Dairy and Food Process & Products Technology

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Lecture - 44
Milk Pasteurization and Homogenization

In our forty fourth class of this dairy and food process and products technology; we were discussing about the milk processing, right. In earlier classes we were discussing about milk processing and we came up to milk pasteurization. Of course, pasteurization is one such a process in milk liquid milk not only in liquid milk in many liquid foods that serves the major purpose we said that reasoning, but will again come in detail a little more right.

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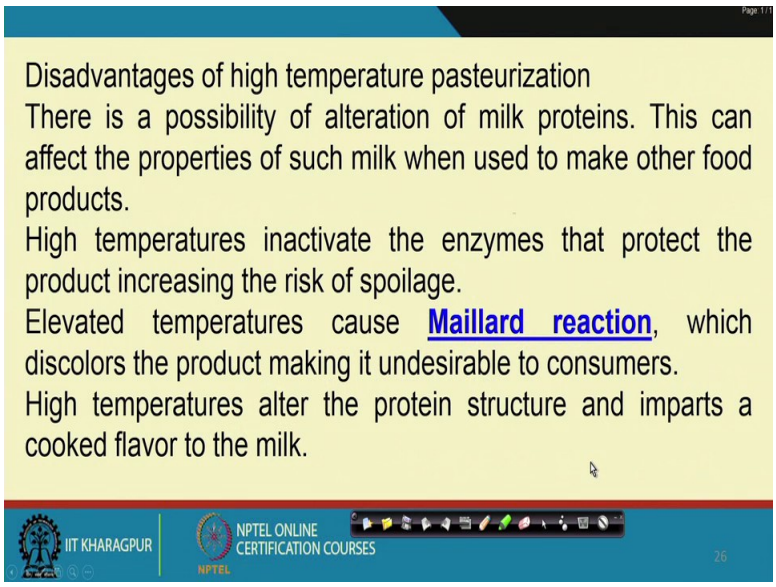

So, we were in the UHT, right. So, some disadvantages associated with high temperature are like this that there is a possibility of alteration of milk proteins and this can affect the properties of such milk when used to make other food products. And in that the major one which comes in is the Maillard reaction. And you remember that we had said in earlier classes that as and when the new things will come will try to define them or extend them as much as possible because that becomes as generalised not only in liquid milk or liquid food, but also in solid food, right. So, if we look at that this elevated

1temperature causes the Maillard reaction and then it comes what is that; what is the
2Maillard reaction.

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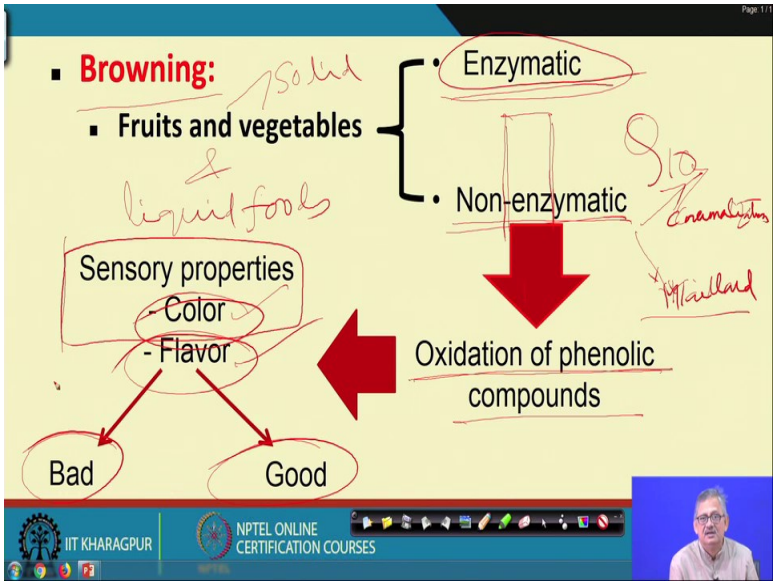

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5We have said that are two types of or three types of in general two types at one is
6enzymatic and another is non enzymatic, right. So, that browning we divide them into
7two types this is true for all foods whether solid or liquid does not matter, it is associated
8with all foods. So, these two types of browning reactions that could be in fruits and
9vegetables that could be in milk that could be in any solid or liquid food material, right.
10So, enzymatic and non enzymatic these two types of browning they are associated with
11this.

12So, here we have written fruits and vegetables and here I write and liquid foods, right.
13So, fruits and vegetables liquid foods, so and this is under solid food right and that is
14under liquid food. So, under for them the browning reaction takes place in enzymatic
15manner or in non enzymatic manner. So, if it is enzymatic manner then this is controlled
16by the enzymes, right.

17We give the example earlier that if we are making say, if you are cutting apple, or if you
18are cutting potato very handy examples because every now and then you come across
19potato you come across everyday; apple may or may not be you are coming across
20everyday, but so, if you cut it even those I said that if you when people are making
21prashads right or offering to the gods then those prashads they also become black brown

different colours depending on what are the fruits you are supplying banana were such it becomes black then apple potato these things we come across very often.

So, that comes under the browning and the other one which you if you remember I give the example of mummy and seniors you and mummy or others they are preparing for you, for god or whatever payasam things like that or kheer that time in boiling milk for longer period and when started it was it was white milk, but after long time it became brown. Though nothing has been given nothing to that milk has been given not even the sweetening not even any other. So, that happens under non enzymatic browning, right.

And, in non enzymatic browning there are again two types one is called caramelization and another is called Maillard reaction. So, this caramelization and Maillard reaction that is associated with the food materials and everywhere that Q_{10} if you remember we had said this Q_{10} that is always associated, right. So, Q_{10} means the more the temperature the higher is the rate of reaction. So, this is true for every material. The higher the temperature, the higher the rates of reactions that is any type. So, when you when kheer or payasam was being prepared that was at higher temperature. So, that rates of reactions that is Maillard reaction that was high caramelization that was high that that is why the browning took place.

So, non enzymatic again we divide them into two; one is caramelization when where the colour would depend is. So, caramelization right and another one is Maillard I am sorry that the writing of with the pen hopefully it is understandable right. So, this these to we divide them into one with caramelization and another is with the with the Maillard. This non-enzymatic so, whatever is with enzymatic it goes there not non-enzymatic it should have been there it should have been up to that, right. So, let us take this arrow up to that so, it is non enzymatic no enzymatic.

So, if it is enzymatic browning oxidation of phenolic compounds that happens, right. So, for which the sensory properties like color, flavor they got changed. So, out of which many could be bad, some could be good. When you made payasam or kheer that color was desirable, right so, because that was different from the milk. So, that was desirable. So, and it also produced some flavor not only color, but also some flavour produced. So, this flavour and color was welcomed in that process, but in many processes they are not,

right. So, depending on what you intend what is your end use some could be good, some could be bad, right. So, bad and good depends on your application your use, right.

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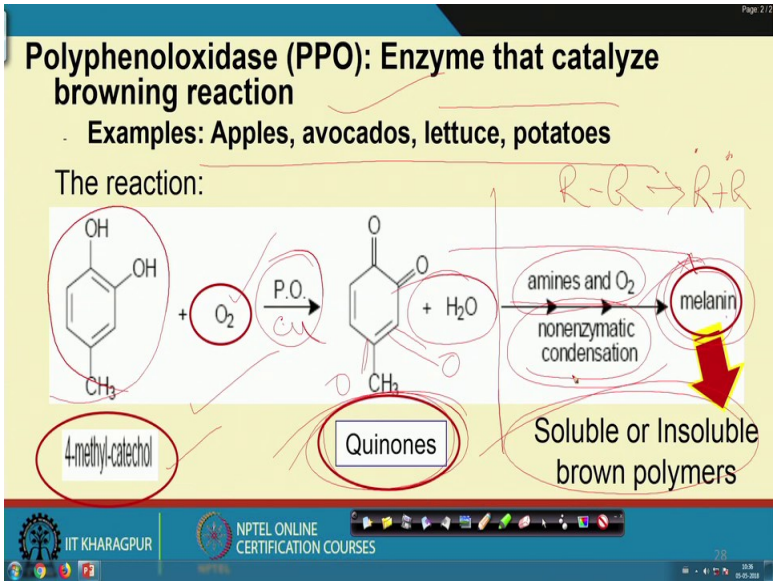

So, if you look at then the enzymatic browning if you look at the enzymatic browning then we look that this enzymatic browning is done by polyphenoloxidase, right. So, let the entire thing come in before you and I think some more will come this. So, PPO or that is called polyphenoloxidase. There are many enzymes which are which are associated with enzymatic browning one such is polyphenoloxidase, right. We cannot give all the examples because time is the primary thing, right? We have to finish up the course within the stipulated time. So, we cannot give all the examples, but polyphenoloxidase is one enzyme which commonly used as you see apples, avocados, lettuce, potatoes etcetera right. So, there it is applicable.

So, many other enzymes are also there which are associated with this right and when many many. So, those are for browning of that particular food product, right. So, what happens in that enzymatic browning? I could not show you because of the time constraint that this enzymatic browning that happens this oxidation under free radical mechanism that is one, right. Free radical mechanism that you have R-R if you have then that comes a free radical R plus R may be right. So, these free radical when it is generated that free radical comes under reaction and produces different in products.

One here we are give example that the reaction which is associated is a 4 methyl-catechol this is the one of the substrate. So, in presence of oxygen and the enzyme in and there could be some catalyst like say copper or something which also may act as the catalyst. So, that reacts with oxygen forming an intermediate compound called quinones, right.

This is the structure of the quinones this is ortho quin can that can be para quinone if there right or if this is also with double one here with that could be and ortho para this is ortho meta and para this is para quinone, this is right. So, there in all the cases this quinone derivatives they are formed and with one molecule of water it makes an oxygen, right. If it is this is one now it is the generalized equation that leads to these melanins or if it is not this part, this part amines and oxygen that could form or may be nonenzymatic condensation that may happen and may produce melanins.

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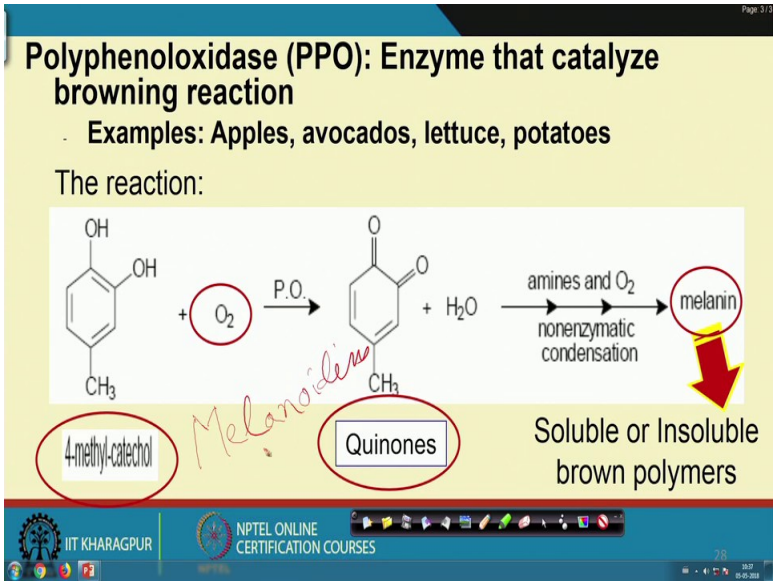

This is with respect to the with respect to the enzymes, right with respect to enzymes which may produce soluble or insoluble brown polymers they are called melanins or melanoidins, right. It is clear melanins or melanoidins melanoidins right.

So, this melanoidins soluble and insoluble brown material that are those are melanoidins, right. So, if we look at the other one this is the enzymatic one and there I said in many cases this mechanism follows this mechanism follows your free radical mechanism, right.

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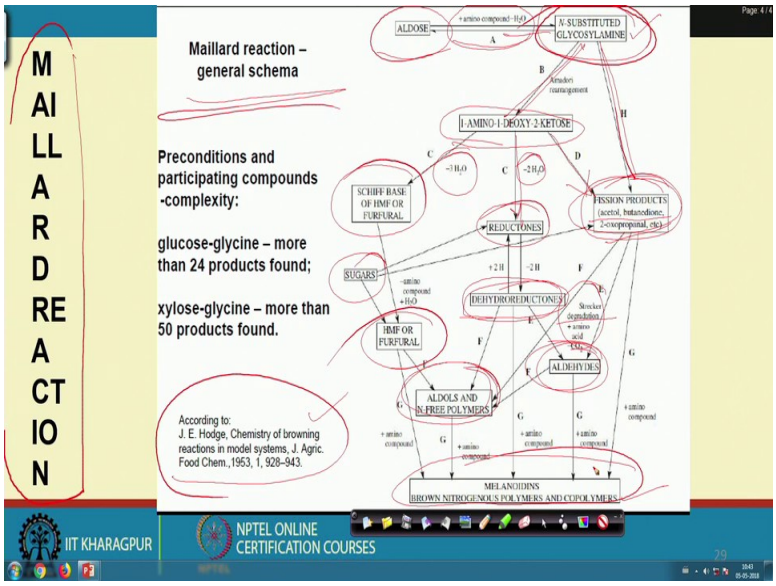

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3That the other one, that Maillard react which takes place Maillard reaction is non-
4enzymatic, right. So, if this happens with caramel or caramelisation caramelisation is
5basically when you are eating sugar when you are eating sugar that times caramelisation
6is taking place that crust on the on the bread there it is caramelised, right. That brown
7color on the bread that is caramelisation. So, similar to that many are there you have seen
8that mummy and grand mummy's are putting some sugar in your daily food preparation
9that is not for making it sweet, but the kind of caramelisation happen and that improves
10flavor as well as the color.

11So, that is why that is given because not sufficient quantity of sugar is given so that it
12becomes sweet not for sweetening, but for introducing some flavor or inducting some
13flavor as well some color to caramelisation, but the reaction is very very complex and
14that also produces melanoidins and melanoids, right. So, if you look at this Maillard
15reaction sorry if you look at this Maillard reaction then we see that this is what Maillard
16reaction I had written in vertical form, right. So, Maillard reaction that this is the general
17schema this was in developed in 50s, early 50s right.

18So, this is the one source has been taken that aldose right this is aldose means aldehyde
19which are in the sugar form, right and amino group so right. So, when they are reacting
20eliminating water and producing N-substituted glycosylamine, right this is the one of the
21beginning of the reaction. Then you see not many parts it is undergoing the paths this

path coming to some intermediate likes right 1-amino 1-deoxy 2-ketose or it may be producing like fission products that could be acetol or butane di butanedione or 2 3oxoproponal, etcetera, right that may also come from here right. This may lead to shift base of HMF or furfural, right or there it may go to HMF or furfural some sugars may also add here or from here it may leave water.

So, it was leaving water and reduction reaction may take place, right which may produce, dehydro-reductones that could be that could be again another intermediate or from here again some more intermediate could be depending on different path like strecker degradation like. So, that produces aldehydes, right that there are many intermediate paths like strecker degradation is one and ketoenol mechanism that could be another. So, many such reactions do happen. So, intermediate and aldehydes or aldols and N-free that is nitrogen free polymers that also could be or ultimately it comes to melanoidins or brown nitrogenous polymers and copolymers that may form it, right.

So, you see in many parts it is coming this is also very not so complicated structure. There are many cases in many many books also it is available that this scheme is even more complicated and they are introduced intermediate path ways intermediate process intermediate products which are developed now it depends on the extent of the reaction where it is getting ended that is why is it is very difficult in Maillard reaction to predict what will be the end product, right what will be the end product it can stop here it can stop here, or some all of them might have been produced. So, some of them or all of them might have. So, that is that is the beauty of this reaction; this Maillard reaction caramelisation that may happen, right.

So, preconditioning and participating compounds and the complexity are like this glucose-glycine more than 24 products could be found, xylose-glycine more than 50 products also could be found like that. So, depending on how far you are extending how far you are your reaction is happening, how long it is happening all these will dictate what could be the end product, right. So, it is very difficult to pinpoint that through that Maillard reaction you got this as the end product that is why you will always see that in general this food scientists and technologists they do say that sugar having reaction produces melanoidins or melanoids or melanins whatever be the naming right they are all synonym and it follows different-different pathways, right.

1and in caramelization also you will have the same you will have the same in 2caramelization, right.

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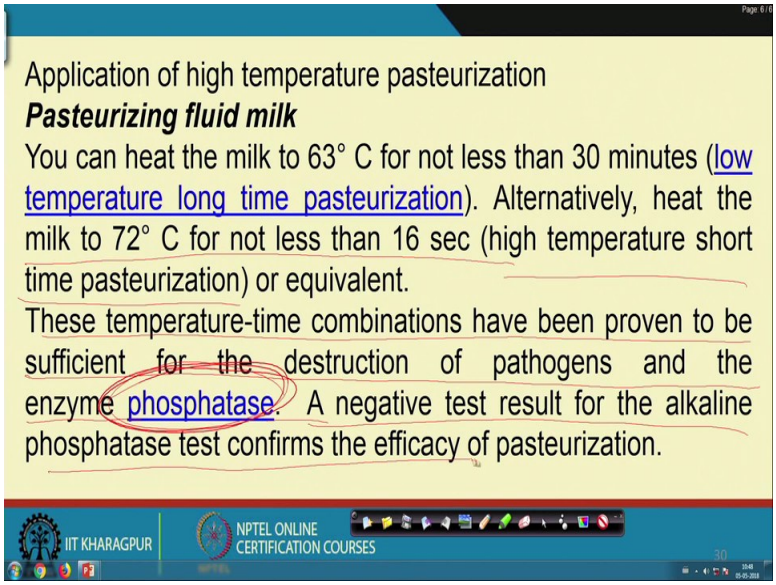

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5Now, let us look into some other aspects also that when we are applying high 6temperature pasteurisation then you can heat milk to 60°C for not less than 30 minutes 7that is called low temperature long time pasteurisation and alternatively you can heat you 8alternatively you can heat upto 70°C for not less than 16 seconds right, that is high 9temperature short time or HTST pasteurisation or equivalent. So, this time temperature 10combinations have become proven to be sufficient for the destruction of the pathogens 11and the enzyme phosphatase we have said that this phosphatase enzyme is one of the 12most heat resistant enzyme.

13So, that can be destroyed by this and a negative test result for the alkaline phosphatase 14test confirms the efficiency of the pasteurisation, right.

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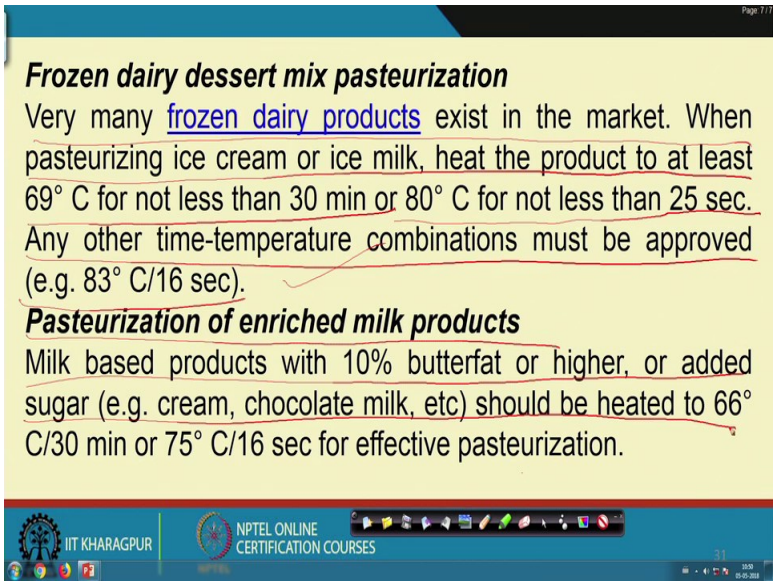

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3So, let us proceed now quick because our total time is fixed frozen dairy dessert mix 4pasteurisation when we are doing dairy dessert we will come subsequently in the other 5class that when you are making ice cream that is a dairy dessert. So, that time you have 6to pasteurise a lot of ingredients to get the ice cream mixed. So, there of course, this 7pasteurisation will the time temperature combination will be different, right.

8So, very many frozen dairy products exists in the market when pasteurisation of ice 9cream or ice cream milk heat the product to at least 69°C for not less than 30°C or 80°C 10for not less than 25 seconds any other time temperature combination must be approved. 11For example, 83°C per 16 seconds etcetera, but that combination time temperature you 12have to generate right you have to generate and see at the end to any through any enzyme 13which is a highly heat resistant that if the inactivation is over then you can conclude that 14your this thing is over pasteurisation is over ok.

15Pasteurisation of enriched milk products like milk based products with 10% butterfat or 16higher or added sugar for example, cream, chocolate milk etcetera should be heated to 1763-66°C for 30 minutes or 75°C for effective pasteurization.

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3Now, let us quickly go through this there are objective your pasteurisation, we have 4already said many many times so, I will just read out. The chief objective of milk 5pasteurisation is to destroy pathogenic bacteria that could have a public health concern 6by destroying these organisms the product become safe and public for public 7consumption. Secondly, pasteurisation eliminates destructive bacteria and enzymes that 8could cause spoilage of the product. This leads to a prolonged shelf life of the milk 9pasteurised milk is commercially commercially sterile which means that they are not 10entirely entirely rid of bacteria; that means, you are not totally making bacteria free. One 11should compound their preservation with another method, usually refrigeration.

12In modern milk first the processing plants the plant heat exchanger is connected to a 13separator and homogeneizer in the same line the milk separates separators help in butter 14fat standardisation while the homogeneizer breaks down fat globules into tiny 15microglobules that remain suspended throughout the milk. It prevents formation of 16cream layer when the milk is left and standing for a long. This we have said many many 17times so that is why I just went through rapidly.

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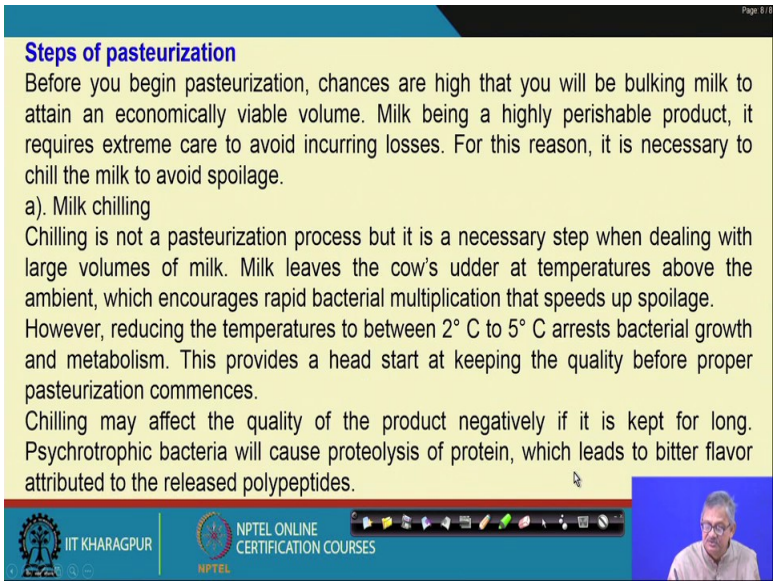

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3Some steps which we have to go through during pasteurisation, but hopefully now the 4time is over for this class we will carry over to the next class, ok.

5Thank you.