Thermal Operations in Food Process Engineering: Theory and Applications
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Lecture - 05
Fundamentals of Food Processing and Preservation (Contd.)

Good afternoon, so you are continuing the chemical preservation, 'right', because we said in the how many ways we can preserve. So, here also we were using chemicals and we in which we also said one generally recognized as safe chemicals which are on the GRAS, G R A S, so those we have seen. So, let us see some more, 'right' this is also under that this is the preliminary class.

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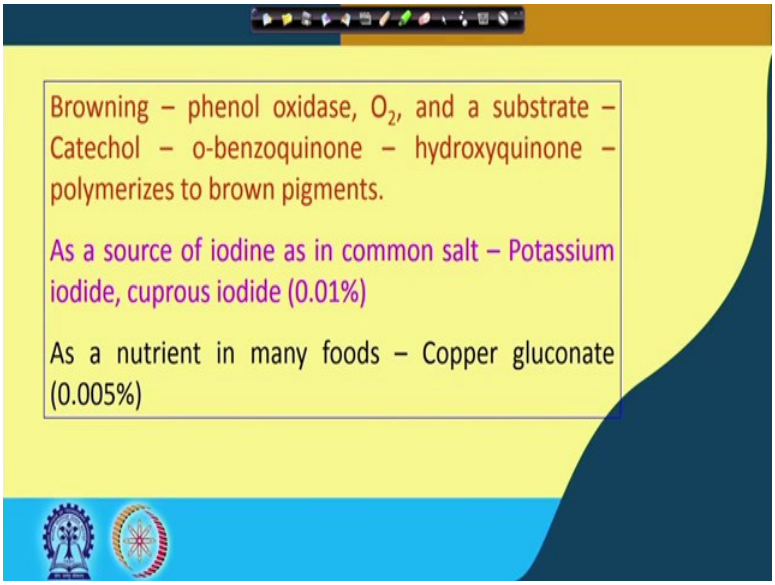

So, here something which is very much required for example, let me show all in one that browning. This browning is a typical thing which is associated also with thermal or non thermal, 'right'. It does not matter whether it is thermal or non thermal, because when it is thermal, then browning is associated with thing called your when you are heating sugar, 'right' brown color formation appears. So, that is called caramelization, 'right'.

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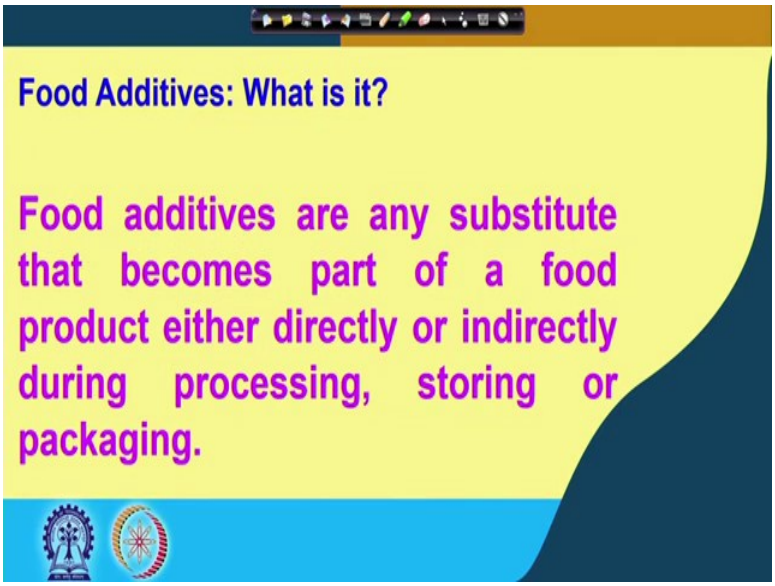

When caramelization is happening, then what we do we see that it is getting brown, but another of way of getting brown is when it is called sugar and amine they are reacting that is called maillard reaction. So, in both the cases it happens it forms browning brown color, 'right', so that is a called browning or chemical browning or reaction browning.

But there is also another type that is called oxidative browning or enzymatic browning, this enzymatic browning for example, when you cut apple, when you cut potato it gets gradually brown, so there it is called enzymatic browning, 'right'. So, these browning if you are putting phenol oxidase, which is due to an inference of oxygen and a substrate, so catechol and then ortho benzoquinone or hydroquinone or which polymerizes to brown pigments this is called enzymatic browning. As a source of iodine as in common salt, potassium iodide, cuprous iodide, 0.01 percent can be used. As a nutrient in many food materials, copper gluconate kind of the tune of 0. 005 percent can be used.

Now, it comes food additives what it is, 'right', what do you mean by food additives? Food additives are any substitute that becomes part of a food product either directly or indirectly during processing, storing or packaging, 'right'.

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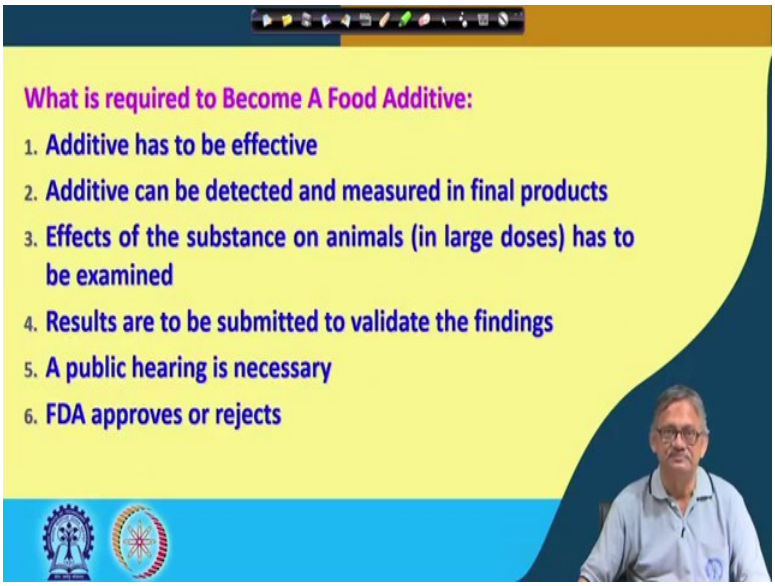

What is required to become a food additive, what you need to have? Additives has to be effective, it can be detected and measured in the final products, which you are making effects of the substance on animals for example, in large doses has to be also examined, because if you are do not give animal trial, then we cannot be sure whether it can be used for human body or not.

Results are to be submitted to validate the findings and the public hearing is necessary, then FDA, 'right' that, then FDA approves or rejects or PFA this depends on who where it is nowadays that another organization globally has come up so many are there. So, they should also act or they should also approve it, 'right'.

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Functions of the food additives are like it acts as preservatives where it keeps the food material fresh and reduces the spoilage, controls the bacteria, mold, fungi, and yeast, 'right'. For example, chemicals like a benzoates, BHT, BHA antioxidants, calcium propionate, inhibits molds, sodium bisulfate, sodium nitrate, they are used.

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Functions of food additives are where you are processing it may act as processing aids. For example, it improves the consistency and stability, aids oil and water mixtures and retain moisture gums, where align, carrageenan or carrageenan and xanthan these are

used, aluminum calcium silicate or benzoyol peroxide these are used. Then, as again, processing as improves consistency and stability, 'right', and so, this is the same page.

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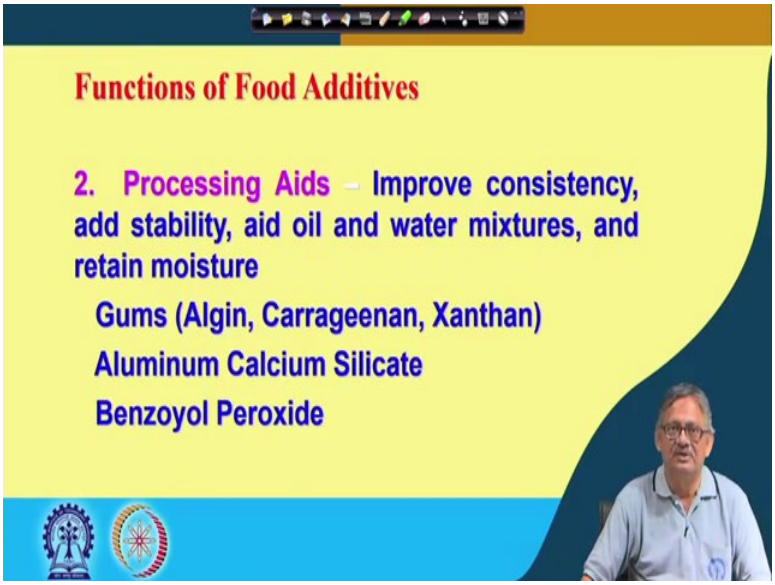

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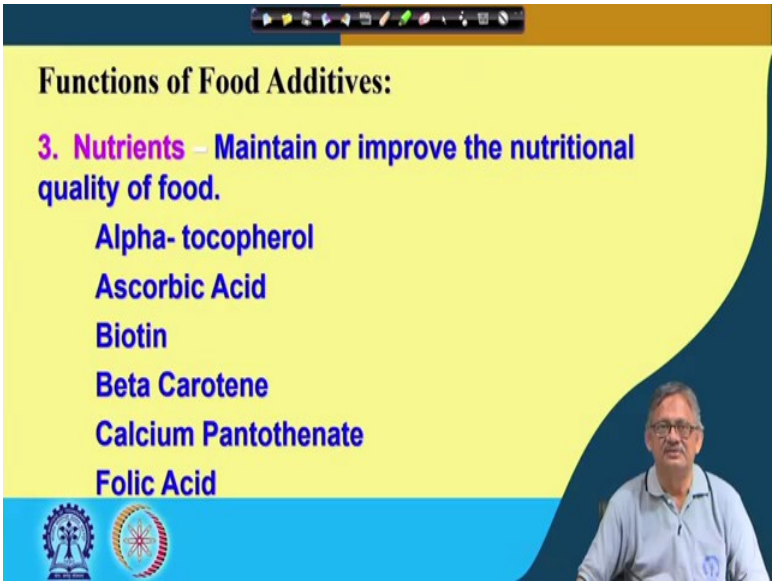

Now, nutrients some functional foods as functions of food additives as nutrients are which maintain or improves the nutritional quality of the food by alpha-tocopherol, ascorbic acid, biotin, beta carotene, calcium pantothenate, folic acid these are used, 'right'.

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Then flavoring material components for example, it complements the food material with the flavor, then which magnifies or modify the taste or aroma of a food, somewhere you have prepared a food the flavor could not be so much acceptable. So, you have given some additional flavor from some other source, so that the whole thing may become now acceptable by the consumers. For example, aspartame, corn syrup, ethyl vanillin, mannitol, monosodium glutamate, these are used.

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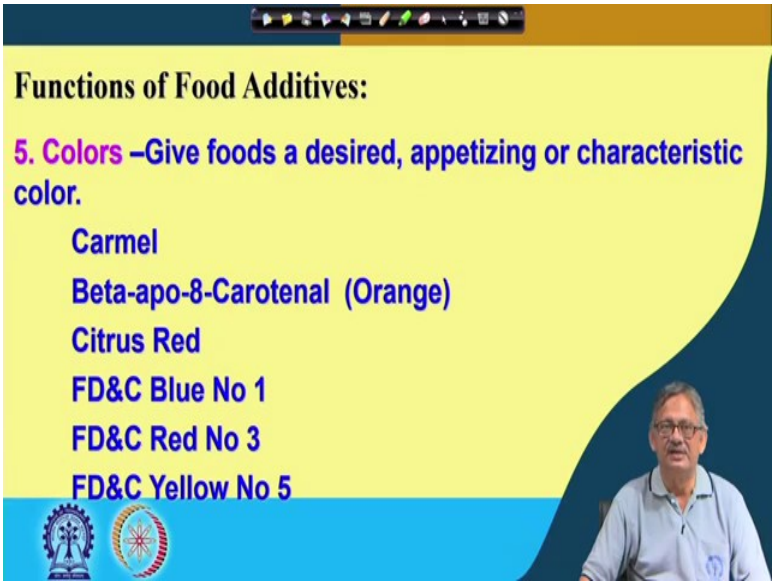

For coloring materials it is also used which gives food desired appetizing or characteristic color. For example, Carmel, beta-apo-8-carotenal orange, citrus red, FD and C blue number 1, FD and C red number 3, FD and C yellow number 5, these colors are used or these chemicals are used as additives, 'right'.

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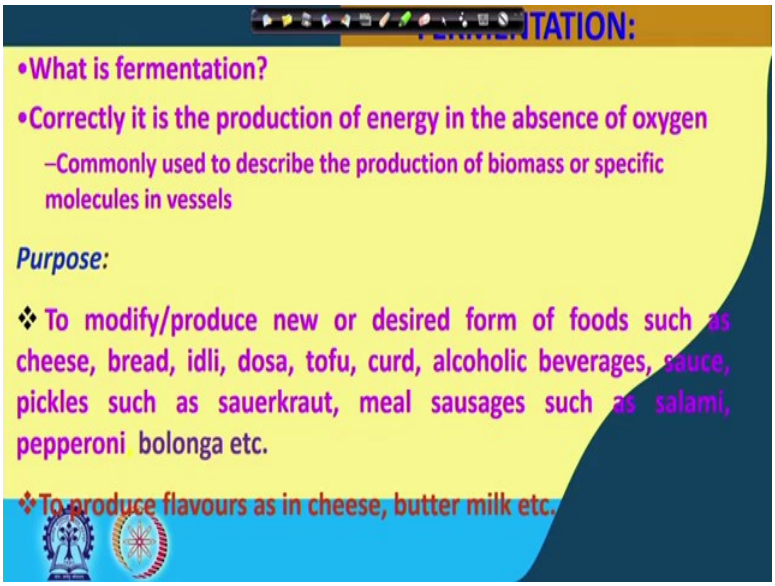

Then we come to another very important that is called fermentation. What is fermentation? The process by which correctly it is the production of energy in the absence of oxygen commonly used to describe the production of biomass or specific molecules in vessels.

Nowadays you will hear from different sources that people are trying to make algae in the ponds, 'right' and algae may be in future not today, may be in future could be a source of your protein because it contains high. So, that kind of things may be coming out of the biochemical or biochemistry, 'right' bio engineering whatever we call.

A purpose is to modify produce new or desired form of food such as cheese, bread, idli, dosa, tofu, curd, alcoholic beverages, then sauce, pickles, such as sauerkraut, sauerkraut is a fermented cabbage used in developed countries, meal sausages such as salami, then pepperoni, bologna, etcetera, 'right'. So, to produce flavors as in cheese, butter milk etcetera are used, 'right'.

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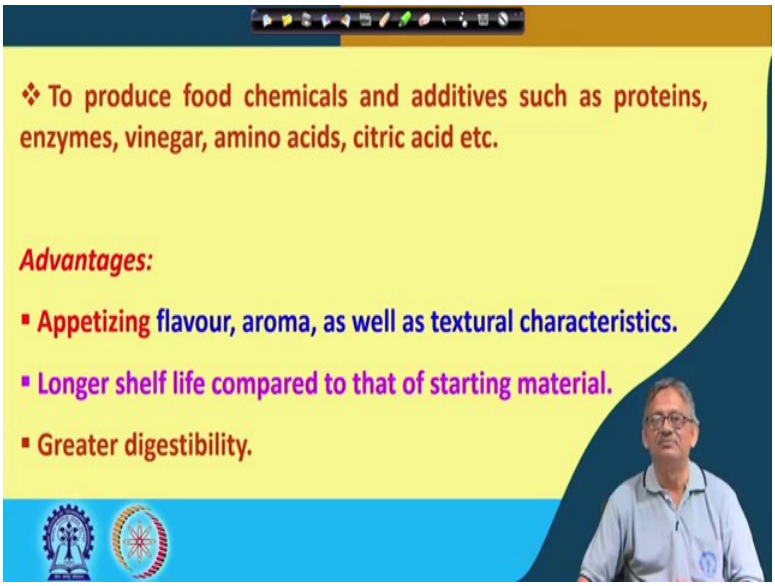

To produce food chemicals and additives such as proteins, enzymes, vinegar, amino acid, citric acid, etcetera are also used. The advantages are it makes appetizing flavor, aroma, as well as textural characteristics, which may be of interest may be modified longer shelf life compared to that of starting material may be prepared by adding these additives, then it could be that greater these digestibility.

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So, digestibility of that particular food by the addition of the little chemical additives can be improved. So, these are the some of the vital points of the chemical additives or

fermentation also, ‘right’ because in many cases you will see that the normal whole thing which may be not so much palatable or acceptable, but by fermentation you can the greatest example is south Indian dishes like idli, dosa, so they are all fermented products, ‘right’. So, fermented products for example, food additives, pigments, antibiotics, industrial enzymes, pharmaceuticals, aroma molecules and organic acids these are some, ‘right’.

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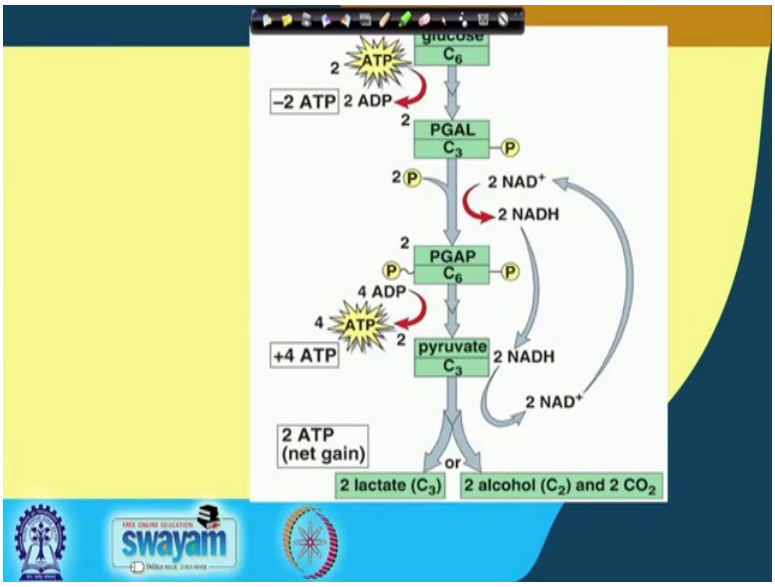

A typical fermentation process looks like this it is not so easy. For example, I give you I am just removing this, ‘right’ it is it is nothing, but you are getting alcohol carbon dioxide from glucose in the this is called anaerobic path, ‘right’. In the anaerobic path you are getting alcohol and carbon dioxide, but also you are getting lactate. So, this just you keep in mind, ‘right’ I will tell a little more on this,

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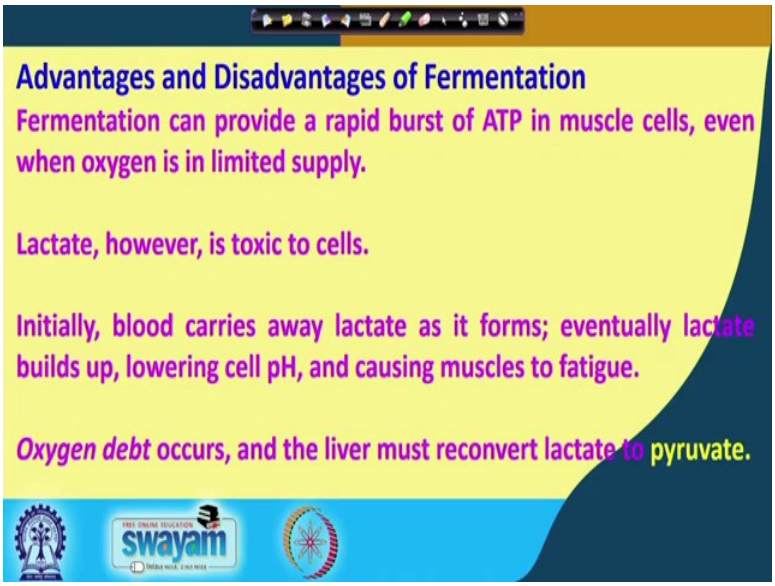

A little more on this means meaning that you know that when you are respiring what is the best material on which your respiration is dependent that best material is the carbohydrate and that to in the form of sugar, that to the lowest form of the sugar that is glucose, 'right'.

So, when you are when you are respiring, this glucose molecule is converted into carbon dioxide, water and energy. So, you are respiring as much you are getting your energy through that and you are eliminating carbon dioxide because you are inhaling oxygen and exhaling carbon dioxide, 'right', this means that you are doing like that; so this means you are doing like that.

Now, in that you are also have observed or you have also come across that when you are running for a sometime maybe 100 meters 200 meters or even more when you are playing. So, you get aching on the leg, 'right' why, because the primary reason is one of the primary reasons is that your body requires more oxygen which is not supplied by the body or your body is not getting and in that case instead of aerobic respiration it becomes anaerobic respiration which we have just shown like this, 'right'. So, that may for lactate or, some lactate or this may cause your ache in the legs, 'right'.

Now, advantage and disadvantages fermentations are many, fermentation can provide a rapid burst of ATP in muscle cells even when oxygen is in limited supply. Lactate, however, is toxic to cells and as I said, 'right'. Initially, blood carries away lactate as it

forms; eventually lactate builds up, lowering cell pH and causing muscles to fatigue. Oxygen debt occurs and the liver must reconvert lactate to pyruvate, 'right'.

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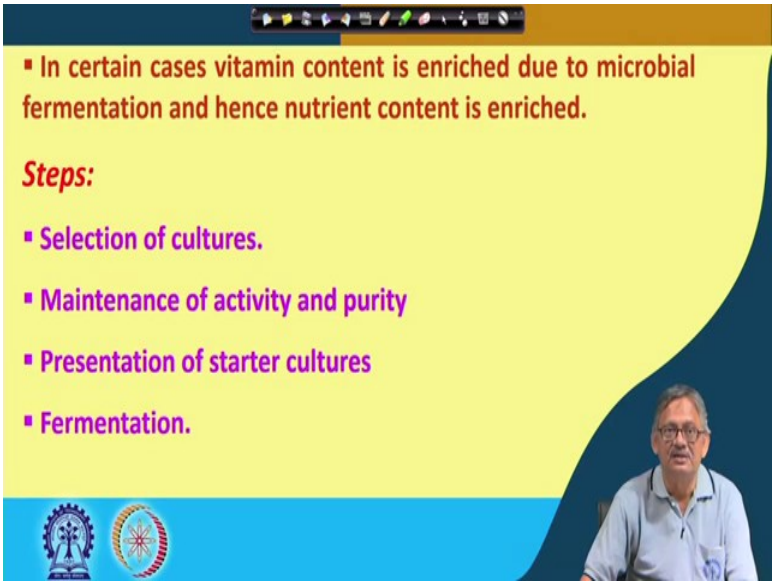

So, in many cases in certain cases vitamin content is enriched due to microbial fermentation and hence nutrient content is enriched. For example, the steps involved are selection of cultures, maintenance of activity and purity, then presentation of starter cultures, then fermentation.

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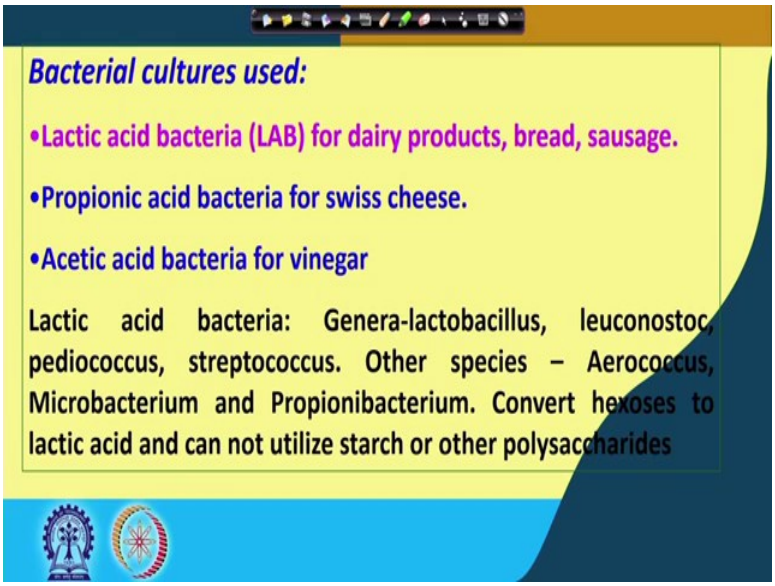

And followed by, bacterial cultures used are Lactic Acid Bacteria which is commonly known as LAB, LAB Lactic Acid Bacteria for dairy products or bread making or sauces making. Propionic acid bacteria for swiss cheese, acetic acid bacteria for vinegar. Lactic acid bacteria: genera-lactobacillus, leuconostoc, pedicoccus, streptococcus, other species for example, aerococcus, microbacterium and propionibacterium. Convert hexoses to lactic acid and cannot utilize starch or other polysaccharides, 'right'.

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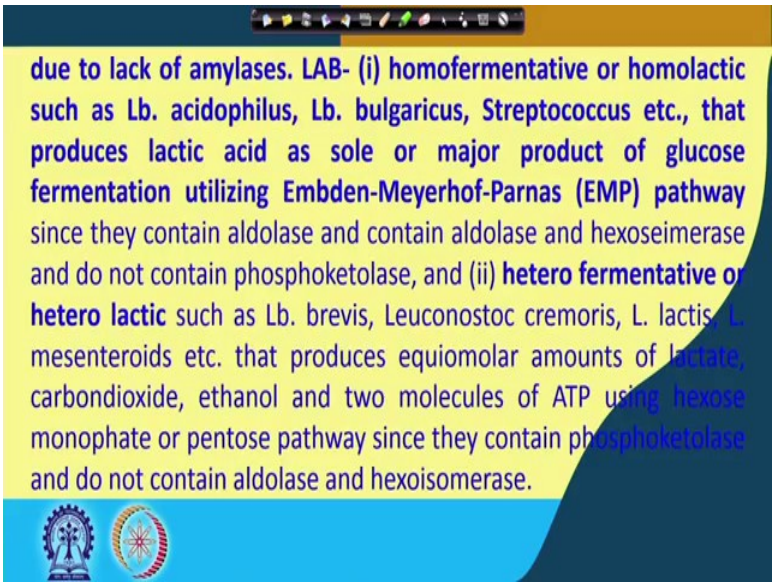

So, due to the lack of amylase; due to the lack of amylase, LAB that is lactobacillus Lactic Acid Bacteria which is homo fermentative or homo lactic such as lactic acid lactobacillus acidophilus, lactobacillus bulgaricus, streptococcus etcetera that produces lactic acid as sole or major products of glucose fermentation utilizing Embden–Meyerhof-Parnas or EMP pathway.

Since they contain aldolase and contain aldolase and hexoseimerase or hexo hexosisomerase and do not contain phosphoketolase and hetero fermentative or hetero lactic such as lactobacillus brevis, lactose leuconostoc cremoris, lactic acid leuconostoc lactis, then a leuconostoc mesenteroids etcetera that produces equiomolar amounts of lactate carbon dioxide, ethanol and two molecules of ATP using hexose be or pentose pathway, since they contain phosphoketolase and do not contain alsolase and hexoisomerase, 'right'.

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Now, when we are doing propionic acid culture propionibacterium etcetera are used, for similarly when you are making mold culture soya sauce etcetera are used, when you are using fermented dairy products then also different cultures are used.

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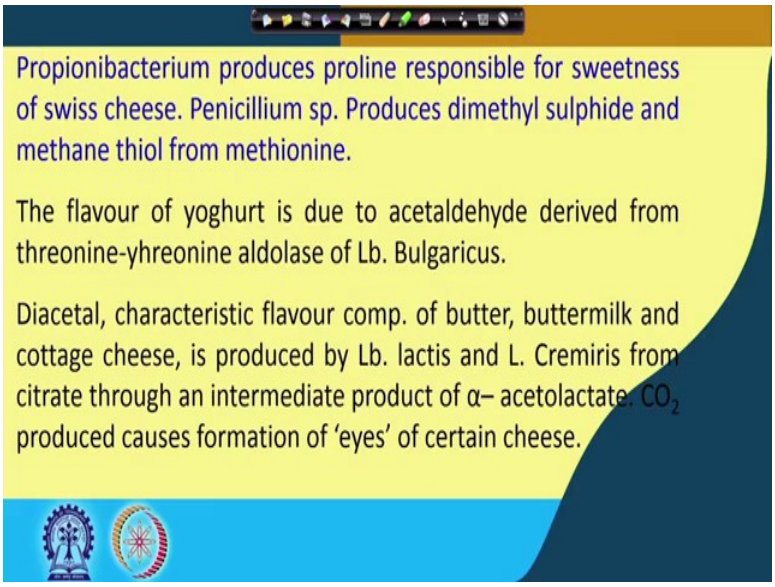

But since today we would like to complete our this preamble, so I would like to also switch over from one to other, so that within this class we can finish the preamble, 'right'. So, the flavour of yoghurt is due to acid acetaldehyde derived from threonine and yhreonine rather aldolase 'right' and of lacto lactobacillus bulgaricus, 'right' from that.

Then diacetal which is a characteristic flavour or flavour compounds of butter, buttermilk and cottage cheese is produced by the lactobacillus lactic acid bacteria or lactobacillus lactis and lactobacillus cremiris, 'right', cremiris it is from citrate through an intermediate product of alpha, acetoacetate, carbon dioxide produced causes a fermentation of eyes of certain cheese.

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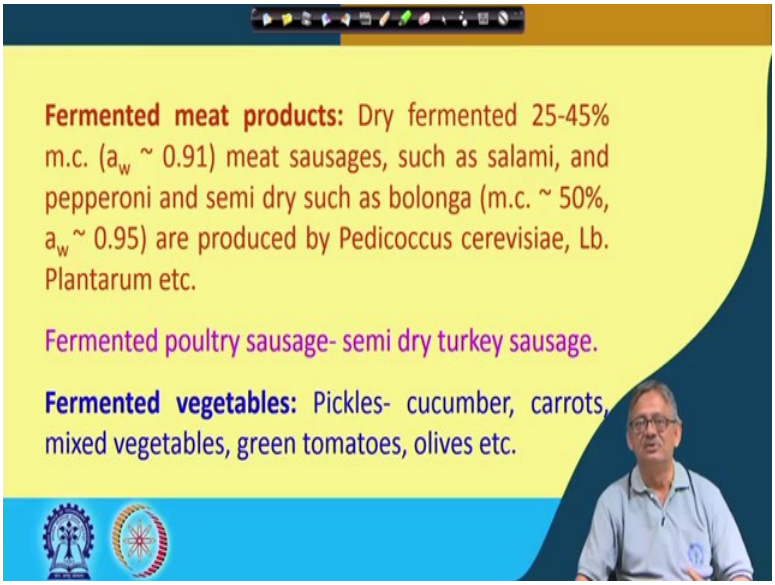

You will see that in many cheese there are some holes and these holes are called eyes of the cheese though this is not that part, so we are not going into detail of that. So, there are many fermented meat products also fermented poultry sausage, semi dry turkey sausage they are also available. Fermented vegetables as we said that sauerkraut is one of them made from the cabbage, pickles are used most popular, 'right', cucumber used, carrots are used, mixed vegetables used, green tomatoes or olives etcetera used for pickles, which is also fermented product.

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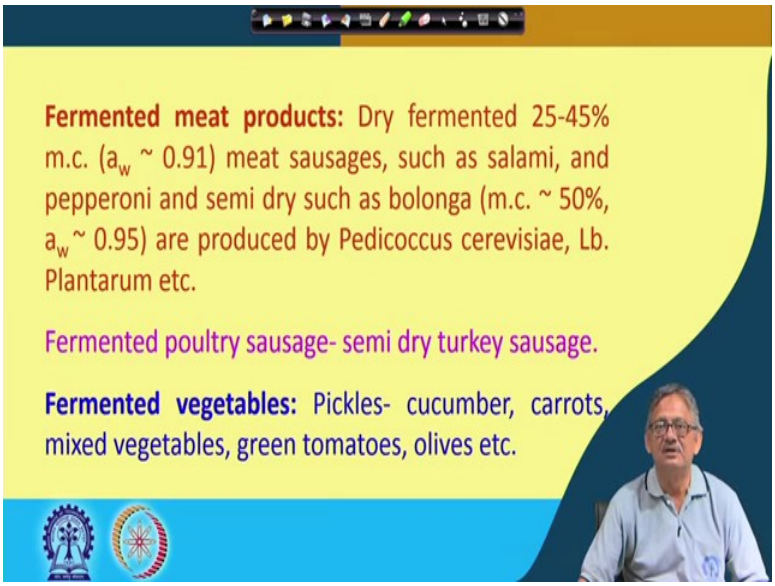

And by this way of fermentation what you are actually doing, you are also extending the available period of that particular vegetable or product for a longer period. Otherwise maybe if you do not make that cucumber or other things for or maybe carrot and as we have said many of them; if you not have used as pickles, then maybe by couple of days that would have gone rotten, but the moment you made it to pickle, 'right'. So, in that process you have extended the life of this. So, this is also one of the method of extending the storage period, fermented meat products which we have already said, 'right'.

So, where in this here it has come one thing which is called water activity you see here that dry fermented around 25 to 45 percent moisture content where the what a_w corresponds to water activity. Now, so, water activity generally when it is around 0.9 then bacteria yeast mold all three can grow and do their activities, if it is 0.8 then bacteria cannot, but yeast and mold can grow, if it is 0.7 then neither bacteria nor yeast can grow or do their activities, but mold can do their activities or grow. So, less than 0.7 that is 0.6 around is a good choice of making in the water activity.

Now, water activity means the availability of water 'right' how available the water is for the organisms. So, that is the and this is measured simply by the ratio of p or partial pressure of water vapour present in the food material to that the vapour pressure of pure water at that same temperature, this is the definition of water activity. So, when water activity if we were lowering down by means as you are doing in dehydration or drying

then you are extending the storage life, this is how fermented meat products are also done controlling the water activity, 'right' by moisture content; fermented poultry sausage, which is semi dry turkey sausage, 'right', then fermented vegetable which we have already said,'right'.

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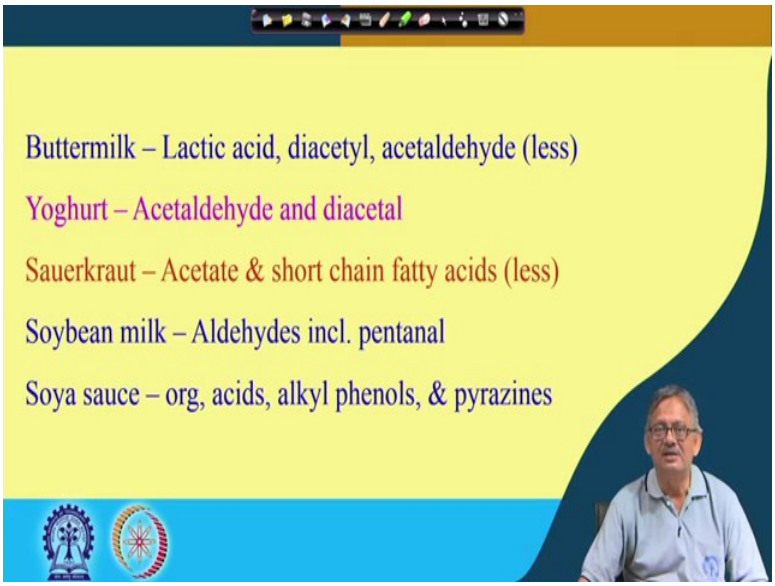

Then buttermilk is a lactic acid, where diacetyl, acetaldehyde which is less, but diacetyl is there and this case producing the characteristic flavour. Yoghurt in which acetaldehyde and diacetal are both present, sauerkraut where acidic and short chain fatty acids in less quantity is present, soybean milk in which aldehydes including pentanal are present and soya sauce where organic acids alkyl phenols and pyrazines are present. So, all these tells that, we are able to extend the storage life of the food material by the way of fermentation, 'right'.

So, as the end of this 1 week preamble course, 'right', so I would like to tell that at the end of this course, end of this week course we are able to tell now that we have come to know that there are many processes by which you can extend the storage life.

We have come across this also that Q_{10} which is known as the temperature quotient and this temperature quotient that told us that if you increase the temperature by 10 degree, then the rates of reaction be it chemical, microbial, biochemical or enzymatic any rates of reaction gets double roughly. And if you lower the temperature by 10 degree, then the rates are become half, 'right' by and large it becomes either double if you increase the

temperature or decrease the temperature by 10 degree then it becomes half. So, double or half the of the rates of reaction, this tells that why higher temperature is not suitable for extending the storage life of any material, ‘right’, any means food material any type of food material be and we have also seen in the beginning that there are 2 general sources of food material one is the from the plant origin and another is the animal origin.

So, whatever with us source of the food material whether it is plant or animal source, so the higher the temperature the lower is the shelf life, lower is the period of storage. So, you would like to and we have also shown that there are many ways of extending the storage life, out of which are pertinent to this course is where you are using the application of heat, ‘right’.

So, when we come to the next classes then we will start from, ‘right’ from the absolutely heat transfer, ‘right’ from the heat transfer will come and there we will start up with the different modes of heat transfer. For example, conduction, convection and radiation, we will start with convection, conduction and that will be absolutely it will start from the very beginning, so that it is acceptable to any beginner also, ‘right’. So, it will be it is frame I will frame in that way, so that a beginner can also do the same thing, ‘right’.

So, whenever you are doing that; obviously, it will be associated with some mathematics, some formulation, some your problem solution. If you are not doing solution of problems and then you are not able to understand it more, because some of the some of the things which are very much important for example, that you know that copper, ‘right’, copper if you want to heat or if you have some oven and on that oven if you put the spade out made of copper.

So, you will not be able to hold the other end for some time after sometime you will not be hold because copper is very-very highly conductive and it being conductive. So, the heat which was given to the other end is migrated to this end and you are conducted to this end and you are getting the heat which is not avoidable, ‘right’.

So, this is and there these problems, these solutions will help you to know, what the conductivity of copper is or if it is some insulating material, ‘right’, then what is it is conductivity. So, in one case highly conducting like copper, in other case less conducting like insulating material, ‘right’. So, this separation or this kind of these distinctions will be able to do and whenever we are doing it any we will be always associating with some

problem. So, that understanding becomes more clear and again the weekend whenever we are coming across in the weekend at the end of the week when the questions will be given to you those assignments in the form of assignments.

So, try to solve your assignments by yourself, reading them, understanding them, if you have any problem communicate it to us, because there will be a mutual portal by which you can also access, we can also access and we can exchange our ideas or exchange our answers or questions. So, those things if you do by yourself it will be very good, because then you will come to know where do you stand, because at the end of the course whenever it would be over 60 classes that is 30 weeks then you have to appear in an exam and in that exam; obviously, you have to do very well, so that you are one of the best, 'right'.

So, this with this preamble would like to conclude the first week preamble class that what is food, why it is required to be extended, the basic thing is that if we are not extending is to his life or his availability, then in the long run when you have less production that time you will not be able to get and when you have no supply or production that time this which you have already stored will be used for the betterment of the mankind.

So, and in what way how many ways it can be that also you have given some highlights, we have given some elaborations also, so different ways by which it gives a utilized. So, these will be taken up by you of course, to do that whenever the thermal process is associated those things will be analyzing subsequent classes and in the classes subsequent classes as I said that will begin with the most fundamental things associated with that and they are primarily conduction and then convection and then little on radiation.

And after doing all these we will do it is application like your boiling, 'right', boiling means you know I do not know whether you have seen or not this is a general thing that, when you are boiling that time when you have taken water in a pot and you are giving heat down below it that time you are you can see that little droplet us are being produced and those droplets are gradually increasing with time as you are heating more and more. And after some time this droplet starts dancing in that liquid and then, the whole droplets they come up to the surface and there is a turbulence inside, 'right'.

So, these are different types of boiling, there are different types of boiling, ‘right’. So, those will take up and likewise many others may be drying that is an application of heat, ‘right’, or lowering of the temperature like freezing, ‘right’, so these things will take up and, but before that we have to know this process ok. So, hope you enjoy the class and next time onwards we will come to the real course on thermal processes, ‘right’.

Thank you.