Course Name: Canning Technology and Value Addition in Seafood
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Additives P2

Welcome back to another session of Canning Technology and Value addition of Seafood. In the previous sessions, we were discussing about canning procedure for various seafood products. And we had discussed about step-by-step process. And we had also seen how it differs from product to product. And we had seen the pre-processing methods. And we discussed why this pre-processing is important. And what are the different tools that can be used at each step. And we were discussing about the food additives. In the last class, we stopped with preservatives and we'll continue with the preservatives.

Preservatives, they are again classified into natural preservatives and artificial preservatives. Natural preservatives, they are also called biological preservatives. And generally, consumers, they prefer natural preservatives because they are derived from living organisms. They can be plant or microbes derived. And these are generally secondary metabolites that are produced by plants or microbes as a defense mechanism. So, whenever there's an infestation or there's some threat to the plant or to the organisms, they produce a secondary metabolite to protect themselves.

And these secondary metabolites, they are considered or they are used as preservatives. They increase the shelf life of the product. And they can be categorized as antioxidants, flavorings, antibacterials. We have different types of preservatives in the food, lysozyme in egg, then saponins, flavonoids, bacteriocins from lactic acids. We also have antimicrobials, which are basically polyphenols and chitin and chitosan. This can be fungal derived or commercial purpose, we derive it from the shrimps. And these also have antimicrobial properties. We can also have conjugates or derivatives of chitosans that also exhibit a natural preservation process.

Major group of preservatives they belong to the phenolic group. And these are very strong antimicrobial agents. And basically, they have phenolic functional groups. And to this group, eugenol, thymol, carvacol, these are some of the examples of plant phenols. And basically, they interrupt with the cytoplastic membrane. And this is the way how it brings down the microbial population or kills microbes. The chemical structure, it exhibits antimicrobial or antioxidant property. If you look at the figure here, the preservatives they exhibit following properties because of their structure or the size of the molecule, they are permeable. They increase the permeability of the membrane. They may enter into the cytoplasm and lead to coagulation so that cell integrity will be lost.

And it will also act on ATPase. ATPase molecules may be arrested or they may not be available.

Then it alters the cell membrane and also disturbs the cell membrane permeability and integrity of the cell membrane. Eventually the microbes are lost or they are killed. And then it also exhibits anti quorum sensing. Anti quorum sensing is the property of microbes where they identify the population and it is a genetic mechanism by which they respond to the other microbes. So, this is also interfered when preservatives are added. But a major disadvantage of bioactive components of plants are that though they have antimicrobial property, they have to be added in higher concentration. So, it is not only the plant derived preservatives, most of the natural preservatives they have to be added in very high concentration and this may interfere with the properties of the food. It may cause undesirable changes or it may also give a flavor change or order change. That is the main disadvantage that is observed with natural preservatives.

Propolis is an insect derived preservative. It is derived, it is weak glue actually. It is derived or it is a combination of saliva and bee wax and it also contains other ingredients which are collected by the bee from the flowers and it's the part of nectar. It contains polyphenols, quinones, coumarins, steroids, amino acids and other inorganic compounds and it has a very high antimicrobial activity. It's basically a resinous product, it's natural. Chitosan is another natural food additive or it's a preservative and it's basically the deacetylated form of chitin. Chitin is commercially prepared from shrimp shell or crab shell and these are deacetylated to form chitosan and this can be changed, the structure can be changed by different modifications like chelation or alkalization which will enhance the property of these food additives.

Now, we also have artificial food preservatives. These are also called chemical preservatives and such kind of preservatives they are synthesized and these are not from the natural sources and examples are caffeine which is used as a flavoring agent also. Then we have saccharin and the very commonly used preservatives are sorbic acid and its salts. It is used in pickles or juices where you have to prevent the growth of fungus. So it's an antifungal preservative and it is used in foods which have very high pH. Next, benzoic acid and salts. Benzoates are also used and these are used as inhibitors of other microbes. It includes bacteria. These are also used in acidic foods including pickles. Then we have salicylic acid parabens and we also have sodium benzoates and these are also used in juices and these inhibit the bacterial growth and fungal growth. Together we can use both benzoic acid and sorbic acid. They can be used collectively or in conjugation with each other. The properties will be enhanced and generally this sodium benzoate it is converted to nitrogenous molecule and it is excreted through the urine as a hippurate. We also have sulphur dioxide. It is another food preservative and sulphur dioxide are used in beverage industries particularly. It is used to extend the shelf

life of wine. It is also used in the case of dried foods and potatoes and these are some of the structures of preservatives. We have benzoic acid, vanillic acid and sorbic acid here.

Another important group is antioxidants and along the antioxidants we have carotenoids, vitamins and polyphenols. You can get it from natural sources like red wine, tea, onions, spinach, eggs and plant oils. These are all rich in or they are natural sources of antioxidants. Antioxidants they interfere with free radicals basically. So, free radicals which have an odd unpaired electron in the outer electron they are highly active and they can be related easily to oxidative damage. We have reactive oxygen species and reactive nitrogen species and we also have superoxide radicals. They are generated as a part of energy generation, as a part of electron transport chain and these reactive species they cause oxidative damage and it can be prevented by enzymatic method and non-enzymatic method. In a physiological condition enzymes like catalyst, glutathione peroxidase they will help in reducing the activity of these free radicals. Also, by non-enzymatic methods by using vitamin C, vitamin E or tocopherols or carotene or there are other additives also or antioxidants. These will inhibit the action of free radicals and apart from these natural sources we can also add synthetic antioxidants like BHA, BHT, we also have ubiquinone. These are synthetic ones. There are many ways to minimize the action of free radicals and prevent oxidative damage. This can be done with the help of enzymes or it can be done without the help of enzymes. In such cases we have to go with the additives and also a mixture of additives so these antioxidants their property can be enhanced when they are mixed together. They exhibit synergistic activity and it's a better result actually. When it prevents the antioxidants, when it prevents oxidative damage, it prevents change in flavor, change in color, change in texture. It also protects the other macro components and micro components but these changes, the oxidative damage in the food, it can be related to cancer or it can be related to other health issues even cardiovascular diseases it can be correlated. When we prevent oxidative damage in food, we can have a control over such kind of diseases.

Also, in our body when we are stressed up, free radicals are produced in large amounts and this in physiology the enzymes can play a very important role in preventing or reducing the number of free radicals. Free radicals, they are a very big area and it needs lots of attention. The oxidation starts with initiation. We have product which releases the free radical and this free radical it couples with oxygen and propagates the reaction and this continues until it is terminated by another free radical. So, here antioxidants come and binds and it is terminated. So, whatever free radicals has been produced if it is allowed to bind with the antioxidant immediately, we can stop the reaction. So, that is why antioxidants are very important and antioxidants they lower the activation energy, they donate hydrogen that is they are proton donators. They hold back lipid oxidation and they also block the generation of free radicals and further they are of

different types natural and artificial antioxidants. Now these are the different artificial antioxidants we were talking about we have propyl gallate, we have BHA, BHQ.

The typical structure of antioxidants they help in preventing oxidation. So, basically what we have seen preservatives, antioxidant and nutritional additives they are the most important ones but we have other additives and we have gums, thickeners, stabilizers, asphytrins. Asphytrins are chelators they chelate the metals for example there are reactions where metals they speed up the reaction they act as catalyst. Such metals they can be trapped and made unavailable. Thickeners and asphytrins they do the same job. EDTA is generally used as a chelating agent. Then we have propellants. Propellants are inert gases which are used in whipping cream and other things. Then we have glazing agents, gelling agents, starch and other polysaccharides.

Then we have flow treatment agents. These are used for dough making. In the bakery industry we have flavor enhancers which enhances the flavor. MSG is a flavor enhancer. Then color retention, coloring agents, immersifiers, firming agents. So, these are individual types of additives that can be generally seen in the food industry. Not all food additives are good and also there's a level for using food additives. We cannot use a random level and there are dangers associated with many of these food additives. They may cause hyperactivity or attention deficit disorder in children or people who are sensitive to this kind of additives when they consume it. They may also develop allergies like rashes, vomiting, hives, then tight chest headache.

Such kind of dangers are there. Even there are some serious disorders also like gastrointestinal disorder when the saccharin is consumed it also affects heart, cause cancer and it is also tumorogenic in nature and caffeine. In small amounts, it is good for health but when it is taken in large amounts, large doses it will cause nervousness, heart palpitations, heart defects, butylates, they raise cholesterol level, impairs the liver and kidney. Then we have bromates which causes nausea and diarrhea, benzoates, it causes rashes and asthma, even it damages the brain. So, within limits it can be used but if it exceeds the limit then it may be threatening. It is important that we label it properly. So here if you see in this particular product Doritos, they have used red color. The color has been used, so it is mentioned in the label blue one, yellow five. So, the colors, whatever colors has been used, whatever ingredients has been used as an additive it needs to be labeled so that people and also here, they have mentioned that it contains milk as an ingredient. So, people who are allergic to milk, they can avoid the food products. Labeling is very important and from the additive perspective also.

Coming to the canning industry, the common additives that are generally used are salt. Salt is a class one preservative. It is used in processing and brining and it should be highly pure. It should not contain any magnesium chloride or other contaminants because it will react the magnesium, this is a contaminant and it will react with

ammonium and phosphate in the tissue to form struvite. And struvite is like the small glasses. So, when you open the can or the container, you may find on the surface some broken glass pieces might be seen. Actually, these are not harmful but these are formed in the container due to the reaction between magnesium, ammonium and phosphate. But it interferes with the acceptance of the food product.

Then we have vegetable oil which is also used in the canning process. So it is used as a covering liquid. It is used to cover the food product. And we have definite standards in codex for olive oil, virgin oil. We also have standards for other vegetable oils. You have to refer the standards to get the specifications and other things. And we cannot use vegetable oils which is from GMO crops. And also, there are specific limits for free fatty acids and peroxide value. These are directly related to the rancidity. It should be within limits.

Then tomato paste which is another covering liquid that are being generally used in case of mackerels, dine and pilchards. And these we use in tomato paste. They should contain around 28 to 30% soluble solids. That is the general range. There is tomato paste which has TSS of 30 to 32% and 36 to 38%. That is also okay. We can utilize it. But in general, we go for 28 to 30%. The standards of tomato paste is also given in this CODEX. And it mentions the viscosity, pH and count that should be there in the tomato paste. There are other ingredients like spices, which may contain allergens.

The details for this are given in directive 2389 EC. Now, this is a CODEX Alimentarius. When you go to the CODEX website or you download the general standards for food additives, you will get a PDF file like this. And it will be written as like this CODEX Alimentarius and in the bottom you will find general standards for food additives, CODEX stan 192 1995. It was adopted in 1995 and since then a lot of modifications have been done. And there you can see the revisions that have been done and the year wise revisions it is given and the different food categories are there. Nine is specifically meant for fish and fishery products. So, if you look at here it is nine is again divided into four different categories and nine point four, it deals with only the canned preserved fermented fish and fishery products and it includes mollusks crustaceans and echinoderms. Echinoderms are sea urchins or sea cucumber and you will also find the details of other types of products that can be developed from fish and other sources. Whereas, the fish-based snacks they are put under different category, they are put in 15 that is ready to eat savories.

Now broad category it is divided into fresh fish and processed products that is 9.1 is stands for fresh fish and 9.2-9.4 it is for the processed products. It includes all the aquatic vertebrates that is fish and aquatic mammals including whale. It also includes mollusks, then aquatic invertebrates like jellyfish, crustaceans and echinoderms. And even the fish products that are coated, that is glazed or spiced shrimp they are also

included in this but they will be notated as glazed or coated or surface treated products. In the category 9.1, we have subcategories also 9.1.1 and 9.1.2, this specifically deals with a freshwater fish product and under the processed fish products, we have ready to eat cooked, smoked, dried, fermented, salted products and again we have subcategories in this. You can go through this literature and 9.4, it deals only with the fermented fish products, canned fish products which includes mollusks, crustaceans and echinoderms and these products they have extended shelf life. They might be developed by steam retorting or pasteurization and they are packed in airtight containers, vacuum sealed and they ensure sterility.

Such containers or such products are categorized in this series and the details or the standards related to these products they are given under this head. If you look at the table here, this is Annexure C. Whenever we are going to add an additive, we have in a canned product in a canned seafood we have to refer to these tables. It is Annexure C, table one, table two, table three. So, these all these four tables need to be referred and also there is a table on general instructions on flavorants. All these need to be referred before we add additives and if you look at the Annexure C, we have three dash 1981 that is in 1981 it was accepted and this standard is for canned salmon and it is put under the head 9.4. Similarly, we have canned shrimps and prawns again the standard number is 37 and it is again under the same head. So, under this head we have canned shrimps or prawns canned tuna and bonito canned crab meat canned sardine and sardine like products and canned fish. Many products have not been listed under this we have standards for few products and lot of new products are being coming up. And this is an example canned tuna where we use acidity regulators, emulsifiers, gelling agents, stabilizers and thickness. We can also use flavorings and these flavorings they have to follow the guidelines given under CXG 66 2008 and so we have to refer all the tables that is table 1, table 2 and table 3 before we add additives to the product.

This is the table 1, this is how it can be seen. So acesulfame is a sweetener it is an artificial sweetener. So, it is for the category 4 that is 9.4 to the canned and fermented fish products and here you can see the amount the maximum level that is 200 ppm. It should not exceed 200 ppm and this was adopted in 2018 and under this head you can find the notes which are relevant to acesulfame. Similarly, we have for acetic acid. Table 1, it gives the information about the product and their standards and to which category it belongs and there are food products which are considered as GMP. This acetic acid, in certain food products it is considered as GMP that is we have to follow good manufacturing process. Limits are not there for such products. Then similar ones are amaranth which is also added and the levels are given here. Amaranth is a colorant and aspartame is a sweetening agent and we also have aspartame, acesulfame it is also a sweetener. Then brilliant blue is a colorant it is a synthetic colorant artificially developed and 500 ppm is the maximum level and butylated hydroxy anisole butylated hydroxy

toluene these are antioxidants and the levels are also given it is same for both. Then we have cantaxanthin, caramel, caramel 4 these are all colorants. Carmine is an insect derived colorant it is derived from the insect and it is basically carminic acid then we have carotenes derived from vegetables, carotenoids, EDTA is a chelating agent it chelates the metals, the neotame is a sweetener, phosphates these are used for holding water they help in increasing the water holding capacity. Ponceau red is again a derived colorant then riboflavin these are nutritional additives, saccharins, they are sweeteners then stevia glycoside these are natural sweeteners derived from stevia. So, you can see the levels also here.

Sucralose is another sweetener then sulfites we have sunset yellow and tartrazine. So, these are the additives that are added to canned and fermented food products. It's not necessary that everything has to be added we can selectively choose what is required and then add but it should be within the limits. And table 2 compiles everything. Here you can see this is for the category 213 which contains lard, tallow, fish oil and other animal fats it is particularly for the fats and you have antioxidants, carotenoids that is colorants and emulsifiers. The INS number is also given this is the E number 304, 305 stands for E numbering system which we had discussed in the previous class that is 304 will be specifically for ascorbyl esters. We have E numbers here then we have the year and the maximum levels that has to be maintained.

This is similarly for 9.4 which for canned and fermented food products. So, you can see here we have acesulfame it belongs to 950 E number similarly the year and the maximum level. Then this is table 3 and in table 3 there are certain additives which has not been included in table 1 and table 2 and such additives are included in table 3 and their functional properties are also given in the table 3. So, if you are going to add acetic acid, glacial acetic acid from this table you will know that it has an INS number of 260 and what it does it do? What is the functional property of the acetic acid? It can be used as a preservative and acidity regulator. Wherever we have to regulate the acidity bring down the pH we can go for acetic acid and the year it was adopted and then we have different informations on the commodity. Likewise, we can get other informations from the table 3. So we have come to the end of this session and in this session we have discussed about different additives, food additives and what are the most important additives in the food industry and what are the other different various types of food additives that also we have seen briefly and then we discussed about the additives that are being used in seafood industry particularly for canning and how codex standards are laid and how we can choose the additives by referring to the codex standards that also were discussed in the class.