Advanced Aquaculture Technology
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Lecture 52
Fish and fish products preservation (contd.)

Hello everyone, welcome to the second lecture of module 11 Aquaculture Industries. My name is Professor Gaurav Dhar Bhowmick, I am from the Department of Agriculture and Food Indian Department of IIT Kharagpur.

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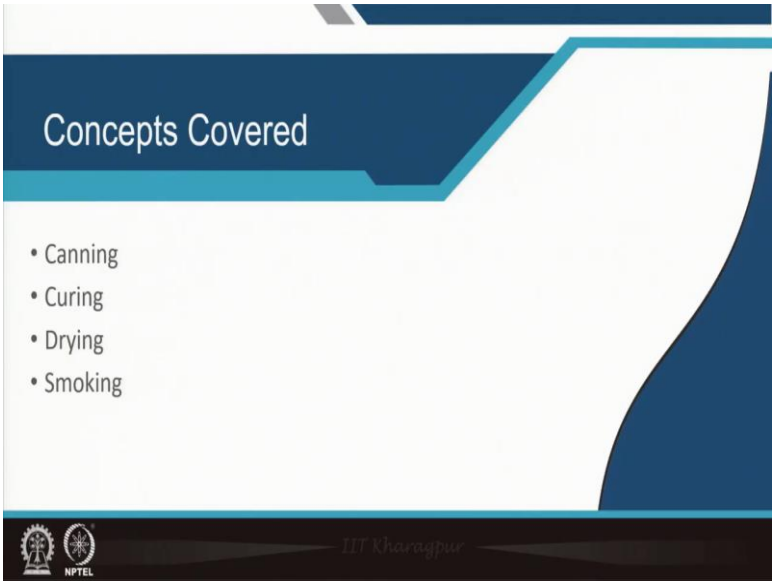

So, it is in continuation of the discussion that we had in the last lecture material. So, here we will be discussing about the canning, curing, drying and the smoking technique in fish preservation or any aquatic species preservation as an aquatic fish processing technology.

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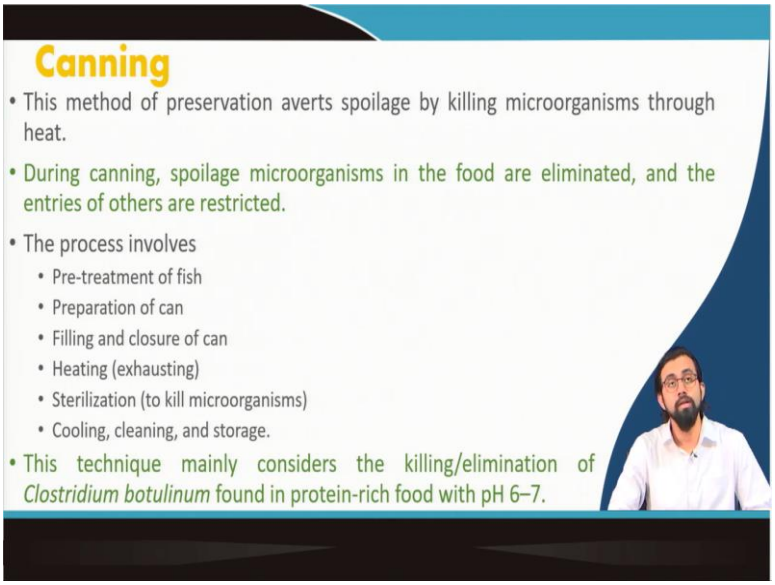

So, the first method that we will be discussing is the canning. This is actually a method by which we try to kill the microorganism, or like in order to avoid the spoilage by using the heat. In general, the canning the spoilage microorganisms like or the spoilage causing microorganisms are eliminated or even their entry is also restricted.

It involves couple of stages of treatment, first, the pretreatment of fish, second, the preparation of can, third, the filling and the closure of can, fourth is heating or exhausting and fifth is the sterilization which is one of the major-part, sterilization part where to kill the microorganisms.

So, sometimes we go for pasteurization techniques also. Anyway so this is the technique by which we can kill the microorganisms or spores forming microorganisms. Then cooling, cleaning, and proper storage. This technique mainly considers the killing or elimination of Clostridium botulinum, which is found in the protein rich foods at pH 6 to 7, it is one of the major-reason why we go for this canning technique, canning procedure.

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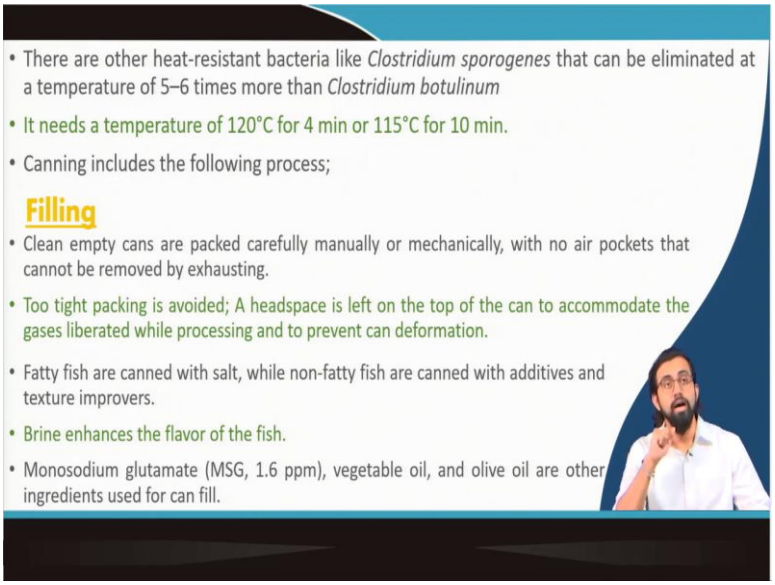

There are other heat resistant bacteria like Clostridium sporogenes that can be eliminated at a temperature of 5 to 6 times more than Clostridium botulinum. So, it needs the temperature of around 120 degrees Celsius for 4 minutes or 115 degrees Celsius for 10 minutes. It depends upon different literature different procedure anyway. So, this canning it actually involves different sub categories.

What are the categories or what are the process that it involves? First is filling. What we are going to do, we take a clean empty can we have to clean it properly first, in order to clean it you have different procedures of cleaning. Then after the cleaning is done you have to pack your product manually or mechanically.

And just to make sure that there is no air pocket that cannot be removed by exhausting, exhausting is the process by which you can take get rid of the air pocket present in the top of it, but if it is present in between, so, it is very hard for you to go ahead with the exhausting procedure, exhausting is another procedure I will discuss about it in coming slides. So, first is filling, you fill it completely in a proper staggered manner or proper stack manner depending on the type of the product that you are actually filling.

After then you have to make sure that there is no air pocket in between, perfect. Next is you have to avoid too much of a tight packaging, you have to lift some headspace, some air space has to be left or headspace has to, which we call it has to be left to accommodate the gaseous liberated while processing or to prevent the can deformation. Third is the fatty fish can be

canned with salt while non-fatty fish can be canned with the additives and the texture improvers.

Brine enhances the flavor of the fish that also you can use. And monosodium glutamate or MSG 1.6 ppm and vegetable oils or olive oils are other ingredients that can be used to fill that can. Sometimes we try to not to use this MSGs because of some industry considerations in the food industry. But anyway, so these are the some of the ingredients that can be used to fill the can, that is the first phase.

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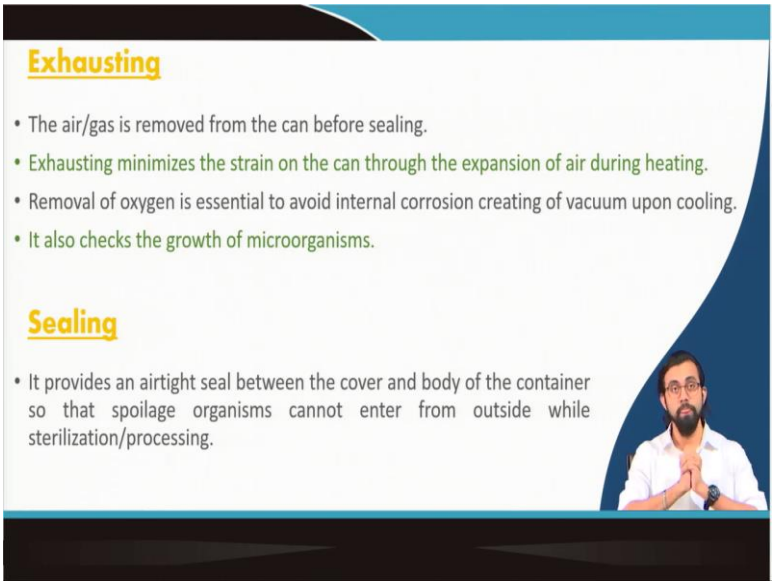

Second is called exhausting. What is exhausting? It is the process by which we can remove the gas or the air that is present in the can before sealing, before the final sealing, you seal the can. This exhausting it minimize the strain on the can through the expansion of the air through heating. It removes the oxygen which is essential to avoid any corrosion creating vacuum upon cooling.

So, that is why you need to make sure that there is no oxygen present in your system, this in your can anymore. So, we can remove it by exhausting process. And also, it can check the growth of the microorganism up to a certain level because of the unavailability of their favorable condition.

The third is the sealing, how you seal it, you have to provide it with a proper airtight seal, which can cover the top and also the body of the container so that any spoilage causing

microorganisms cannot enter through the process while stay from outside after sterilization or the processing is done.

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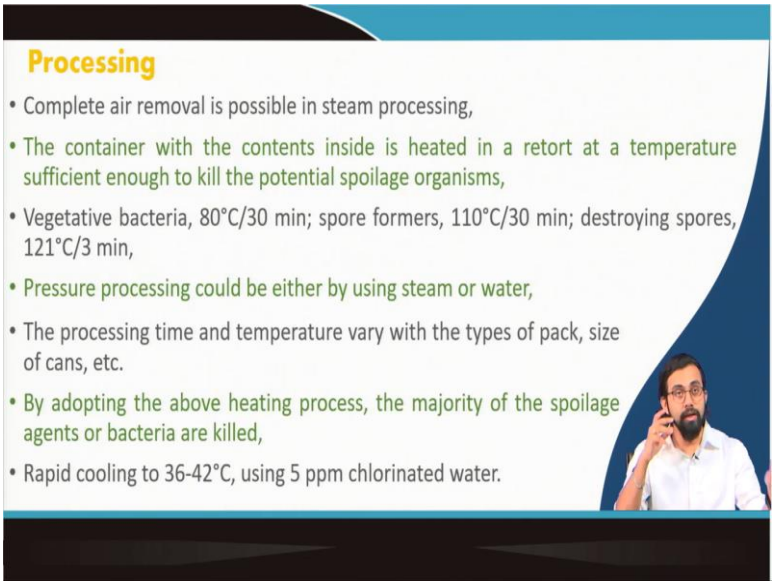

Now, the processing, how you are going to process it. Complete air removal is possible in stream processing first of all, the container with the contents inside is heated in a retort at a temperature sufficient enough to kill the potential spoilage causing microorganisms. The vegetative microorganisms like 80 degrees Celsius for 30-minute, spore formers 100 and 30 degree for 30 minutes and destroying spores you have to go for sterilization process which is 121 degrees Celsius for 3 minutes.

Pressure processing could be either be steam or water. The time and the temperature of this processing it can vary depending upon the type of the pack, size of the can, etcetera. By adapting this, all this any one of these heating procedures the majority of the spoiling agent or the microorganisms which are responsible for this kind of spoilage activity can be eliminated. Rapid cooling just after that you can go ahead with the rapid cooling with 36 to 42 degrees Celsius after using 5 ppm chlorinated water.

These are all the very standard procedures. There are a lot of in-depth analysis it involves. Definitely because of the short amount of time I cannot go and discuss in details but definitely you can find these things in the literature's and if you are interested to know more about how this packaging is done, the canning and packaging are done.

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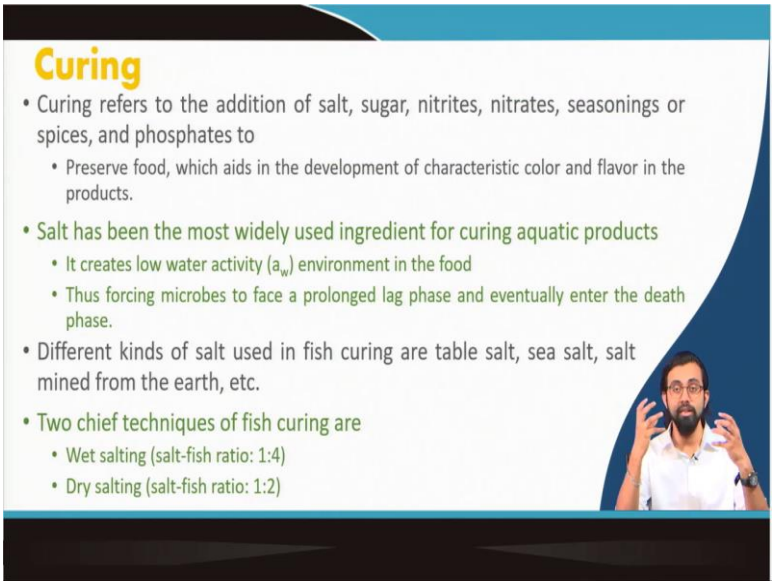

So, next procedure that we are going to learn is called the curing procedure. Curing is one of the very historic process food processing technique that people used to do it like in the 1000s of years back. How it is done? Even we name with a curing you may even understand that it is a process by which the addition of salt, sugar, nitrites or nitrates, seasonings and phosphates and the spices are done to preserve the food which aids in the development of characteristic colors or flavor to the product.

Salt actually most widely used ingredient for curing any kind of aquatic products, it creates a very low water activity environment for the food so that all the disease-causing microorganisms or all the spoiling agents cannot work on it because it has a very low water activity. And also, it forces the microbes to face a prolonged lag phase and eventually enter the death phase. What are the different types of salt that we use?

Normally, the table salt, sea salt or salt mines from the earth, etcetera. And the two major technique is wet salting and dry salting. Wet salting is where you need to provide less amount of salt actually in a salt solution so normally we call them wet salting procedure where salt to fish ratio will be 1 is to 4. In case of dry salting the amount of salt that it requires is very high, so we call them dry salting procedure. So, these two are the procedures of curing that is very famous for 1000s of like from ages.

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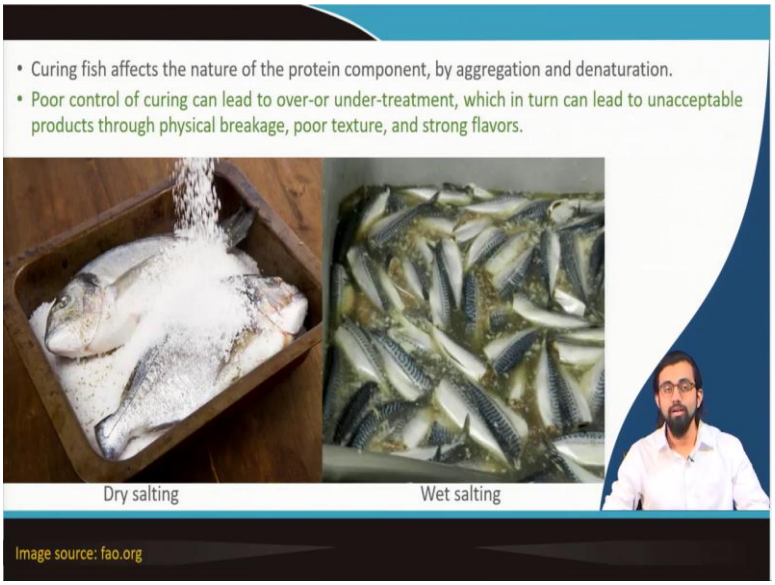

So, you may also think about and if you think like earlier days what used to do your grandma, mom like they used to do preserve the food for long when it is preserved in when you marinate it with a proper margination procedure and before that they all the time they use salt which is one of the major ingredients because it reduces the water activity and it helps to increase the shelf life of these kinds of perishable items.

So, curing what happens it actually affects the protein component, the nature of the protein component by aggregation and also by denaturation, we call them denaturation of protein is happening. The poor control of curing can lead to over or under treatment sometimes which in turn can lead to unacceptable product through physical breakage, poor texture or strong flavors.

So, sometimes with the curing if you put the salt in a very high amount or very low amount it can cause different kinds of issues which we do not want in our system so that you have to take care of, specially if you do not want your final processing stuff to be poor in texture or very strong in salty flavor.

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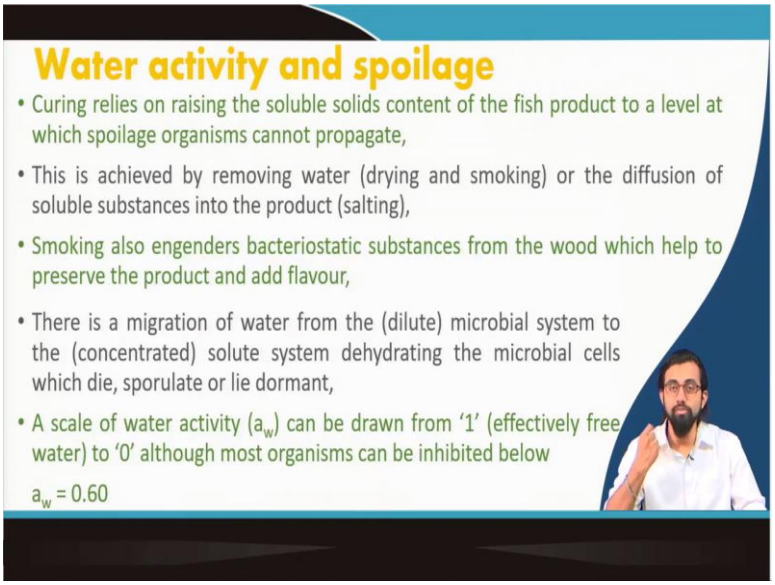

What is water activity and spoilage? In general, how curing is affecting this water activity and spoilage is discussed. Here, the curing is actually it relies on the raising in the soluble solid content of the fish product to a level that the spoilage organisms cannot propagate anymore. This is also achieved by removing the water like drying or smoking procedures or by diffusion of the soluble substances into the water by salting procedure by which we can reduce the water activity.

Smoking is also engenders the bacteriostatic substances because from the wood which helps to preserve the product and add flavor because sometimes if you realize why we go ahead with the grilling, this grilling especially if you can do it with the instinct of say like coal or something suppose you are using wood, just to give you some example in layman's language, if you use wood for when you do the smoking in the wood smoking.

So, wood has specific type of gaseous substances, which actually reduce the bacteriological activities by reducing the spoilage causing microorganisms and also it adds a certain type of flavors to your food and because of that the food is much more tasty, its texture is completely different and some people find it very tasty. So, that is called, this is called the smoking procedures and it is very famous in the European region, even in USA it is very famous in smoking of food.

There is a migration of water from the dilute microbial system to the concentrated solute system when you provide this kind of curing procedure because of that the microbial cells they become dehydrated and which actually cause them to die, sporulate or lie dormant in

nature. In the scale of water activity, normally it is like it goes from 1 where effectively free water is available for microbial contamination then to 0.

Although which means the water activity is very low and because of that there is a very low chance of microbial degradation is there in this kind of, it can be anywhere but if it is less than 0.6 only then I will say you can say that your food can be inhibited by this kind of spoilage causing microorganisms. This water activity range has to be less than 0.60.

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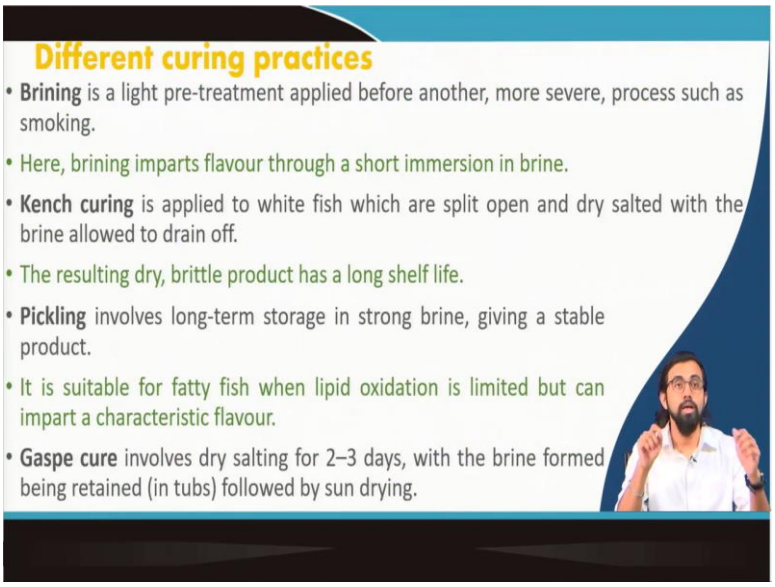

Different other curing practices like brining, brining like brine means is like a saltwater you can say which actually it is a pretreatment applied before say like smoking. So normally, we go ahead with this brining actually in order to maintain a flavor we put our product in a brine solution for a short amount of time.

Another process is called kench curing, it is applied to the white fish which then is split open and dry salted with the brine allows them to drain off the solution, so because of that there is a dry and brittle product you will get which has a very high self-life or long sell price. Another is pickling, pickling is very standard procedures for Indian context if you know we do pickling a lot and also if you go to the polar regions people do the pickling, pickling is a standard food preservation techniques, it can store you can do the pickling and it can store the food for a very long period of time.

It is actually a very strong brine which gives a very stable product. It is suitable for the fatty fish when lipid oxidation is limited but can impart a characteristic flavor. And other processes

Gaspe cure where it involves a dry salting for 2 to 3 days and the brine formed being retained followed by sun drying. This is another process of curing.

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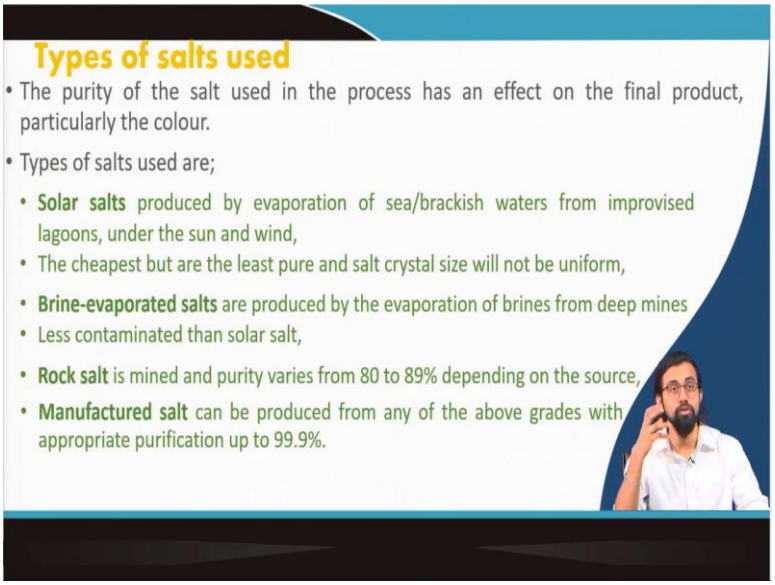

So, when we go ahead with all these processes, we use different kinds of salts in general and this is a very famous way of doing it. So, what are the types of salt that we normally use? And purity of the salt actually very important because you cannot just simply use any salt and unless until it is like manufactured on the food grade one is better not to use it actually because see, let me give you one example.

Suppose you are using the solar salt, solar salt it is produced by simply evaporation of seawater from improvised lagoons or under the sun and wind. This is the cheapest but are the least pure and salt crystal size is always uniform and it is contaminated with a hefty load of foreign materials, which are definitely I will not advise you to go ahead and have it. Then there is there Brine-evaporated salt, which is produced by evaporation of the brines from deep mines.

It is less contaminated than solar salt, but still not up to the mark for using it as a brine solution in your, I mean like for curing process for your product that you are going to consume. You can go with the rock salt, which has a purity level of around 80 to 89 percent depending on the source. You can go ahead with this provided that you ensure that the minerals that it contains are not harmful in nature.

In case of manufactured salt which can be produced from any of the above grade but with the appropriate purification up to 99.9 percentage then only you should go ahead and have that salt and they can use it you can use it for the curing process.

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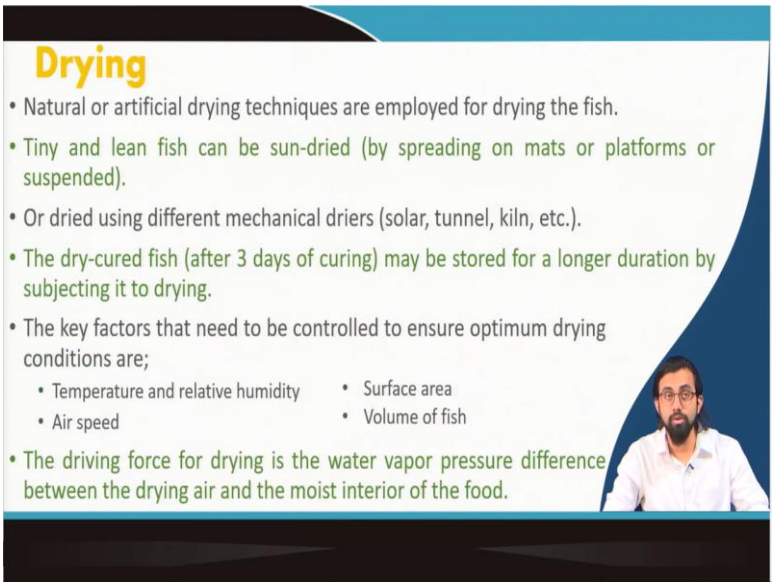

Another important processing technique is the drying where we can go ahead with the natural drying or the artificial drying somehow to get rid of the moisture content from the fish. So, tiny or the lean fish can be sun-dried by spreading on mats or platforms and or suspended condition we normally do it the process of drying, it is very famous in the developing countries, it is dried on a mechanical driers, solar dryer, tunnel dryer or kiln dryer.

There also you can do it and it is much more advanced and you can have higher production rate in a very short amount of time. The dried cured fish after say like 3 days of curing may be stored for a longer duration by subjecting it to the dry. And the key factors that actually control to ensure the optimum drying conditions are temperature, relative humidity, surface area, air speed and the volume of fish.

What do you think like why these are the conditions that makes the more difference? I am giving one simple exam, one simple physical phenomena, suppose you know about diffusion process, how you can increase the diffusion process, suppose you have a cup of hot tea how you can cool it down it, these are all the processes that are interlinked. So, how you can cool it down?

You have to first, what you can do, you can increase the surface area you can put it in a plate instead of having it from the cup, surface area will be increased more area it will get for temperature back to the air. So, for it to cooler down temperature definitely if it is 100 degrees Celsius and if it is like 50 degrees Celsius, the one which is 50 will definitely takes lesser time to get dry.

The relative humidity, if the temperature, suppose your product has a relative humidity of say like 95 percentage and outside air also the relative humidity is like 95 percentage what will happen. So, it will take less time. Whereas in case of relative humidity say like in case of air that humidity is there 40 percent is in certain place. So, in which case the drying process will be faster?

Definitely, where that humidity is 40 percentage rather than the 95 percentage because the difference is much higher there. Airspeed, the more the airspeed, that is why we blow air in a hot cup to lower it down the temperature, to lower the temperature, this is the same process you just blow the air the water that is get diffused back to the air will be much higher.

And also, the volume of the fish which will also, volume and the surface area of the fish, the more the surface area the better the diffusion rate. Another driving force for drying is the water vapor pressure difference between the drying air and moist interior of the food because that is very important, this vapor pressure difference this is one of the major characteristics for the diffusion process.

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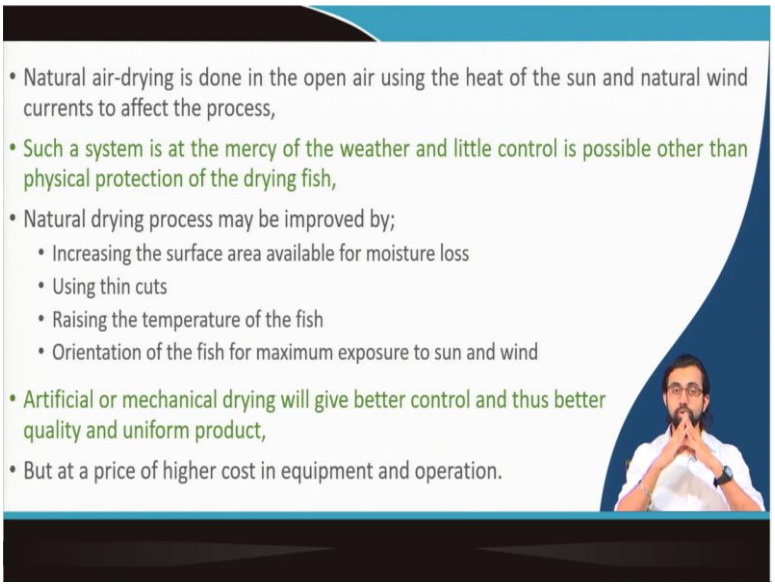

Natural air-drying is done in an open air in general using the heat of the sun and the natural wind currents that affects the process. Such a system is at the mercy of the weather and little control is possible other than physical protection of the drying fish. However, this natural drying process can be improved by utilizing certain techniques like you can increase the surface area available for the moisture loss.

You can put it in net and you can put it in an elevated ground rather than drying in a, how to say it is like a mat because only one side of its area is exposed. When it will be in your which is higher pore size not bigger than the size of your product if you hang it from somewhere what will happen it will get both the side for drying doses, the upper side will be sun dried and the lower side not only sunlight but not lower side also be utilized for wind drying process.

Also, the solar energy that is dissipated back from reaching the ground it will also create the enough area for, the higher area will be exposed for drying process. Using the thin cut, you can put a small cut, so it will, so the moisture present in the deep inside the body can also get air. Faster if the process of the drying will be much faster in this case. Raising the temperature of the fish and also orientation of the fish for maximum exposure to sun and wind.

If you have say like Bhetki which is like almost like this elliptical shape. So, you do not put it in like this, you will put it like this so that maximum area sunlight will, the heat will be effective for its maximum exposed area. Artificial or the mechanical drying will give better control and thus give better quality and uniform product. However, it comes with the high cost of equipment and operations.

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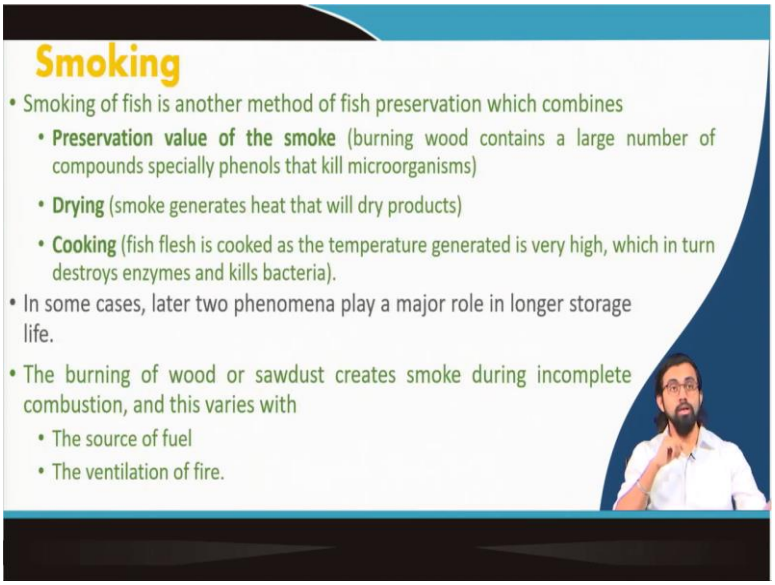

So, what are the other techniques like the smoking. Smoking, the very basic thing about smoking I already discussed like there is another method of fish product preservation, which actually combines the preservation value of the smoke like burning wood, I told you remember the burning wood it contains a large number of compounds especially phenolic compounds that can kill microorganisms, just remember this is a very important fact that why we use this burning wood.

It has this phenolic compound, vaporized phenolic compound like this compound these gases are harmful for microorganism. Second thing is the smoke generates the heat which will dry the product. And third is cooking, fish flesh is cooked as the temperature generated is very high and which in turn destroys the enzymes and kill the bacteria.

In some cases, this cooking and drying phenomenon plays a major role in longer storage life and the burning of wood or the sawdust it creates a smoke during the incomplete combustion and this varies with the sources of fuel or the ventilation of the fire the amount of air that is available for the curing procedures.

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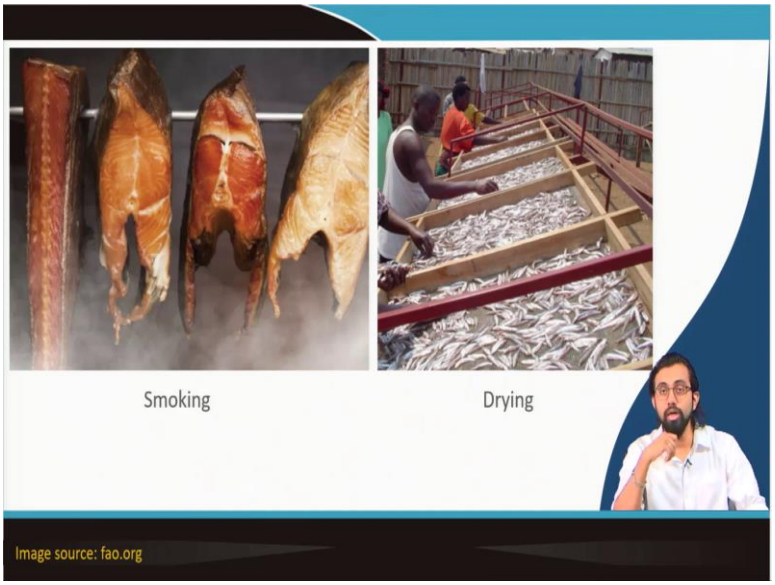

You can see the drying how it is done, in small net at the elevated ground is there for higher rate of sun drying. And so, left one this is the smoking is done, see in the temperature wood is burned for smoking of your product.

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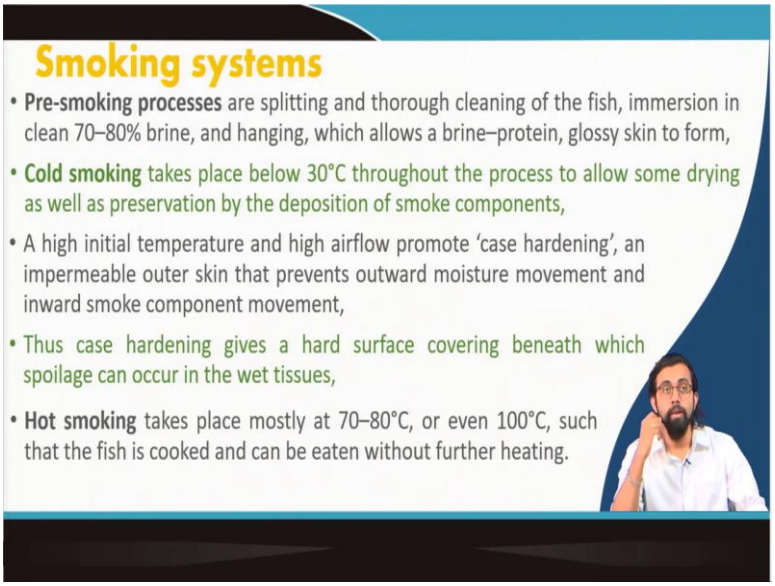

Systems like we normally go ahead with the different pre-smoking procedures. First, we do, what we do we split the, there are the different prosses, first we clean the fish then we immerse in a clean 70 to 80 percent brine and hanging and which allows a brine protein and glossy skin to form. Then we go for this cold smoking it takes like 30 degrees Celsius without the process to allow some drying as well as preservation by the deposition of the smoke compounds.

A high initial temperature and high airflow promotes case hardening and because of that an impermeable outer skin there is like normally generates and which prevents the outward moisture movement and inverse smoke component moment also. So, this kind of this case hardening gives a hard surface covering beneath which this spoilage can occur in the wet tissues. However, in case of hot smoking, this phenomenon is not, in case of hot smoking it happens in 70 to 80 percent or even at 100 degree Celsius such that the fish is cooked and can be eaten without further heating process.

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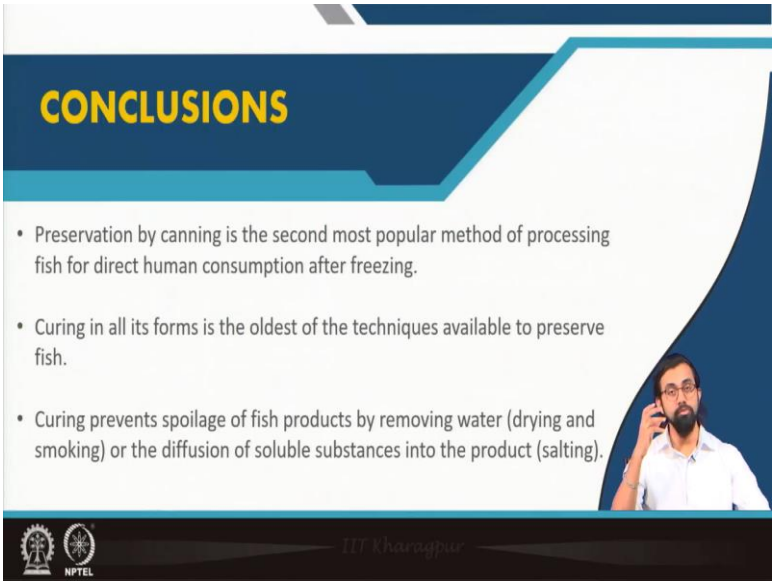

So, all these techniques all the preservation techniques that we discussed is used by canning by fisheries and aquaculture industries or fish processing industries. Out of them this canning as I told you it is one of the, like it is the second most popular method of processing fish for direct human consumption after freezing. And also curing is all like in all its forms is the oldest of the techniques available to preserve the fish.

Curing it prevents the spoilage of fish products by removing the water. How we can remove the water? By drying process or smoking process or the diffusion of soluble substances into the water product like the salting process, we use different kinds of curing agents, salts. That can also be done to reduce the spoilage of fishes from this kind of aquaculture-based industries.

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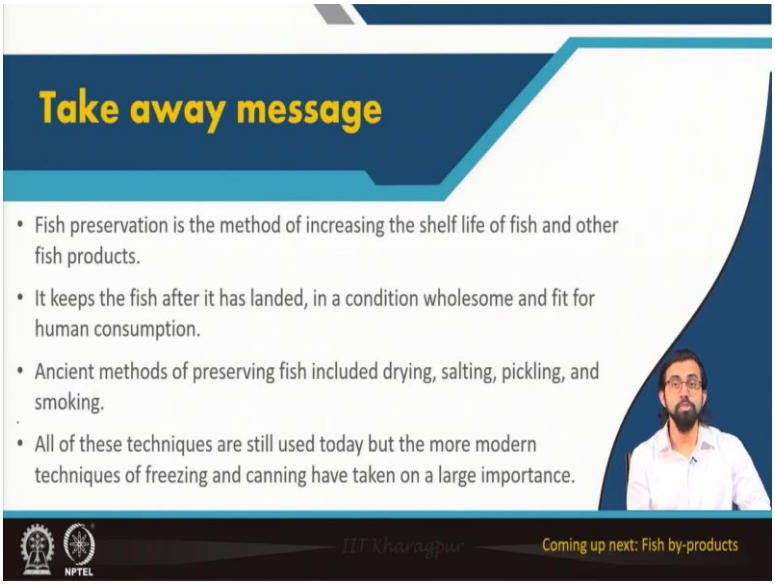

So, what are the takeaway messages, like fish preservation, it is one of the methods which can increase the self-life of fish and other fish products. It keeps the fish after it has landed in the condition in wholesome or fit for human consumption or for any further byproduct recovery. There are ancient methods of preserving which still people are using like drying, salting, pickling and smoking.

All these techniques are still used today, but more modern techniques of freezing and canning have been on the large importance right now and people are working on it and it is there like if you are interested definitely I would request you to go and study more about all these individual techniques, especially you go for what are the different freezing techniques, what are the different curing techniques that is available nowadays in the high end technical industries like where the fish processing in done in a very high rate, I mean, like in a large scale.

So, what are the techniques that they use? You just simply go and google it and you can search for different YouTube material, it will definitely help you understand these different processes much better way. I hope you get to know a lot of information from this last two lectures regarding the fish preservation techniques.

So, in the coming week, I will be discussing about different byproducts in coming two weeks, I mean, like two lecture material, I will be discussing more about the different byproducts of fish and how that can be utilized. There is nothing in the fish that we can throw away. It is not only for human consumption and then we can just throw out all the other parts.

All the other parts normally when we do it in a manual process in the normal haat or the bazaar we go what we do, we only take the flesh and we get rid of all the scales, we get rid of all the inner parts, we get rid of a lot of essential portion of the fish body, actually, I am telling you, it is really been possible for the industries, if you can make a proper industry in scientifically way if you go ahead, you can actually utilize each and every part of fish, regarding that I will be discussing in details in the coming two lecture material.

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So, these are the references that you can follow to get more knowledge about it. And I hope you will get to know some information about these processes if we define fish processing, preservation techniques. I hope you can understand more much better if you go ahead with some other literature review and would definitely be happy to help you by any means if I can to understand it better. Thank you so much. See you in the next lecture.