Course Name: Canning Technology and Value Addition in Seafood
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Canning Technology and Value Addition- Canning process - Part 2

Hello everyone, welcome to the fourth session of Seafood Canning Technology. In the previous sessions for understanding of this particular subject, we have divided it into three components, which is the concept, the container and the process. We have described it as a CCP. In the previous sessions, we have discussed regarding the basic concept of this technology and the last session we discussed regarding the container and in this session, we will be dealing with the process.

There are different kinds of additives that is used in the Canning technology for two purposes. One is for, as we said that liquid will assist in filling the gaps, providing a normal uniform thermal conductivity and additionally it provides, according to the filling material that we use to manage or balance the flavor of the product, it imparts a characteristic flavor, a characteristic color, etc. to the material. Different kinds of additives are used. The sardine can be used, you can see that normal thing is brine, the fish can be processed for tuna in brine is an example and tuna can be preserved in oil and different kinds of curry, gravies can be added, different kinds of tomato sauces can be added. These are the different kinds of liquid media that is used as an additive. In the case of salt that we use, we need to follow certain standards, that is the BIS standard that is available which is IS253, which is the standard that determines the quality of the edible salt that we use. Only salt that qualify that standard needs to be used for addition to the canning material. And when we are preparing brine, we need to make sure that we use the pickling salt. Pickling salt is basically normal sodium chloride without iodine. The non-iodized salt needs to be used because if you use iodized salt, when you prepare brine that after thermal processing the brine may look as a clouded liquid. That will basically deter the consumers that the product is spoiled or something like that. It may impart spoiled look to the product. To avoid that, to maintain the clear brine solution even after the thermal preservation, we need to make sure that the non-iodized salt is used for preparation of the brine.

And even in the case of oil, the particular oils need to be avoided. Different kinds of oils impart different flavor to the product. In the case of canning, we generally prefer neutral oils or oils does not carry its own characteristic flavor. Like sunflower oil, which is basically a neutral flavored oil. It can be used for oil preparation of the different kinds of canned products. And in the case of sauces that we use, normally tomato sauce is used. But the sauce also needs to have 20 to 30% lid content in it that to prepare a uniform

consistency product is available at the final. And in the case of sugar, different kinds of sugar are used. Then pectin is also used in the case of color retention in acid foods. A huge range of additives or chemical additives are there which are approved additives.

There are different codes are given. For example, sodium nitrate which is coded as E252, which is a normal preservative and color fixation agent that we use. And there is potassium nitrate is used, which is coded as E252. It is preservative at the same time it is a thickening agent in soup. And there is erythorbic acid is there E315, which is an antioxidant. There is sodium erythrobate, which is basically the synthetic isomer of vitamin C. This can be used as an antioxidant. And phosphates are used. Different kinds of phosphates such as phosphoric acid, which is coded as E338, which is an antioxidant and sequestrant, escalating agent as well. And also, there is sodium phosphate, which is coded as E339, which is al an emulsifier, humectant, sequestrant, etc. These are the various additives that is used in the case of seafood. And also, in the case of crustacean based canned products different range of chemical additives are used, especially potassium phosphates are used, which is coded as E340, which is used as an emulsifier and a humectant, etc. And there is also, calcium phosphate is generally used for similar purposes. There is magnesium phosphate, which is used as a stabilizer, thickener, etc. It is coded as E343. And there is sodium acid pyrophosphate (SAPP), which is like preventing fluoride formation. Also, we use sodium tripolyphosphate or STPP as a humectant. Humectant means basically it helps in maintaining the moisture content, protects the moisture content of the product. And there is also, different kinds of polyphosphate. E452, coded polyphosphates are added, calcium disodium is also added, E385, which is also a sequestrant or a chelating agent like EDTA can be used and there is also saccharine used as general sweetener, which is called as E954. These are the different kinds of approved chemical additives, which can be added in the canned products.

The next process is exhausting the container. Exhausting is one of the important processes in the canning and it is basically removing the air or another unwanted gas from the headspace. Different kinds of exhausting procedures are thermal exhaustion or heat exhaustion, hot filling, mechanical exhaustion and steam injection. These are the various exhausting procedures that we use. Hot filling is basically what we use is that you do not have any exhausting machinery available. We can follow the hot filling procedure. In hot filling what happens is the liquid that we are going to fill the container is in hot condition. For what happens is that the steam that is coming out from the hot liquid will eventually replace or push away the air from the headspace. When it is sealed, the steam will condense and when it is cooled, the steam will condense and create a perfect vacuum within the container. That is what hot filling is called and also steam injection is basically nothing but using steam nozzles, we are injecting steam into the headspace through the container lid. There are proper steam injecting machines are used. This particular care is

taken by the steam injection machines are there and there is vacuum seeding machines which suck the air outside the container and seal it simultaneously will seal the container and proper pressure needs to be maintained as well.

Exhausting is basically the removal of air from the container headspace. Before exhausting what happens is it is just placed on the container which is called the lidding. Single seaming is there, double seaming is there, this is also known as clinching. Before double seaming, a single seam is provided. It is called clinching. After lidding, a normal clinching is provided to the container that the next step before double seaming. The clinching is done because some kind of gap is provided within the container body and the lid material and the lid and the can body. There is a small gap that a proper exhaustion of this, like for example, if it is a vacuum sealing or heat steam injection, etc., proper exhaustion can be provided, proper gaps can be provided for that. It basically minimizing the strain on the container due to air expansion. This kind of exhausting is very important because it will minimize the strain on the container due to the internal air expansions. It removes oxygen which facilitates corrosion and oxidation. That is one of the main advantages of exhaustion procedures. Also, it creates a vacuum. On cooling, what happens is the cans become concave. Otherwise immediately after the processing stage, because of the expanded stage of the internal gases, steam, whatever it is, the cans will have a convex shape. But when it is cooled down, all the steam is going to condense and a proper vacuum is created and finally the cans need to be concave. This final concave nature of the cannons is an indication of proper exhaustion procedure. That is very important. In the case of hot filling, what happens is that a liquid is filled, it is in a hot condition, steam replaces air. It helps in heating time as well. And vacuum inside the can is generally made in 20 to 45 millimeters of mercury. That is a normal vacuum pressure that is maintained inside the container. Mechanical vacuum sealing machines are there, steam injection is selected. As we discussed, steam is blasted into the headspace. After exhausting the procedure, the immediate process that is going to follow is the can sealing of the process. The session in which we discussed regarding the container, we also told that how a perfect double seam is very important for the proper protection of the internal raw material. And if you take a cross section of a proper double seam, there is going to be five metal layers including two can body and three lid. After double seaming the can, the can needs to be properly coded so that the batch, the process, etc. can be properly identified.

Can coding is, earlier we used proper embossing machines, but what happens is that embossing machines tends to damage the container because it is basically pushing the metal, stretching the metal part. It may damage the external lacquer, internal lacquer, the tin coding of the container. now it is usually the laser coding is used or a container inject CIJ processes is used, it is called as container inject processing. And also now barcode, QR codes, etc. are applied that in the container, the metal engraving is

minimized while mostly the concentration given on the particular barcode or QR code provided. There is basically can embossing was initially prepared, then there is a container inject or CIJ is used and al laser printing is used. To read a particular can, the coding inside the can is also very important. The first letter usually determines what month it is indicated and the last two digits of the year is followed by that and al day of the month is also marked, then the facility code is marked, then the production line can is, code is marked, then the time is marked. This is the particular can code which is embossed or printed over the can surface will provide this kind of information.

After can coding, the can needs to be properly washed because after filling the container, some of the material may be over spilled after the sealing that oil, fish pieces or sauces, etc. that may be attached to the outside of the can container which needs to be removed. If it is not removed, what happens is after the processing or cooling, after the thermal processing, it may solidify and it may peel off the external metal layer as well. So that proper can washing is required. There is can washer with oil reclaimer is available and can washer with dryer is also available. Can washing is one of the important processes because cans leaving the seaming machine will have either oil, it will have brine, sauce, etc. Or pieces of fish on the surface because generally we use high speed canning machines that conditions may occur. Such cans if not washed, can may contaminate or clog the retort, either contaminate or clog the retort. These are food materials basically. If they are placed in the retort, it can result in subsequent contamination of subsequent batches also there. Then stick fish pieces could peel off external can lacquer, printing whatever was printed on the surface. It also prevents label from properly sticking on the container. That is very important. And for washing generally hot detergent solution is used. It is around 1 to 1.5% sodium polyphosphate at 80 ˚C. This is the solution that we use. And finally, hot water washer is provided to remove the detergent as well. Otherwise, the detergent will create an alkaline corrosion. After washing it with the detergent, hot water rinse needs to be done. Before processing can washer with oily cleaners are used and after processing can washer with dryers are used.

After washing the can properly, the most important process is basically thermal processing or heat sterilization. Basically, what we do is enclose food inside a container, seal it, fill it with proper filling medium, maintain proper headspace, seal it properly and then washes it properly. And then proper heat is applied and pressure. It is basically time temperature combination. For every product, proper time temperature combination needs to be standardized. We need to apply ideal temperature for ideal period of time. The time temperature combination is depending upon type of the food, the type of container, medium of heating, whether it is saturated steam, water, steam, air, mixture, etc. Also, type of the machinery that we use. The purpose of thermal processing or thermal sterilization to achieve conventional sterility. According to WHO or FAO, commercial

sterility of low acid foods is defined as follows; 'Commercial sterility means the absence of microorganisms capable of growing in the food at normal non refrigerated conditions at which the food is likely to be held during manufacture, distribution and storage'. Thermal processing basically application of heat for a particular period of time at a particular temperature. That is what we mean by time temperature combination, which depends upon the type of the food or machinery, the type of the food in which we are aiming to achieve commercial sterility. According to the commercial sterility that we need to achieve in a particular type of food, this time temperature combination is going to change. The heating medium that we use is steam. The transfer of heat is by condenser. Phase change is there. It has a good latent heat capacity is there. By condensing what happens is it generates more sensible heat. Hot water is around 500 watts/m^2°C. That may be the latent heat capacity of hot water. But in the case of steam is around 10,000 watts/m^2°C. That much difference is there using hot water and steam. Steam has much more latent capacity and it can transfer heat more successfully than liquid. Hot water and oil are examples of heat mediums that heat by lowering their own temperature. What happens is when you use hot water or hot oil, the oil basically transfers the heat to the colder body by reducing its own temperature. But in the case of steam, steam transfers the heat that it carries by condensation or phase changes. That is why the latent heat in the steam is released instantaneously. Instantaneous release of heat is there. The heat transfer is much faster in the case of steam compared to hot water or oil. Using latent heat or steam heating for heat transfer is far more effective than utilizing sensible heat or hot water or oil heating as much higher amount of energy is released in a shorter period of time.

The steam has different properties like property and advantages that steam heating is rapid that improve product quality and productivity. And also, it has a property of controlling the pressure and so, we can control the temperature. The advantage is that the temperature can be quickly and precisely established. And also, it has high heat transfer coefficient because smaller required heat transfer surface area enabling reduced initial equipment outlay. These kinds of advantages are there because of the properties of the steam.

Properly heating the can products, different kinds of machineries are used. We generally term it as retorting machinery or retort. Retorts can be classified different methodologies, different ways it can be classified based on orientation. Retort can be classified as horizontal retorts and vertical retorts. And according to the method of heat or pressure applied it can be steaming retort, water retort and air overpressure retort. And according to the movement, it can be either static retort or agitating retort. And by the process it can be either batch or continuous retorts. Retort is basically like an advanced form of normal pressure cooker that we apply. The normal pressure cooker that we apply in the kitchen for normal cooking procedure is also a kind of retort but the pressure is

limited. So, in the retort, a standard retort higher pressure can be applied. If we consider normal parts of a retort, the normal vertical retort will have a pressure gauge is going to be there, temperature indicator is going to be there, pressure regulator is there, the control panel, steam inlet. These are the basic components on a normal retort, normal vertical retort. But in the case of air overpressure retort what happens is an additional compressor is provided to provide this air overpressure. That we already told that in the case of flexible and semi-rigid containers we need to provide an additional air pressure of 5 PSI other than the normal 15 PSI that which can counteract the increase in internal pressure, expansion pressure of the container that this flexible and semi-rigid container will not burst during the process. That is why in the case of air overpressure retort we use an air compression addition to create this additional air overpressure.

A commercial air overpressure retort line will have a retort assembly. Then there will be additional boiler to provide the steam and al additional air compressor is also going to be there and there is going to be a water-cooling system for water cooling tower is going to be there to work with water inlet and outlet that the product can be cooled efficiently. Different kinds of commercial retort setups are there like vertical retorts are there, horizontal retorts are there, steam air retorts are there, then water immersion retorts are there. Water immersion retorts basically we use in the case of water immersion superheated water is used around 122˚C water is heated and that superheated water is finally used for heating the containers. The advantages of water immersion retorts are that steam is used to heat the water and then the superheated water is used to heat the container.

The advantage is that uniform heating is there and other the time is also comparatively less. Normal steam retort- only steam is there, steam air retort means the additional air overpressure is provided, mixture of steam and air is used. And also, continuous retorts are there where the containers there is a continuous lever system is applied where the containers are passed continuously without any breakage in the process that the multiple number of containers can be processed, a large number of containers can be processed given a period of time. And there are also hydrostatic continuous hydrostatic sterilizers were used where high hydrostatic pressure is used instead of steam pressure high hydrostatic pressure is used for applying particular pressure that the particular temperature can be applied. And also, agitating retorts are there and in the case of agitating retorts we use different kinds of rotation one is side over side rotation is there and also, end over end rotation is provided.

Cooling and drying are one of the stages is very important because rapid cooling has to be conducted to a temperature of 35 ˚C is very important because the presence of *Geobacillus stearothermophilu*s. Basically, it is a thermophile and is widely distributed in soil hot springs and ocean sediments and is cause of spoilage of in the food products by

producing various organic acids and no gases formed and it creates flat sour spoilage. It will grow within a temperature range of 30 to 75 ˚C but optimally at 55 ˚C. Spores of *Geobacillus stearothermophilu*s may enter a cannery in soil, on raw foods and in ingredients such as spices, sugar, soya meal, etc. Their presence in some processed containers of commercially sterile low acid foods may be considered normal and not of particular concern because although Geobacillus *stearothermophilu*s can grow at higher temperatures the spores will not develop if the product is stored at temperature below 43 ˚C. because of this presence of *Geobacillus stearothermophilu*s this cooling procedure is very important. It should be brought at a rapid cooling towards 35 ˚C to prevent the *Geobacillus stearothermophilu*s to evaporate.

What happens is that if the cooling is not done, if sufficient time is provided by cooling to reach the temperatures during that 55 to 40 ˚C which is the ideal temperature for Geobacillus spores to multiply. What happens is that it will create ultimately create in flat sour spoilage if the cooling is not rapid. The rapid cooling has to be done and also only up to 35 ˚C it is provided. The reason for cooling the canned containers only up to 35 ˚C is that one intention is that by rapid cooling the temperature is not maintained at that critical zone where the *Geobacillus stearothermophilu*s is ideal temperature zone. It is quickly passed through the zone and al sufficient heat is maintained to evaporate the remaining water. It will provide in facilitate effective drying of the material. That is also very important. Proper cooling is also important because immediately once the steam is cut off to initiate the cooling procedure internal temperature keeps on rising. If internal temperature keeps on rising it will result if rapid cooling is not followed it will result in over cooking of the product that is also very important. So, rapid cooling to 35 ˚C is usually achieved using chilled chlorinated water is used, chlorinated water up to 2 ppm is used. What happens is that chlorinated water is not used what happens is that there may be percolate microscopic pores on the seal. The part which is used for double seaming is filled with a rubber containing sealing compound that we already discussed that rubber containing sealing compound is used. Once it is heated what happens to the rubber containing sealing compound is that it will become soft and it will allow small microscopic water to enter during this particular stage. If the water used is not chlorinated, it may result in a post process spoilage because other microorganisms can enter with the water inside the container and make spoilage.

And there are also other methods like pressure cooling is used. Pressure maintained while cooling using air there is one pressure cooling when steam is cut off to prevent the can distorting due to the sudden pressure drops. Pressure cooling is another method for rapid cooling method that is used for cooling the container. And also, the final method is that can labeling and storage is very important. There are proper labeling standards available throughout the industry as determined by FSSAI and international standards national and international standards are there. Proper labeling standards needs to be

followed and the ideal temperature for can storage is around 10 to 21 degrees Celsius. And immediately after the processing the cans are basically stored up to 14 days so that any kind of a post process spoilage can be detected and therefore storage temperature of 10 to 21 ˚C is the ideal storage temperature for canned products. By this, before marketing or before transiting the products after production a period of 14 days incubation period is provided that any kind of post process spoilage can be detected and which can be corrected and which could be traced back to the process and which area the defect can be detected that the corrective action can be incorporated.

Other than heat sterilization, pasteurization also is one a heat preservation technique that we use. Pasteurization is a process in which water and certain packed and non-packed foods such as milk or fruit juice etc. treated with mild heat usually to less than 100 ˚C to eliminate pathogens and extension of life. There are different kinds of temperatures are used like any temperature that we are using above 100 ˚C is called as a thermal sterilization temperature and any temperature that we use below 100 ˚C generally termed as pasteurization temperature. Therefore, there are different kinds of pasteurization methods are there for common types of pasteurization techniques used for pasteurization milk and other liquid products. There is a low temperature long time process or LTLT process which is generally around 63 ˚C for around 30 minutes and is high temperature short time HTST process is there. It is generally 72 ˚C and it is for 15 minutes average and al there is ultra pasteurization which is 138 ˚C and for 2 seconds and is ultra heat treatment UHT treatment is there it is around 140 ˚C for 1 or 4 seconds. These are the different pasteurization techniques that we use and al in the case of different varieties of seafood are also heat sterilized the seafoods are also there and there is also pasteurized seafood is there.

Crab is one of the pasteurized normal varieties that is called blue crab. The pasteurization temperature is around 121.1 ˚C the pasteurization time is around 10 minutes then caviar the temperature is around 68.3 to 71.1 ˚C for 60 minutes there is also crab Dungeness crab is there it is around 88.9 ˚C for 90 minutes also smoked salmon is pasteurized for 85 ˚C for 90 minutes and surimi based imitation crab meat 91 ˚C for 25 minutes. These are different kinds of time temperature combination that we use for pasteurized seafood products. Pasteurization can be in general divided into two like solid food pasteurization and liquid food pasteurization. In solid food pasteurization, that is both batch pasteurizer as well as continuous pasteurizers are used. On the other hand, in the case of liquid food pasteurization usually heat exchangers are used. The heat exchangers are two types one is direct heat exchangers and indirect heat exchangers.

Batch pasteurizers are machines which can use a limited number of material and each batch, the machine has to be stopped, the container need to be opened and the batch needs

to be removed and additional batch needs to be added that is why called a batch pasteurizer and there are continuous pasteurizers where the process is continuous unlimited number of containers can be pasteurized at a time large number of batches can be continuously processed. Here, indirect heating methodology as well as direct heating methodology is used. The case of indirect heating methodology the liquid that we need to pasteurize does not come in direct contact with the heating medium which is usually the steam. There is the passage of steam and passage of the pasteurization liquid in between two different walls; which is basically the stainless-steel tubes or walls cabins stainless steel structures and through these walls only the heat is transferred from the heating medium and to the processing liquid. That is what indirect heating is all about.

In the case of direct heating, what happens is that direct steam is cold liquid is sprayed towards a continuous flow of direct steam and actually the steam and the pasteurization liquid come in contact. That is why it is called direct heating the heating medium directly comes in contact with the liquid or the food particle in the case of indirect heating it does not come in direct contact. Hence, there is a difference. In the case of direct heat exchangers, the common exchangers that we use is bubble column heat exchanger, cooling tower heat exchanger as well as spray condenser heat exchanger. In the case of indirect heat exchangers there is plate heat exchangers where the heat is transferred through the heated plates and that is called plate heat exchanger and there is also called tubular heat exchangers where the heating medium as well as the processing liquid passes through tubes stainless steel concentric tubes either it is can be through plate surfaces or tubular surfaces.

Another form of pasteurization is the aseptic packaging or tetra packing technology or otherwise it is known as ultra-high temperature short time processing which is another form of pasteurization or high temperature short time processing basically it is used for a liquid product such as milk etc. and regarding in the container session we have already discussed particular characteristic of the tetra pack that is used for UHTST process. The general principle of a common aseptic packaging system is that cartons are formed from a roll of packaging material which passes through a sterilizing bath containing a 35% solution of hydrogen peroxide at 70 to 80 ˚C and the packaging material then passes through rollers and a curtain of air at 125 ˚C which evaporates the solution and also serves to increase the rate of sterilization. The film is formed into a continuous tube sealed along the longitudinal edge and the base of carton is then formed by a transfer seal. Milk from aseptic storage tank is filled into the carton under aseptic conditions maintained by a heater and the carton is sealed by another traverse seal which also forms the base of the next carton. An appropriate cut along the traverse seal separates the carton. This is a process in which a proper seal is formed in the case of aseptic packaging. Aseptic packaging the basic concept is that both the packaging container as well as the material or the food is aseptically or sterilized at different conditions and they are packed

together under sterilized conditions. Both the product and the container merges together in a sterilized aseptic zone which is individually sterilized. Then the filling and sealing is processed and an aseptic enclosure is formed. That is why it is called an Aseptic Packaging Technology and it is also known as Tetra Packing Technology.