**Dairy and Food Process & Products Technology**
**Prof. Tridib Kumar Goswami**
**Department of Agricultural and Food Engineering**
**Indian Institute of Technology, Kharagpur**

**Lecture - 37**
**Chemical and Microbial Spoilage of Milk and Milk Products**

Hello. After completing as far as possible the constituents of milk in details along with along with; so many associated things we have tried to cover so that it helps you in understanding not only in milk, but also in other food whether it is processed or as a whole. Now we move to that spoilage; spoilage of milk that was our one of the mandate; given mandate means, outline which we had given. And the spoilage normally we come across is primarily by microorganisms.

The other one we normally don't talk about spoilage because that is not the chemical one unless you are adding some chemical which is not desirable which may be toxic and others. So, unless that is done normally they are not spoiled by the chemicals as such. So, it is mainly the microbial spoilage which are concerned; however, we will try because chemical associated things like we said if you remember that when you are heating milk for whatever be the reason.

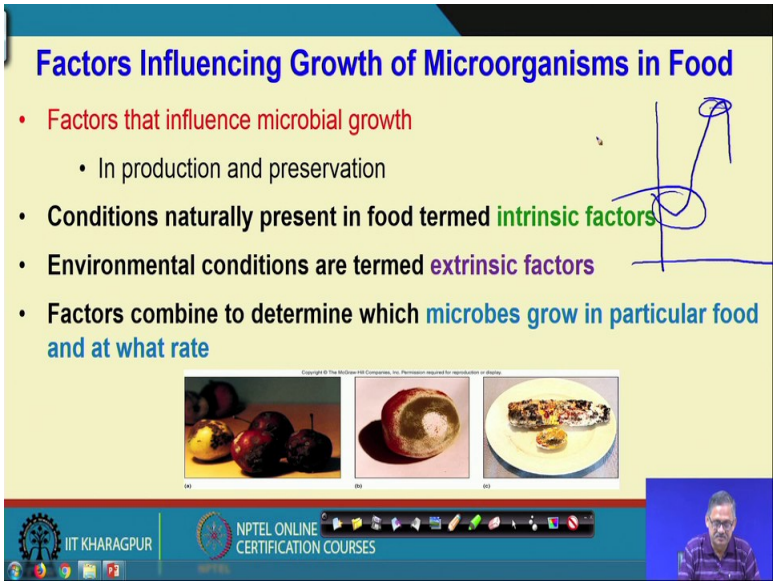
When you are heating milk then there may be browning and that browning is primarily because of either caramelization or Maillard reaction. So, here also if that comes in we will try to because I have said we will try to encompass as much as possible. Because this is not true that Maillard reactions or caramelization happens only in milk, it is also associated with all other foods wherever the things are happening or wherever you are heating, wherever there is the reason for caramelization reason for Maillard reaction.

So, we will come across with them also right; of course, now we have to also progress a little faster because our leftover number of lectures are also not so, high and our leftover as we have given the more or less some outlines; those are also to be taken care of right. So, we will try, but again I will not compromise with the subject, with the depth of knowledge or understanding that I am not going to compromise right.

So, as far as practicable I will try to analyze I will try to explain and ok we will go along with the time and then someday definitely the course will be over. So, before that at least

I wish all of you gain sufficient knowledge, understanding is also there; see if that can be that is my objective and motto; that you must be benefited. So, that benefit toward extent both it depends on the giver and the taker isn't it?

So, let us come to today's one that is lecture number 37, this is lecture number 37 and this encompasses chemical and microbial spoilage of the milk and milk products that was the outline right. So, in that we will first talk about microbial spoilage right.




So again a little background of the microbiology though this is not coming under the purview of the course explicitly, but since implicitly it is also associated; so I hope some knowledge, some idea because there may be some students who had no microbiological background. So, for them this will be a grick; I don't want that right. So, now, we come to these factors influencing the growth of the microorganisms in any food.

We eat milk, we eat any food; so what are the factors those are responsible for the growth of the microorganism. If you remember in some class we had said that the growth curve of microbes are like this right; so, it is lag phase and growth phase and decay like that this is there right. So, this lag phase, stationary phase, lag phase, growth phase; so, those are there I am not going to explain on that because that is not the subject of this.

But what are the factors which will influence the growth of the microorganisms? Definitely you must know because that should be applicable to dairy as well as any food product right. So, we must look into the factors which are responsible for the growth of the microorganisms. For example, I; I give you that you keep some milk just like that

outside and maybe, may not be for couple of hours, maybe for depending on what is what is the outside condition.

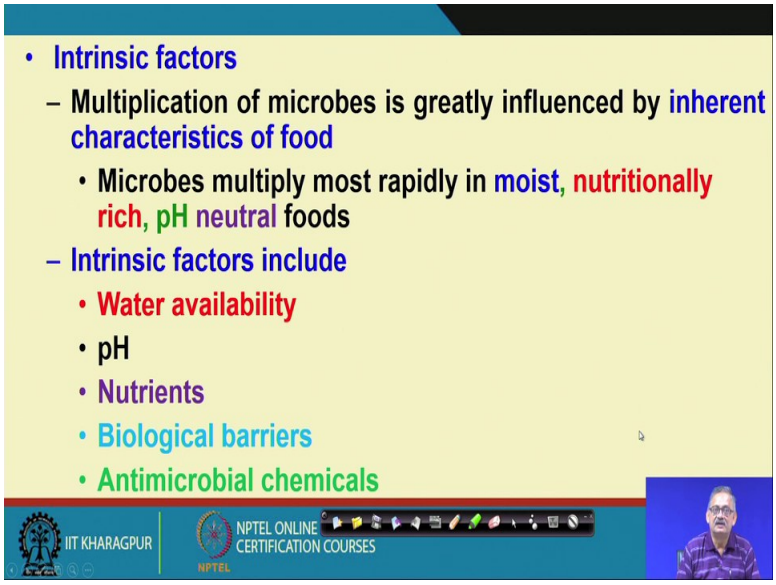
So, in that condition maybe after several hours; I should use that several hours because we don't know what is the outside ambience. So, whatever it be; so that is why after several hours you will come and see that milk is no longer remaining as milk, something has happened to that. So, there it means microbes which we cannot see that is why it is microbe and micro means 10 to the power minus 6; any microbe is 10 to the power minus 6 order.

So, if that be which we cannot see in naked eye; so whether it was originally in milk or it is invading from outside that is not known to us, but whatever it be, whatever be the source of the organism; it got sufficient food in milk that is why it could grow or multiply and then those microbes multiplied microbes, they did action on the milk and milk became not acceptable right.

So, we should talk about the; what are the factors those are responsible for the growth of the microorganisms right? So, there in production and preservation factors that influence microbial growth in production and preservation both, that conditions naturally present in food termed as the intrinsic factors. So, those which are in the food itself the conditions; they are called intrinsic factors and environmental conditions are termed as extrinsic factors right.

So, those conditions which are already prevailing in the food material; they are called intrinsic factors and those which are outside the food material, they are called extrinsic factor. So, these 2 factors intrinsic and extrinsic are governing the growth of the organism; microorganisms right. And factors combined to determine which microbes grow in particular food and at what rate?

So, there could be some; where the combination of these 2 that is intrinsic and extrinsic may also decide that which microorganisms will grow under what conditions right? Which microorganisms will go grow particularly in which food that will depend on the food and the environment both together right. So, these we will discuss today maybe if the time does not permit. We will carry forward to the next class or subsequent classes as and when it is required right.



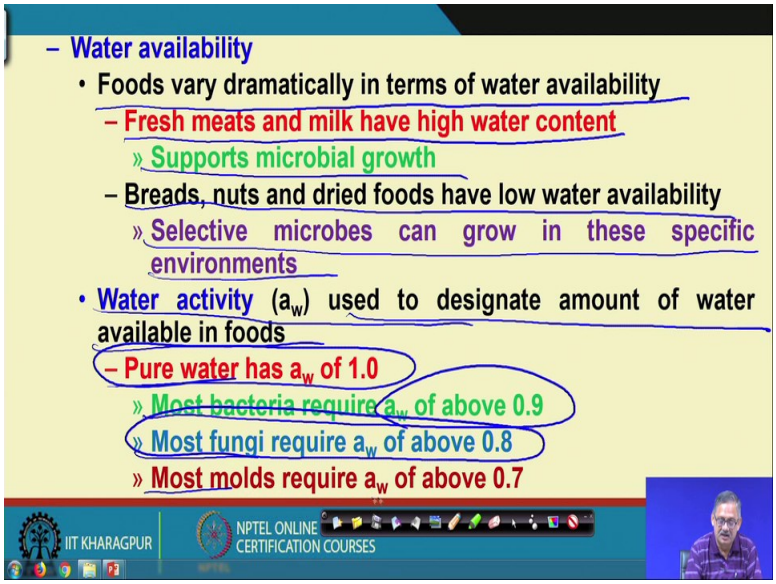

Now, if we look at intrinsic factors what are there? So, the intrinsic factors which are there are multiplication of microbes is generally influenced by inherent character of the food. So, what is the character of the food? Because that is one primary reason right; character means say some are acidic food, some are high sugar food or sweet. So, depending on what type of factors some are less acidic food.

So, depending on this definitely the growth of the organisms will be influenced right. So, if we look at microbes multiply most rapidly in moist; nutritionally rich pH neutral foods right. So, they multiply mostly where it is moist; so moisturize is a primary factor. Again I have referred to many times that water activity; this water activity term is always associated because that is the availability of the water for the organism to grow.

Now, this we are not saying which organisms; it could be bacteria, it could be yeast, it could be mold. Because in the earlier class we said we are concerned food engineers, food scientist, food technologist; we are concerned mostly with these 3 organisms, these 3 types of microbes that bacteria, yeast and mold right.

And earlier in earlier classes we are also showed that bacteria needs high moisture water activity level is high is needs relatively less, water activity is relatively lower than that. And the mold needs even lower that this water activity is even lower, but in all the cases moisture is a must; that is why in dehydrated or dried food, the microbes are not growing or not spoiling the food right. So, where the water availability is not there in dehydrated food which is less than the water activity level required for the organisms to grow right.

So, it is microbes are multiply rapidly in moist, nutritionally rich, pH neutral foods right. So, in that if we look at the intrinsic factors what are they? One is water availability, second is pH, third is nutrient availability, fourth is biological barriers, fifth is antimicrobial chemicals if there is present. So, these are the intrinsic parameters which influence the growth of the organisms right; now let us look in to what it says.




So, water availability; so, water availability we can say that foods normally do have very foods vary dramatically in terms of water availability. Some food do have 90, 95, 98 percents, some foods may have around 50, 60 percent depending on the food right?

Those nuts they are having very low moisture that is why you see that nuts; we go to the shop you just ask and you don't know when it was supplied. Though nowadays as we said in our earlier class in laws and regulations that is mandatory that if it is packed one, then the date of manufacture and expiry has to be, but still there are many many local small scale industries; they do supply in packs and where there is neither the pack; the companies name not the any kind information is given, but still available. In railways you see that many occurs at bring selling those right, but the thing which is of our interest is that those are not getting spoiled.

The same person is selling everyday; maybe he collected 7, 10 days back, but still it is selling. If the package it is not bad if; that means, if there is no external migration of moisture from outside; then though it is remaining same because its moisture content is very low; below the level required for the organisms to grow. So, we say that is why we

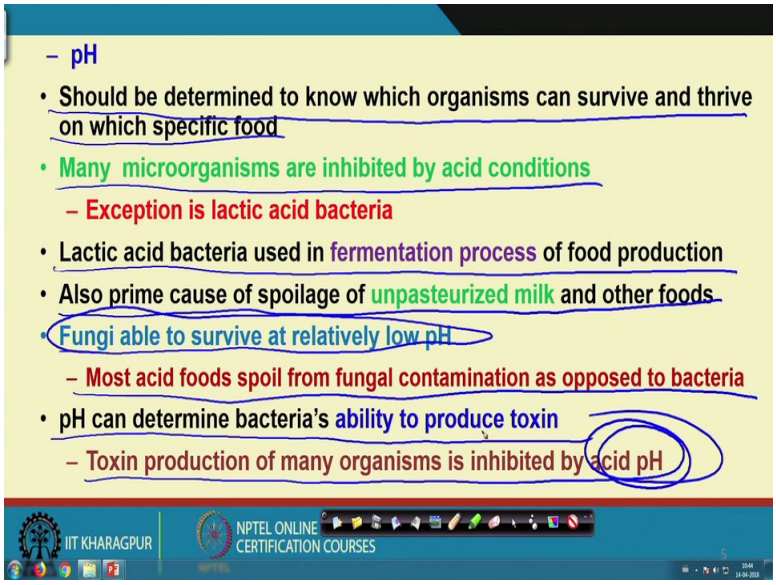
are saying that dramatically it varies right; right from 98, 97 percent in leafy vegetables right to this that cereals, pulses, nuts all these where the level is much much lower.

Now this moisture suppress meats and milk have high water content; if we look at that fresh meat and milk; their water content is very very high where organisms can easily grows that's why they need preservation technique right. And this high water supposed the microbial growth, but others like bread, nut, dried foods have low water availability.

So, there organisms growth is relatively much much lower or at a lesser rate depending on the moisture level. Selective microbes can grow in these specific environments right; so, we come to water activity which says and we defined earlier also; water activity in all practical purposes, we define as the in this way as the ratio of partial or vapour pressure of water in that food, vapour pressure of water in that food at a temperature that temperature. And the vapour pressure of the pure water at that temperature, this ratio says the water activity at the temperature in that food right.

So, water activity used to designate amount of water available in foods which we are repeatedly saying. So, pure water has an water activity of; has a water activity of 1. Whereas, most bacteria they grow at a water activity of 0.9 and above, most fungi or fungi require water activity of 0.8 and above and most 4 molds require water activity at 0.7 or above right.

So, depending on their water activity that is the availability or in turn availability of moisture for the organisms to grow, the different organisms grow at different moisture level right; so this is one intrinsic property.




So let us go to the others because if we discuss in one only, then we will be stuck of; pH pH as we just said that if it is high acidic food then its chance of getting infected by organisms are much lower compared to those whose pH or acidity is much much higher or closer to neutral.

Because in the beginning we said, if the if the nutrition or nutrient availability, moisture availability and pH level net neutral foods are there; they are the most ideal for the microbes to grow. So, pH has a great influence on that right; so we can say that pH should be determined to know which organisms can survive or thrive on which specific food right. So, many microorganisms are inhibited by acidic conditions right exception is lactic acid bacteria.

The other day, I was saying if you remember that lactic acid bacteria they are using the lactose in milk and that lactose is converted into lactic acid. Now the beauty of it is that lactic acid is being produced by the lactic acid bacteria. And lot of lactic acid is bringing down the pH, now under that conditions other organisms cannot come in and get into that.

So, lactic acid bacteria is producing lactic acid; so, which of course, after certain time these organisms also will not survive or we will not be able to grow. But for the when they are active; others cannot come and because the acid level is high right. So, this is a unique thing that lactic acid bacteria, they can grow in the acidic medium, but many many organisms cannot grow right.

So, lactic acid bacteria used in fermentation process of food production normally in many cases this is a desirable; in some cases it may not be desirable detrimental depending on that I gave the example of knife. So, sometimes you can use it for good cause, sometimes you can use it for bad cause. So, like that here also the lactic acid can be or bacteria can be used for good cause or that is fermentation technology or can be there they can be they can be seen from the point of view of detrimental organisms or which can cause bad to the food.

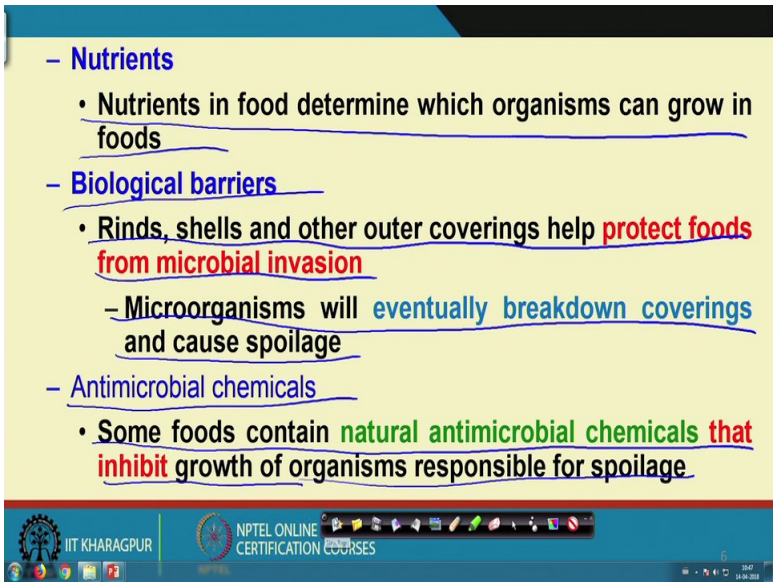
So, depending on what, how you are looking at, where is the use; it can be good or it can be bad. Also prime cause of spoilage of unpasteurized milk and other foods, this lactic acid organisms are also as we said the example you keep some even pasteurized milk also if you keep it for some time that is sufficiently if you give time then that milk may get wrong or may get spoiled right.

Primarily by might be because of the lactic acid producing organisms, but if it is not if it is not pasteurized then from the source where from you are bringing; from there after sometime couple of hours, it will get wrong because of this lactic acid producing organisms. Fungi available; fungi are available rather to survive at relatively low pH right. Fungi are able to survive at relatively low pH; most acid food spoil from fungal contaminations as opposed to bacteria that is the again another thing to remember. That if it is acidic food, then it may not have that much threat for getting spoiled by bacteria, but there is lot of possibilities that it may be infected by fungus.

So, fungi maybe there and it may cause the deteriorations; so you have to take care not the bacteria, but the fungus. So, because they can also some of them can also tolerate high acid food or high acid condition; pH can determine bacteria's ability to product produced toxin; that is again some p high if it is high pH, then may not be the product which is desirable are being formed. Some products which are not desirable like toxic materials, they can be produced by the organism which are toxic; so that is not desirable.

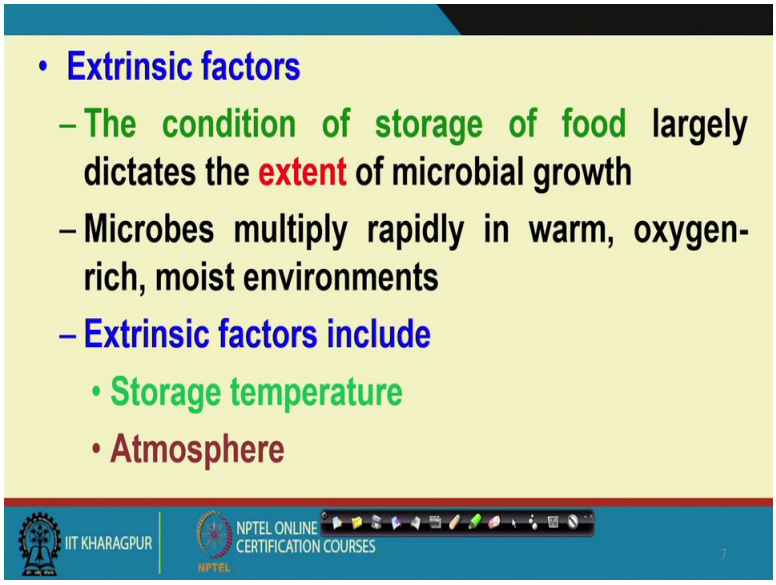
Toxin production of many organisms is inhibited by pH; so pH is one of the regulating factor. So, if you don't want toxin to be toxin to be produced in the food; so that pH is regulated or high. One of the best example is at home; what you see that that achaar or what you call pickle right; so those pickles are at very low pH and you just keep on the table, you do not keep it in the refrigerator also. And maybe for months together or may

be years you are consuming those pickles, there are primary reason it is having high pH and high acidity. So that is not allowing other organisms to grow or toxic materials to grow right. From pH, let us now move to others like nutrients right.




So, nutrients are in food determine nutrients in food determine what; which organisms can grow in which food? That what a the nutrient is available in which food that will dictate which organisms will grow right. Biological barriers; biological barriers like rinds, shells and other outer coverings help protect foods from microbial invasion rinds; means that hard cover like the shell of the your orange right.

So, they are called rinds; so shells like your egg shell right. So, these are this covered, this protect food material from this is given by nature from the invasion of the organisms, unless there is some abuse or something; so it is not getting spoiled by organisms, so easily. Microorganisms will eventually breakdown coverings and cause spoilage of course, is it is for sometime but not for all the time because some or other kind of bruise is always there and the organisms do with bend and ultimately spoil including that rind also, but it takes long time. Some antimicrobial chemicals are also controlling or affecting the growth like some foods contain some natural antimicrobial chemicals that inhibit growth of organisms responsible for the spoilage right.




So, let us look into some other because we would like to complete that intrinsic factor ok. So, intrinsic factors we have completed and our time is also less; so, out of which we have seen that for the intrinsic factors primarily it is the moisture which determines a lot, then the nutrients. And after the nutrients it is the pH which affects directly and if there are some chemicals which act as the antimicrobial agent.

So, these are the factors; intrinsic factors which control the growth of the organisms' right? So, the extrinsic factor which will come; we will do it in the next class ok.

Thank you.