**Course Name: Canning Technology and Value Addition in Seafood**
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# Value addition in thermally processed foods.

Hello and welcome back to the new session of NPTEL course, Canning Technology and Value Addition of Seafoods. In the last classes, we have seen about composition and nutritional quality of seafoods. We have also seen the muscle structure in fish and the spoilages that are common to seafoods and what are the different preservation techniques in brief that can be adopted to increase the shelf life and retain the nutritional quality and thereby prevent the spoilage. In today's session, we are going to discuss about the value addition not only in the thermally processed foods but generally in generally what are the different value-added products that can be prepared. So, before we go into the value addition there are three questions one has to ask: Why value addition is important? What do you mean by value addition and how to do the value addition?

So, let's address these questions. First one is what is value addition? Value addition means adding value to something. So, why add value? By employing some processing methods, we can add value. Adding value to something means, for example, in the case of canning, what we have been learning: lot of byproducts are produced from the canning industry. These byproducts, instead of just dumping them, we can utilize them to develop some value-added products. We can utilize them to extract some value-added products, or we can convert it into some other forms that will be beneficial to human beings or to animals. So, it can be given as rather than dumping it, wasting it, we extract and we utilize it properly, and by this means, we are using the ways of reducing the waste, and which will also have less impact on the environment.

And how do we do value addition? We add specialized ingredients. Sometimes it is adding ingredients to it or you can extract a particular compound. For example, if you feel that it is rich in some one particular compound, you can extract it using a suitable method. You can also pack it, give a nice packing which will enhance the nutritional quality. For example, fish products might be lacking in one particular component and you can add some innovation, that is, you can add some other bioactive components which are extracted from other sources and which will increase the nutritional quality of the fish. That is one way of value addition. So, when you do value addition, it increases the sensory qualities but it also increases the shelf stability of the product and it makes the food product convenient, that is, you can eat it immediately. There are two types: ready to serve and ready to eat.

Ready to eat, you can eat immediately. You don't have to process it, but ready to serve it has to be processed and then served. So that is another way of value addition and why value addition is done? Nowadays, we find that consumers in a household, if you look at a home, even both the parents, they might be working, so there might be time constraints where they cannot prepare food. So, in such cases, if they get ready to serve or ready to cook food or value-added products, they don't have to cook it, they don't have to spend time on cooking, washing, cleaning, or doing some other processing techniques. So, this is one reason why we go for value addition: increased convenience to consumers so they can just take the product they can utilize it as mentioned on the label. Another reason why we go for value addition is increasing the shelf life.

If, for example, if you are pickling, you can add spices and other ingredients to it and you can increase the shelf life of the product. It can be utilized in off seasons or it can also be transported to different places where it is not available. For example, in Kerala, we have jackfruit and this is the season for jackfruit but there are times when we don't get jackfruit and if we process the jackfruit, we can utilize it later. Also, we can export it to other countries where jackfruit-loving people are there. So that is one reason why we can do value addition. Another reason is increasing the flavor diversity. So generally, there might be one or two ways of improving the flavor but if we do value addition, the flavors can be improved many times so different kinds of products can be developed. So, that is another reason and also it should be cost-effective. Eventually, purchasing power of the consumer determines the marketability or market scenario. So, if we produce a product, it has to be purchased by the consumer and it should be cost-effective for consumers to purchase. All these criteria need to be considered when we do value addition and ways of value addition.

How do we do value addition? Before we go for value addition, we have to understand the market. What is the demand from the market? What kind of products will be marketable which will be given importance? So, if you are developing a product and it cannot be marketed then it is not a value addition even though it will limit to the research level it will not go to the field. We have to develop products which will go to the market and which will be utilized by the consumers and also what are the different methods of doing value addition. One particular method of value addition is not sufficient. We have to try out different methods and see which is the most suitable one and which is more appreciated by the consumer of the market. Also, how innovative it is we cannot repeat a same method doing drying and selling it to the market. It doesn't make any change to the product is the same conventional technique that we are adopting. So, what is the innovative method you are going to add to it? What is the innovation that you are going to add? That is also very important when value addition is being done.

So, let's see different value-added products or the byproducts from the industry. We have shark fins, rays, cartilage, fish extract, fish entails and fish entails or fish extract most of

the time they go as pet foods or animal feeds. We also have non-food byproducts from the seafood industry which includes fish body oil or liver oil. We have fish glue which is highly water-resistant. Then we have fish leather. It is replacing the animal leather. We also have artificial pearls and then pharmaceutical and biochemical products, fish albumin, swim bladder, fertilizer, and fish silage.

Now let's look into products: fish oil and shark liver oil. In the previous sessions, we had seen that the liver is the main organ where the oil is or the fats are deposited, and in fatty fish muscle tissue is the main organ or main tissue where you can see the deposits of oil. These oils are rich in omega-3 fatty acids and therefore they have a lot of health benefits. The muscle tissue of the underutilized fish or the liver of the sharks can be used to extract these oils that can be consumed in different forms. In the market, we often see capsules of omega-3 fatty acids. Cod liver oil is a very common fish oil that is seen in the form of capsules, and some of the oils which are not to the consumable level can be sold for industrial purposes and as paints or mixes in lubricants. Generally, the oil content in the fish is 1 to 20%, and the liver contains around 20 to 65% of the oil. So, instead of wasting the liver or the tissues which are not utilized by the industry we can utilize these parts to extract the oils.

To extract these oils, we can go for wet rendering method. In this process, we are just cooking the product, steam cooking, and squeezing it out applying pressure. We get pressed liquor and the residue. Residue can also be called as press cake and it can be sold as feed. The pressed liquor is allowed to clarify and we get fish oil because it's less dense, it floats on the surface. The fish oil can be collected and the liquid which is collected contains high amounts of soluble fish solubles and it is called the stick water. It can be concentrated and used for other purposes. We also have a dry rendering method. In the drying rendering method, we go for solvent extraction method or use hydraulic press. It's highly expensive so often for commercial purposes when rendering method is more suitable. Once the fish oil has been separated, it contains a lot of glycerides and fatty acids, so these things need to be removed and this process is called refining.

Refining can be done by five steps. The first step is winterization, which is also called cold clearing. The name suggests that the temperature is brought down. In this process, we are bringing the temperature to 5 degrees Celsius which precipitates the glycerides so this helps in clearing it. The second step in refining is gravity settling. The oil is mixed with salts at high temperature and the temperature is raised by inducing or blowing moist steam into the oil. This allows emulsion to be formed and which settles down under gravity. Again, alkali refining is equivalent to saponification where soap formation is the main method. So, you add high amounts of alkali which interacts or reacts with the free fatty acids and soap is formed which can be removed again. Bleaching is another method which helps in decolorizing. Fuller’s earth or activated charcoal can be used and then the activated charcoal it can be washed and reused so it traps all the coloring compounds like

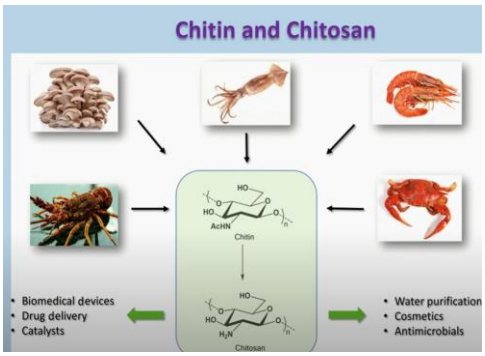
carotenoids which are present in the oil and it makes it colorless. Deodorization is the last step in refining and it includes stripping, sparging, or steam into the oil so that volatile odors are removed so these refining steps it is common for other oil extraction process also whether it is from the plant sources or other sources oil seeds so refining processes are same.

Now, liver oil, we go for direct steaming. We can also go for indirect steaming. In indirect steaming, the steam is cooked directly at high temperature which causes the rupture of cells whereas in case of indirect steaming there is no direct contact between the tissue and the steam so it is packed in a double jacketed kettle which heats up the kettle and from the cells the oil is extracted. So, in the direct steaming method, since it ruptures the cells, the oil it comes out is suspended in the solids along with the moisture and then we centrifuge it and allow the solid heavier particles to settle down on the supernatant oils are collected and these are separated out. In the case of indirect steaming method, we can go for mechanical methods also we can employ the same method as being employed in the direct steaming method. Sometimes we also go for alkali digestion here alkaline solution is added and sodium bicarbonate or sodium hydroxide is added which makes sample alkaline or it helps in extracting the oil and this is maintained at 80 to 87 degrees Celsius and then digested liquor is collected and oil is separated from this.

There is also acid digestion method. In acid digestion method, instead of alkaline or making it alkaline, we are reducing the pH, making it acidic. This is done under constant stirring so that there is no burning or charring out, and then oil is extracted after centrifugation. We can also employ enzyme alkali digestion. In the previous method, we have seen that alkali is being used. We can also use enzyme. The combination of enzyme and alkali can be used to extract the liver oil, and here in this case papain is used. Papain is active at acidic pH. So, we reduce the pH of the slurry, and the liver is ground and it is converted to slurry. The pH is reduced using HCL and then papain is added. It is allowed to digest the tissues or hydrolyze it, and then it is made alkaline using sodium carbonate. When you add sodium carbonate, the pH increases, so it becomes alkaline. In that condition, it is digested for 1 hour at 80 degrees Celsius, and oils are separated after centrifugation. So, these are the different methods of extraction from the liver.

We have fish silage, which goes into the market as feed or fertilizer, so it can be liquid or semi-solid. Fish waste products are collected, ground, and mixed, then formic acid is added. After adding formic acid, it is allowed to digest and liquefaction happens. After liquefaction, the oils are separated and the liquid or moisture content is separated by evaporation. The concentrated product obtained in the end is called fish silage, which can be sold in liquid or semi-solid form. Enzymes degrade the proteins and convert them to smaller units, which are resistant to bacterial spoilage.

The third product we commonly produce using the shell is chitin and chitosan. Commercially, we use shrimp shell, crab shells, and also find chitin and chitosan in the cell walls of fungi, although in minute amounts. The pens and the cuttlebones are also rich in chitin and chitosan, with unique structures. Because of their unique properties, they are important in biomedicine, drug delivery, wound healing, cosmetics, and water purification methods. They exhibit antimicrobial properties.




The chitin is obtained from the shell after demineralization and deproteinization, removing proteins and minerals. The material obtained is chitin, which is not soluble in water. Solubility increases by deacetylating it, and anything deacetylated above 50 becomes soluble in water. This product is called chitosan.

The next product is fish sausage. In fish sausage, the meat is taken and other ingredients are added like salt, sugar, starch (starch is a binder here), fat, and spices. These are packed in synthetic casings, sealed, boiled, and cooled. Fish sausage is a readily available source of protein and can be eaten as such or cooked. Generally, it has a shelf life of 2 weeks at room temperature, but this can be extended to 14 weeks in refrigerated conditions. Fish sausage can use fish alone or in combination with pork, beef, or chicken, though combinations with pork are more common. The protocol for preparing fish sausage involves cleaning the fish, collecting the white or red meat, grinding it, mixing it with pork fat, stuffing it into casings, thermal processing, and packing. It typically contains 2.5% salt, and value addition can be done by adding vitamin C to reduce oxidative rancidity. Commercial sausages may contain pork meat or porcine gelatin. Other types of sausages include liver sausage and blood sausage.

Advantages of converting underutilized parts into sausages include their availability as a protein source, healthiness, lack of excess oil and other ingredients, affordability, ease of processing, and versatility in using various varieties. However, disadvantages include the addition of other meats, such as pork, and fillers like starch, soy protein, carrageenan. Fish sausage lacks myoglobin, so it lacks its own pink or red color, which can be achieved by adding other meats. A major disadvantage of fish sausage is its fishy odor, which can be challenging to remove without increasing the amount of other meats. Sausages can be categorized as ready-to-eat or not ready-to-eat types. Ready-to-eat sausages are cooked or fermented and can be consumed without further processing. Not ready-to-eat sausages require cooking, boiling, or steaming before consumption.

Then, the next step by-product is fish protein concentrate, also called fish powder. It contains a very small amount of fat. Fish protein concentrate comes in three types: Type A, which is of high quality and meant for human consumption. Usually, solvents are used to remove the lipids, and it has only 0.05 to 0.75 percent lipid. As the concentration of lipid increases, the grade of fish protein decreases. Fish protein concentrate B and C have high amounts of fatty acids, making them prone to rancidity, so they are mainly for animal consumption, used as animal feed. Fish protein concentrate typically has a shelf life of three to four years and is rich in protein and lysine, along with minerals. The recommended daily intake is 35 grams. Fish protein concentrate is also used in breads and biscuits, where it may be added at five to ten percent; this addition is indicated on the nutritional label.

Another important value-added product is fish meal, derived from the underutilized parts of the fish industry. The products obtained are dried and ground, typically from underutilized fish or waste from the fish industry. Fish meal from white fish contains below 6% oil and below 4% salt. So, fish meal is sold as powder, mainly for the animal feed industry. It's given as feed, residues after removing the liquor, which is also called stick liquor. Stick liquor is rich in fish oil. The cakes are dried and powdered or stored as it is. After separating the oil, the stick water contains high amounts of fish solubles, water-soluble components. It can also be concentrated and sold in various forms. Drying of the cake can be done by direct sun drying or using mechanical dryers. If using mechanical dryers, the temperature should be maintained between 100 to 500 degrees Celsius. At higher temperatures, most of the biotic components are lost.

The next value-added product is icing glass or fish maws. In China, icing glass and fish maws are considered delicacies. They are made from the air bladders or string bladders of fish, typically discarded as waste. These are collected, cleaned, and dried. Fish maws contains 15% moisture content. It can be used for refining and converted into icing glass. To make icing glass, it is cut into small ribbons, compressed by passing it through rollers. The compressed material is then cut into small tubular structures, about 0.4 millimeters thick. These are used to develop soups and stews, considered a delicacy. Collagen in fish maws is also used in the beer industry for clarification, helping to remove suspended particles in beer. It can also be converted into water-resistant fish glue, as collagen turns into gelatin when heated, making it suitable for developing glues.

Coming to the byproducts discarded from the canning industry, they produce immense wastage in the form of heads, fins, or other gut regions. These can be used to extract oil. We can also treat them with urea. Once treated with urea, the liquid fraction can be used to extract omega-3 fatty acid esters, and the solid portion can be converted to biodiesel. These are the two byproducts that can be produced from the canning industry's waste. The biodiesel produced by this method has almost the same composition as commercial

diesel. Additionally, these waste products can be used to produce biogas by anaerobic degradation.

Other products produced from the industry include pearl essence, which is used to create artificial pearls. Pearl essence is a crystalline material containing crystalline guanine in water or organic solvent. Chemically, it is 2-amino-6-oxypyrene, a purine base, which gives a glow similar to real pearls. Beads can be coated with pearl essence to create artificial pearls.

Other products like fish pickles, gelatin, glue, fish cake, salads, flakes, wafers, bones of sharks, and other shellfish can be used to develop ornaments and other products. So, these are some of the other byproducts that can be produced from the industry. A very common evolving product is fish leather. Leather from salmons, bassa carp, or perch can be processed and converted to fish leather, similar to animal leather. Fish leather can replace animal leather and can be used to develop watch straps, belts, purses, and even shoes. These are the other set of byproducts.

Again, scientists are working on extracting enzymes from the seafood industry. Enzymes are important in living systems as they catalyze several chemical reactions. Fish, being poikilothermal animals, can adapt to cold conditions, and the enzymes are designed to survive and adapt to environmental stresses in cold conditions. Such enzymes can be extracted and utilized positively. Studies are also exploring endogenous or autolytic enzymes in seafood, which are mainly responsible for the loss of quality. However, these enzymes can be repurposed for degrading proteins in other areas. Therefore, seafood enzymes also play a very important role.

Scientists have reported that goldfish and shrimp contain high amounts of carotene, with different types of carotenes present. We also find xanthophylls like astaxanthin, which can be extracted from shrimp. Enzymes extracted from shrimp can be utilized for the synthesis of astaxanthin. Astaxanthin is known for its immunomodulating effects. Additionally, there are reports indicating that some fish can accumulate inosine. These are not converted into hypoxanthins. This is advantageous because once hypoxanthin is formed, the product becomes bitter and cannot be consumed. Accumulating inosine in the body provides an additional advantage, which can be further explored. Antioxidant enzymes present in fish vary between species. These enzymes can be extracted. Examples include cysteine protease found in dark mussel, phenolase, thiaminase, and carosinases. These enzymes can be studied in detail and sold in the market. Fish phospholipase is also involved in the synthesis of PUFA or icosanoids. Research into the biogenesis of PUFA and how it is synthesized, along with the involvement of 12 and 15 lipoxygenases in this process, is ongoing.

So, in short, scientists are now turning their attention to seafood enzymes because they have been recognized for their multiple functionalities. The merits of value addition include genuine market demand, income generation, employment opportunities in both the fishing community and other sectors of the population, and the ability to introduce innovations and develop a variety of products. Value addition also increases consumer satisfaction and allows for the design of a wide range of products. It's not necessary to limit oneself to particular products; many options can be explored, and numerous changes can be made during value addition.

However, there are some demerits to consider. Value addition is often more expensive than conventional methods, so consumer demand for such products is essential. Additionally, while non-food value-added products are acceptable because they are not consumed, ensuring quality assurance for food products is crucial. Skilled personnel are required for value addition, and the process can be time-consuming.

In conclusion, value addition presents ample opportunities for innovation and the development of new ideas and themes. If there is demand, it can create employment opportunities and generate income. Overall, value addition is an intriguing topic that can be approached with fresh ideas and research efforts. Thank you.