation. During the spoilage, cans progress from normal to flipper, to springer, to soft swell and to hard swell. Microbial spoilage and hydrogen produced by the interaction of acids in food products with the metal of the can are the principal causes of swelling. Some microorganisms do not produce gas and cause no abnormal appearance of the can, but cause spoilage of the product.

Microbial spoilage is caused by leakage or under processing. Before concluding the cause, a lot of factors have to be studied and thoroughly examined so as to have high degree of reliability on the results.

Eight tube technique is one of the commonly employed techniques for microbial examination of canned foods, which can give a good idea about the type of organisms responsible for spoilage.

Generally, a large number of cans should be examined bacteriologically to obtain reliable results. When the cause of spoilage is clear, culturing 4-6 cans may be adequate. Unspoiled cans may be examined bacteriologically to determine the presence of viable but dormant organisms, in which case the procedure is the same except that the number of cans must be more.

A. Equipments and materials required:

1. Incubators, thermostatically controlled at 37ºC and 55ºC
2. pH meter
3. Microscope, slides etc.
4. Sterile can opener
5. Sterile petridishes, test tubes, pipettes etc.
6. Soap water, brush and sterile towels
7. Indelible ink marking pen
8. Examination pans, balance etc.

B. Media and reagents:

1. Glucose tryptone broth
2. PE-2 broth or thioglycollate broth
3. Crystal violet or gram stain
4. 4% iodine in 70% alcohol

Glucose tryptone broth

Tryptone	-	10 g
Glucose	-	5 g
BCP	-	0.04 g
Water	-	1 L
pH	-	6.8-7.0

PE-2 Medium

Peas make an excellent base for the cultivation of all types of spore forming bacteria. They are used either whole or ground along with the following ingredients

Yeast extract	-	3 g
Peptone	-	2 g
BCP (1%)	-	4 mL
Water	-	1 L

C. Can preparation

1. Remove labels, mark suitable on the side of the cans with a marking pen.
2. Separate all cans to be listed by code numbers and record the size of the container, code, product, the condition, evidence of leakage, pinholes or rusting, dents, buckling or other abnormality.
3. Classify each can according to degree of spoilage signs lije flipper, swell, etc.
4. Examination of can contents
   a. Analyze the springer and swells immediately.
   b. Place normal cans including flipper in the incubator of 37^{o}C and examine at frequent intervals for 14 days. When cans become increasingly swollen make note of it and when swelling no longer

progresses or the can become a hard swell examine the contents. When thermophilic spoilage is suspected or when the cans will be held at high temperature in storage or at transit the cans have to be incubated at 55°C.

3. *Opening of can:*

a. Open the can in an environment as sterile as possible.
b. Chill hard swells in the refrigerator before opening.
c. To sanitize use 4% iodine in 70% alcohol and wipe off with a towel (do not flame). For cans other than hard swell, scrub the entire uncoded end of the can with a brush using warm water and soap. Rinse and dry.
d. Flame the end thoroughly or flood with iodine-alcohol solution and burn it off.
e. Sterilize the can openers by flaming.
f. When swollen can is punctured, hold the mouth of a sterile test tune at the site of puncture using forceps to capture some of the escaping gas. Flip the mouth of the tube to the flame of the Bunsen burner – a slight explosion indicated the presence of hydrogen. Immediately turn the tube up right and pour in a small amount of lime water. A white precipitate indicates CO_2.
g. Make an opening large enough to permit removal of sample.

4. *Removal of material for listing and culture examination:*

a. Remove large portions from the center of the can using wide mouthed pipettes or spatula in case of solid pieces.
b. Aseptically transfer the contents (1-2 ml of product) into 4 tubes of PE-2 medium and 4 tubes of glucose tryptone broth and incubate as follows:

Medium	No. of tubes	Temperature (°C)	Time of Incubation (days)
PE-2	2	37°C	4 – 5
PE-2	2	55°C	1 – 3
GTB	2	37°C	4 – 5
GTB	2	55°C	1 – 3

Note:

Stratify PE-2 medium tunes with sterile paraffin or 2% agar. Pasteurization can be done to one complete set of tunes which would give an idea as to whether the organism are spore formers or not.

FLOW CHART

Sample from the can

Glucose tryptone broth — Aerobic
- Pasteurized: $37^{\circ}C$, $55^{\circ}C$
- Un-pasteurized: $37^{\circ}C$, $55^{\circ}C$

PE-2 broth — Anaerobic
- Pasteurized: $37^{\circ}C$, $55^{\circ}C$
- Un-pasteurized: $37^{\circ}C$, $55^{\circ}C$

This technique gives the idea about

1. Whether the organism is aerobic or anaerobic
2. Whether the organism is spore former or non-spore former
3. Whether the organism is mesophilic or thermophilic
4. Whether the organism is gas former or non gas former

Microscopic examination

a. Prepare a direct smear from the contents, air dry, heat fix and stain with methylene blue or crystal violet or gram stain.

b. Examine under the microscope and record the types of bacteria seen and estimate the total number per field.

Observations:

https://www.fda.gov/food/laboratory-methods-food/bam-chapter-21a-examination-canned-foods