Course on Industrial Biotechnology
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Lecture 50
Module 10
Cheese Production

Welcome back to my course Industrial Biotechnology. Now today I am going to cover a very interesting topic that is the cheese production because you know that nowadays throughout the world cheese has been largely used, previously it was spreaded in the western country because most of the people they used to take cheese but slowly slowly this spreaded in the our country also.

First problem is that what do you mean by cheese, cheese is kind of food product through which we can preserve the milk protein and fat for longer period of time. Now question comes how because as we know the milk protein and fat they are very good for human health. So so but we cannot preserve the milk protein and fat in the form of milk for longer period of time even if you do the pasteurization then after some time that milk will be spoiled.

So so the cheese is a process through which you can preserve the milk protein and fat for longer period of time because the the main reason behind that is that cheese is produced through one process what you call curd making process and through this curd making we it produces some lactic acid and lactic acid there is a enzyme called rennet they precipitate out this milk protein and fat and that comes out in the soluble form and liquid that comes out from this industry we call it whey.

And so this is this is during this fermentation process during the curd making process is produce a lactic acid and as you know as I mentioned before the lactic acid used as a good preservative. So that is the reason that when you you you prepared the this that curd after that the you separate the milk solid and fat in the form of solids and then you reduce the moisture content significantly then there is a process in the cheese making I shall show you what you call heating, cooking and also salting process and through which we can have the different type of cheese.

Now you will be very surprised to know that in the world there are more than 500 varieties of cheese available and some cheese you can use as a spreader, some cheese you can take directly as a food.

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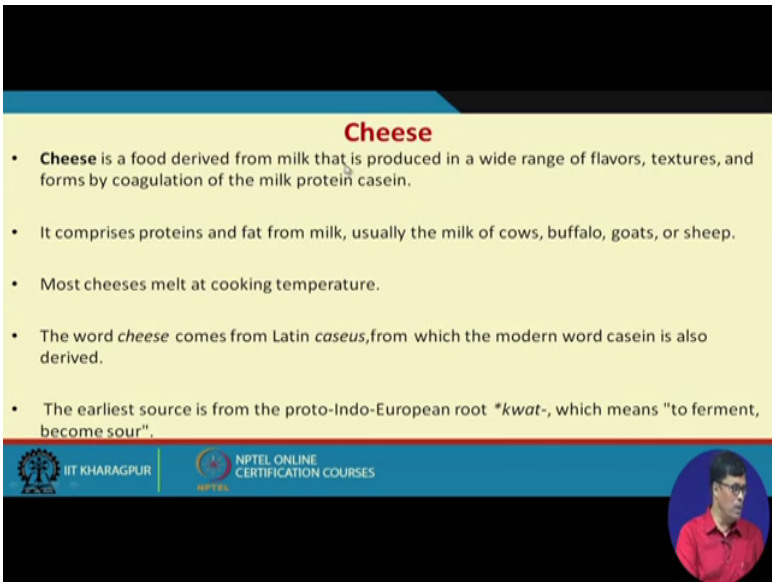

So let us discuss this process in details. Now cheese is a food derived from milk that is produced by wide range of flavours, textures and forms by coagulation of milk protein casein. It comprises of protein and fat from milk usually milk of cow, buffalo, goat and sheep milk, you know that here I want to point out that the cheese may be of different colour it may be if you want perfectly white colour we go for sheep milk that but but usually in case of cow cow milk and buffalo milk sometimes we add some kind of colour also in the in the cheese making process to give a yellow colour.

So most of the cheese melt at cooking temperature the word cheese comes from the Latin caseus which from which the modern word casein is also derived. The earlier source is from the proto proto-Indo-European group kwat which means to ferment becomes sour sour because at this fermentation during the curd making process is produced lactic acid

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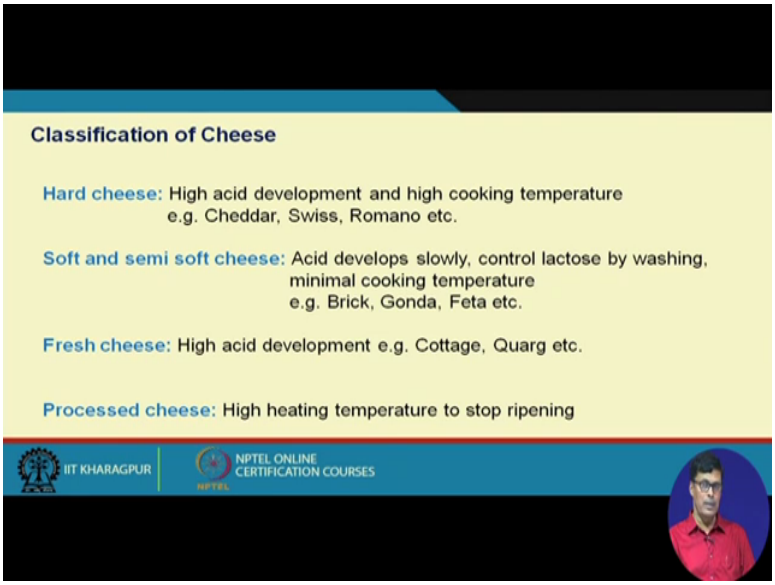

Now what is the classification of the cheese there are four different broadly it can be classified one is called hard cheese, another is soft and semi soft cheese, another is fresh cheese, another is processed cheese. The hard cheese means high acid development and high cooking temperature because as you increase the cooking temperature the texture will be more hard and as you reduce the temperature the texture will be little bit soft that is why you call it hard cheese. Example are Cheddar, Swiss and Romano these are the very famous cheese particular Cheddar is is largely used in the UK.

Soft and semi soft cheese acid develops slowly and control the lactose by washing because if you if you wash out the lactose naturally the acid production will be very small very low because because lactose is converted to lactic acid and minimal cooking temperature. The example are Brick, Gonda and Feta these are the example of this soft and semi soft cheese.

Now fresh cheese is the high acid development as per examples are Cottage and Quarg and processed cheese actually high heating temperature to stop ripening because one important step of the cheese making process the ripening So it usually heat very high temperature to stop the ripening process.

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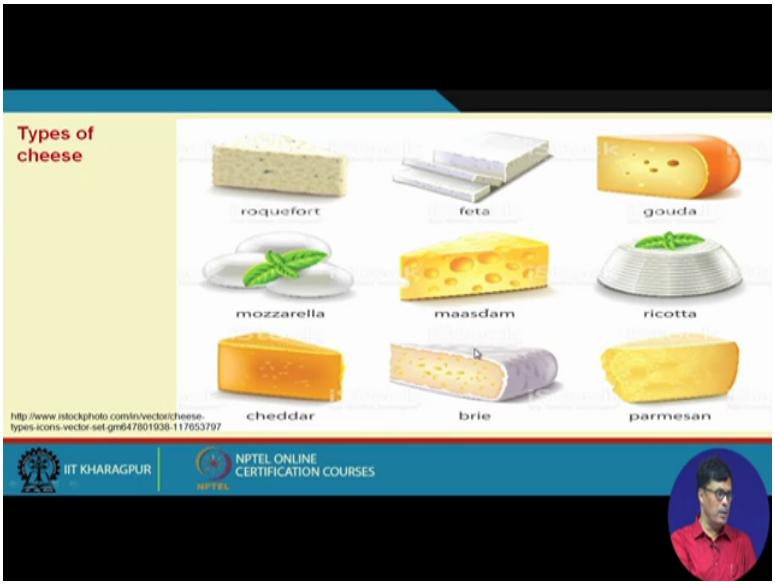

Now if you look at the how it looks that you will find here that this is Raquefort, this is feta, this is Gonda, this is mozzarella largely used then ricotta, cheddar cheddar is looks like this brie and parmesan, this is a kind of cheese.

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Six types of cheese use extremely in the in the pizza pizza six pizza this is what you call Parmesan then we have Monterey jack, then Romano, Mozzarella and Provolone and Cheddar that use in the cheese cheese is an ingredient six pizzas.

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The ingredients that required for this cheese making process is milk, salt, rennet and starter culture because all are all plays very important role in the cheese making process obviously that that milk quality of the milk I shall show you how the quality of the milk affects the cheese production process. Now before that I want to tell you that about the cheese, cheese is the bacterial ecosystem that is in constant transformation as it mature through the numerous biochemical transformation during the life span. So it it undergoes lot of biochemical transformation process during this bio during this cheese making process.

So milk quality because milk contents I told you that cheese making process is a is a process through which you can preserve the milk protein and fat for longer period of time. So milk quality plays very important role particularly the the the milk contains fat and proteins. Now if the fats and proteins is high naturally the yield of cheese will be high. If if milk and protein is less then yield will be less. Salting is usually done not only to develop to test to reduce the bacterial contamination

Rennet is kind of groups of enzymes particularly proteolytic enzymes that is used for separating out the casein that you know precipitation of protein and starter culture that is largely used like you know that is curd making process we use the lactobacillus casein, Leuconostac lactis the different type of that organism so we use for the for the curd making process.

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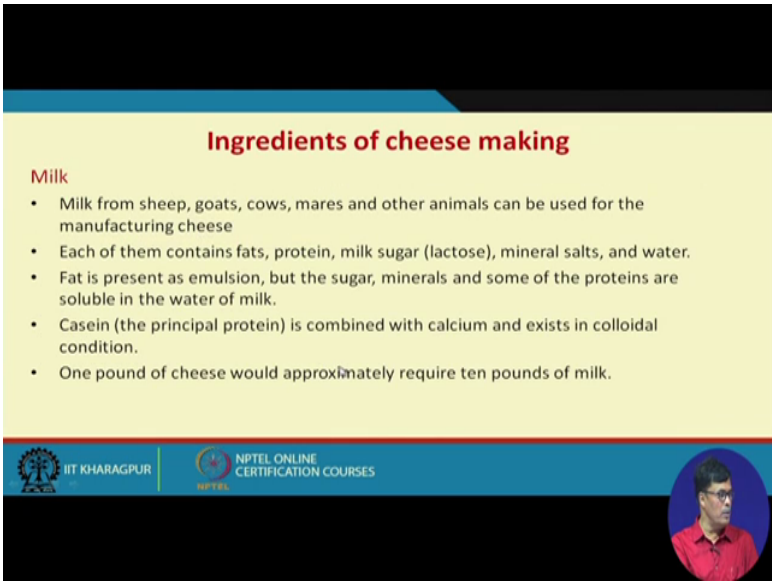

Now milk from the sheep, goat and cows mares and other animal can be used for manufacturing cheese. Each of them contains fat, protein, milk, sugar, lactose, minerals and water. I shall give you very detail analysis of this process and fat is present in emulsion because we know the fat is insoluble in water so it should be it should always present in the form of emulsion but the sugar, minerals and other proteins are usually remained in the soluble form in the milk.

The casein in combination with with calcium this is very interesting, it has been this is typically added during the curd making process that calcium iron in the form of calcium fluoride and in the normal curd making process, you might have seen that when you cut the curd it spreaded the water because natural I shall show you the picture and but in case of cheese making process you know curd making process in cheese production we add some calcium chloride to make the structure of the curd little bit harder. So you can cut it, if you can make it in the forms of blocks.

So 1 pound of cheese would approximately require 10 pounds of milk this is your product is approximately one tenth it may be little less or more than that. It depending on the several factors.

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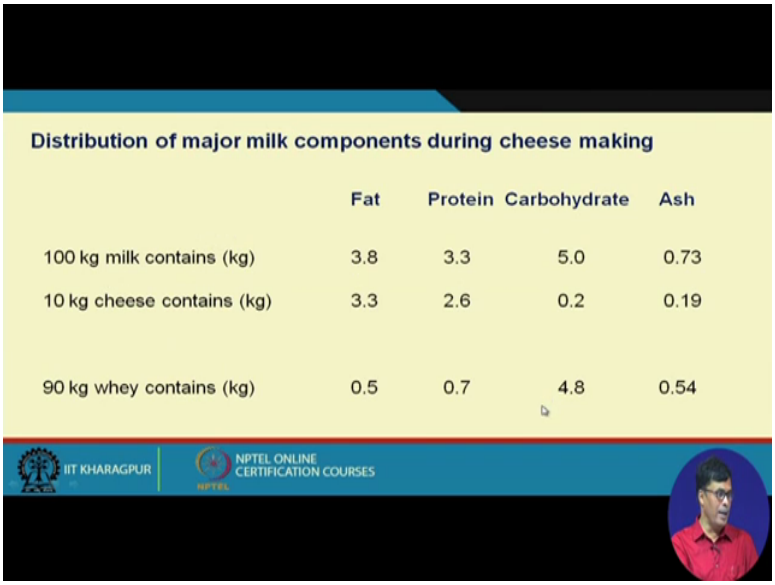

Now I can give a typical analysis that that if you have the major distribution of major milk component during the cheese making process. Now suppose we take 100 kg of milk it contains 3.8 kg usually that if you consider the cow milk usually it is if you consider the buffalo milk usually the fact contents it is high.

So this is 3.8 kg that 3.8 percent weight by volume then or weight by weight you can say that 3.3 kg of protein and 5 kg of carbohydrate in the form of mostly in the form of lactose and (0.3) 0.73 kg of ash, ash means it is minerals. Now when we produce I told you the 10 percent of milk that converted into the cheese now if you assume the 100 kg of milk produced, 10 kg of cheese then it contains 3.3 kg of fat, 2.6 kg of protein, 0.2 kg of carbohydrate and 0.19 kg of ash.

So this indicates during this cheese making process most of the fats and proteins they recover in the form of cheese but carbohydrate and ash that goes in the mostly in the form whey you can see the 90 gram whey contains about (0.3) 0.5 grams of fat, 0.7 gram of protein and 4.8 out of 5 kg of this carbohydrate and 0.54 kg of ash.

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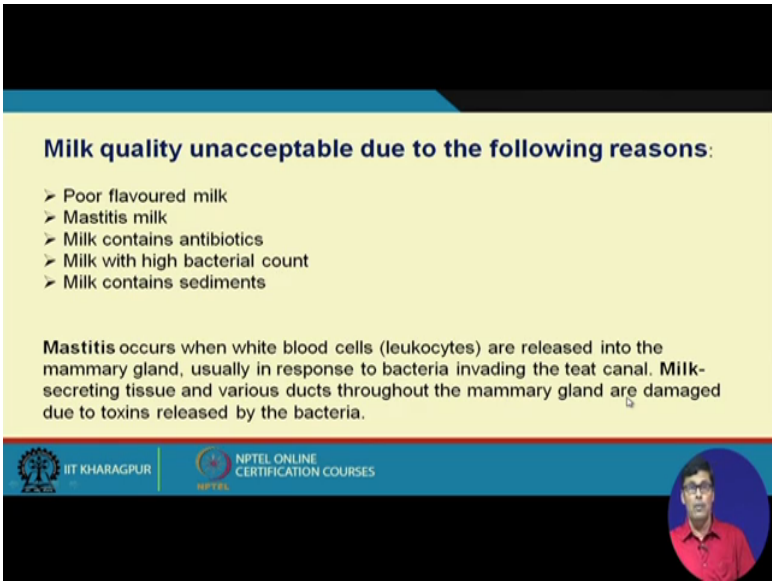

Now milk quality plays very important role in in in the curd making process that the quality of the milk now question comes what are the parameters that determine the quality of the milk. The first parameter is the poor flavour milk if it gives a very bad flavour that is undesirable that is not desirable. There is another property called mastitis that milk but the mastitis milk is that that there is a kind of disease that you have in the curd, in the cow and if cow suffering from mastitis disease then then it is it is quite possible those bacteria may come in the in the milk.

And then milk contains antibiotics because when cow undergoes some kind of infection we apply some kind of antibiotics and these antibiotics is present in the milk that will hinder the bacterial growth, so your curd making process will be affected and milk contains high bacterial counts that is also undesirable because if you high bacterial count there is every possibility of contaminations, then milk contains sediments some of the milk they have the sediments because that is also not desirable.

The mastitis the explanation is given here what we call mastitis occurs when white blood cells are released into the mammary glands usually in response of bacteria invading the in the teat canal. So this bacteria will comes in the milk that that is undesirable.

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So now another another important things is that milk contents uhhh milk can use in milk lot of pathogens can grow and this milk of the pathogens are micro bacterium tuberculosis TB we know that, then cell staphylococcus aureus, then salmonella species, shigella and E coli. These are the different pathogenic organism that can grow in the milk.

So that is reason why we cannot preserve the milk in the as it is for longer period of time, so if you reduce the moisture content then and only then the growth of the organism will be reduced and at the same time we produce some lactic acid which acts as a preservative and also it contains some salt so that this will not allow the other bacteria to grow.

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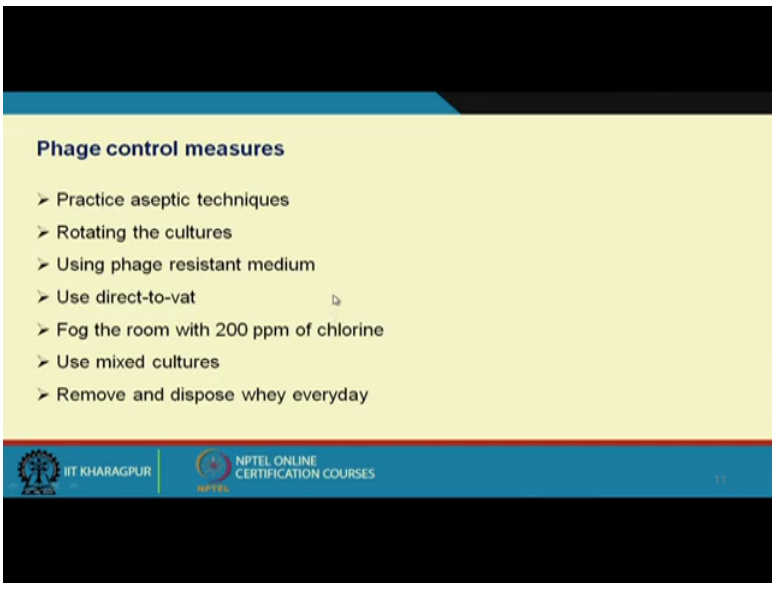

Now there is a another problem that we have in the curd making process that is the phage contamination problem you know we know the bacterial phage that will attack because this is kind of parasites this attacks with it grow on the bacteria and kill the the bacteria and this is if this any kind of phage contamination take place then it will not allow the bacteria which use for the curd making process to grow. So your curd formation process will be totally affected. Now question comes how we can hold how we can avoid these kind of contamination problem, phage contamination problem.

There are several remedies are there practice the acetic techniques this if you if you conditions with the aseptic it is possible to avoid the phage phage that contamination problem, rotate the culture daily. So you know that if you use the cultures daily because it is not the same culture you are rotating every day then it is not it will cause some kind of problem, using the phage resistance media because if the media has some kind of chemical compound which not allow the phage to grow, direct to fat we do not use any kind of intermediate system directly we add the culture in the vat.

And fog the room with 200 ppm of chlorine let me here tell you that when I talk about air sterilization process you can remember that I told I told that two type of air is we have one is stagnant air, another is moving air because the air that is passing through the pipe line the compressed air that is we usually sparse through the reactor bioreactor to for the growth and multiplication of the organisms because organisms can grow only can use only the dissolved oxygen that is present in the fermentation media.

But in case of this this curd making process this curd formation usually take place in the open vat. Now naturally the room in which this curd making is taking place that should be that should be free from the contaminants. So how you do that we just fog this room with the help of oxidizing agent like chlorine, sulphur-di-oxide like this we can we can we can iodine we can we can we can we can use in fogging the room with that so that no bacteria can present in this room and so that your your culture can grow properly.

So this is one, another very interesting very interesting mix culture because you know that as I as I talked I was telling about the phage contamination problem, the phage is very specific with respect to a particular bacteria. So if you if you have one bacteria only in your culture then and if attacks it phage attack the bacteria then whole process will suffer. Now if you have 2-3 different types of bacteria present in the culture they even phage is very specific for

one bacteria the other other bacteria will grow because it will not affect the growth of other bacteria.

So usually it is recommended. The mix culture is preferable for the curd making process. And remove and dispose off whey everyday because whey is the byproduct of the cheese making process this is to be removed and disposed off.

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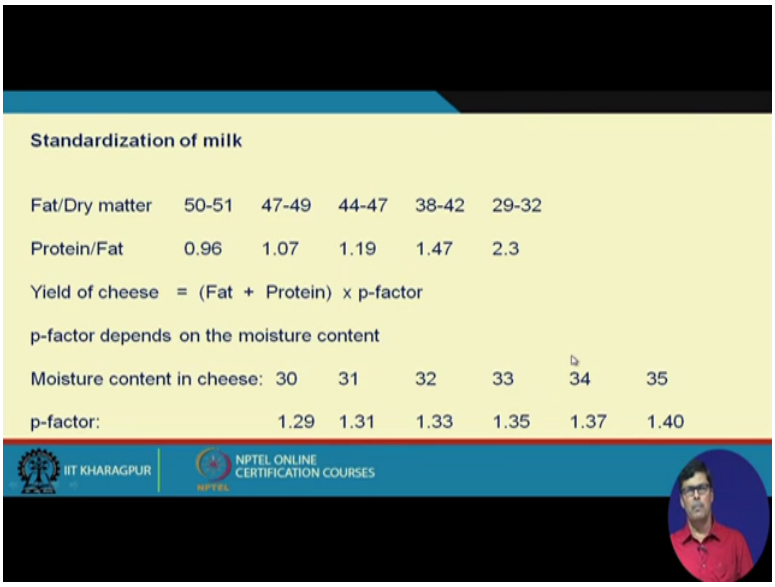

Now another some kind of calculation I want to show you that how you can how you can calculate the how much cheese you can produce from the 100 kg of milk. Now it is very interesting the fat by dry matter ratio that as it is decreases then you see that protein fat ratio that will increases because you know because dry matter total dry matter comprises of what comprises of fat, comprises of protein, comprises of carbohydrate, comprises ash, so if this this ratio decreases then what will happen the protein fat ratio will increases so that ratio will be this.

Now now yield of yeast yield of cheese means that you know on the this yield is always calculated on the basis of 100 kg of milk. So 100 kg of milk it can produce how much of cheese how we can calculate the equation is very simple percentage of fat plus percentage of protein and it is multiplied by the p factor and p factor is totally dependent of moisture content as the moisture content increases the p factor value will increases.

So here you can see that if the moisture contains 30 percent p factor is 1.29, so you have to multiply here 1.29, if it is 31, 1.31, 35 percent is 1.40 if you keep on increasing the p factor will increase.

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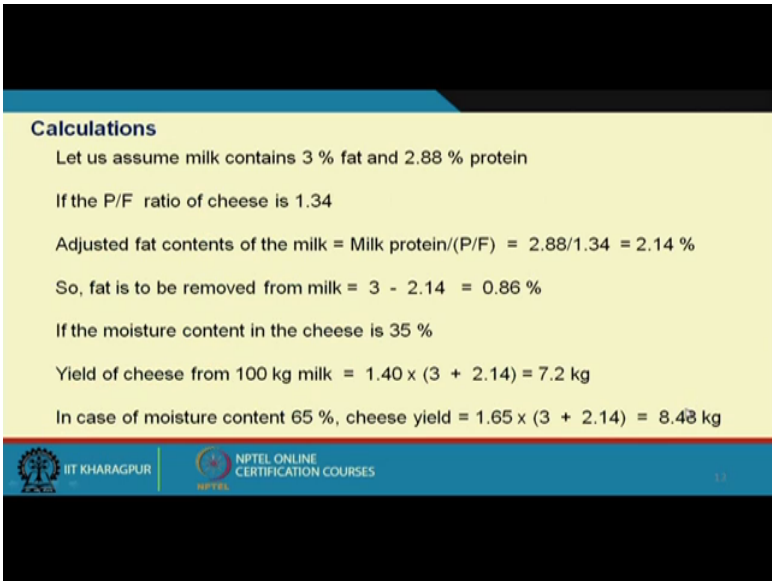

Now I have taken a typical example suppose one milk contains 3 percent fat and 2.88 percent protein and we want to produce a cheese where the protein by fat ratio should be 1.34. Now question comes then how we can do that. So you have to develop the you have to prepare the milk accordingly so so how you can adjust the fat content in the milk, the milk protein how much we want we want that suppose we want 2.88 percent. So 2.88 percent is the milk protein if you divide by P by F ratio that 1.3 we can easily find out how much fat is required, so that is required 2.14. What is the fat contained in the milk is 3 percent so how much fat you should remove 3 minus 2.14 that is point 86 percent.

So this fat is can be easily removed from the milk you know there is a process called churning process and through the churning process this is how we produce the ghee and other things because through the churning process we can separate the milk fat and this fat we can use for making different butter or ghee like this we can produce. That so you know that so we can easily through churning process we can we can separate out this much of fat from the milk and and then you you see that let us assume the moisture content of this cheese is 35 percent, then 100 grams of cheese is this is 30 percent if you look at if I can show you the exact calculation of this.

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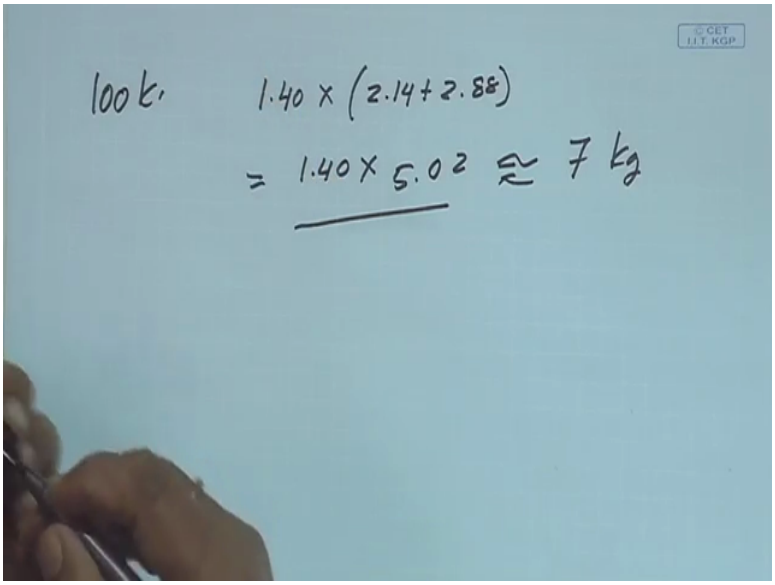

This will be 1.40 into this is we we want fat is how much this is 2.14 and protein content is 2.88 so this is to be added so if you add 1.40 then this should be this is 2, this is 0 and this is 5 so if you multiplied by 5 this will get approximately 7 kg approximately 7 kg of cheese. So 100 kg milk is produced about this this figure is this is little bit wrong it will come so this is similarly this also you can correct this will be replaced by 2.88 because 2.88 is the protein content.

So this will count around 8 that this is. So I want to show you how the moisture content affect the yield of the cheese, if moisture contain 35 percent it is around 7 kg, if it is 65 percent it would be around 8 kg.

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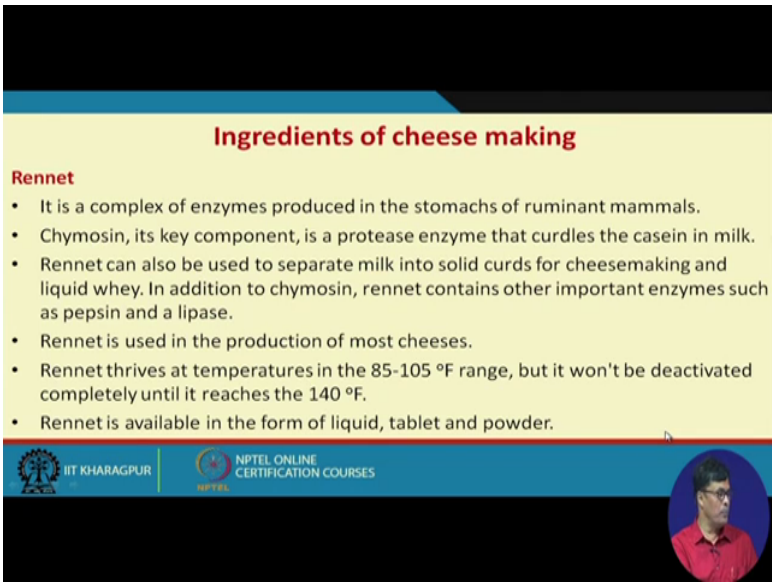

Now other ingredients present in the cheese making is the rennet that it is a complex enzyme produced from the stomach of the ruminant mammals because it is a different type of enzymes and mostly it is proteolytic enzyme. The examples they have given that is the chymosin this is the a key component it is a protease enzyme that curdles this casein in milk. So that this rennet can be used to separate milk into solid curd for cheese making process.

So this facilitated the solidification because one thing is that when you what is the what is the purpose of adding culture in this curd making process. I told you it is it is main purpose is to produce lactic acid and since the lactic acid this acid will reduce the pH as it reduce the pH it will precipitate out the proteins and fats. But you know if you use rennet then further you know whatever other protein is there further precipitation of protein also may take place in this system. The rennet is used for the production in most of the cheese rennet thrives the temperature 85 to 105 degree say finite range is would not deactivated completely until it reaches 140 degree Fahrenheit and it is available in liquid tablet and powdered form.

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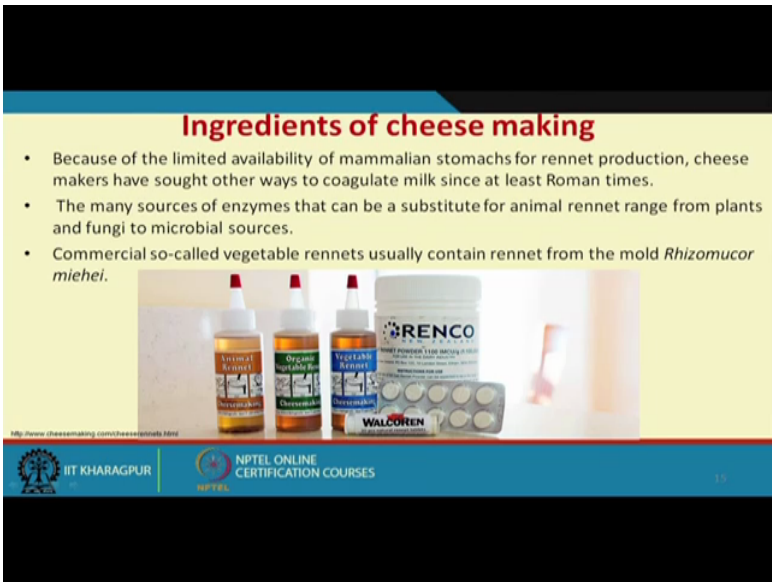

Now this is this is how it is available in the market that is the rennet that I do not like to discuss much in details written here that it can be taken for we talk about the animal system but it also can be from the plant system, fungal system also we can have and commercially so called vegetable rennet usually contain rennet from the molds this Rhizomucor miehel.

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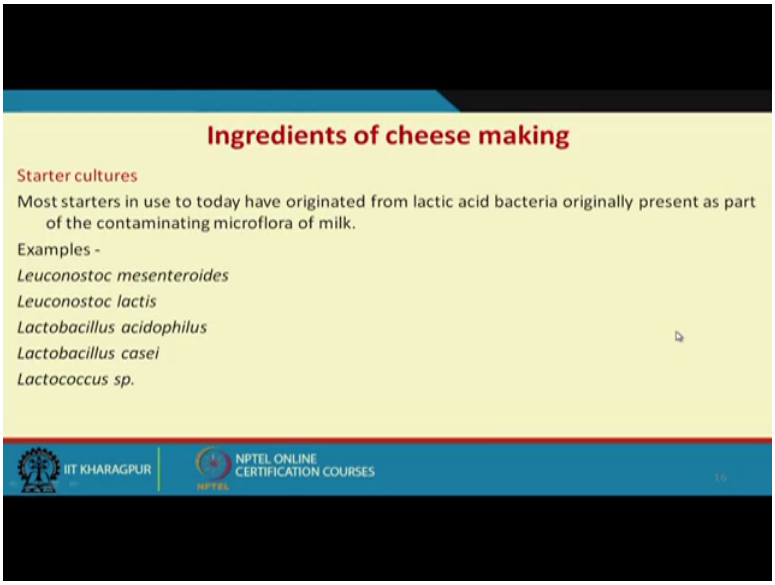

Now let us let us talk about the culture that what are the organisms that is used in the cheese that you know curd making process and if you find that most of the starter today has originated by the lactic acid bacteria, originally present as the part contaminating this micro product that lactic acid bacteria itself present in the milk and it is like Leuconostac mesenteroides, the Leuconostac lactis, Lactobacillus acidophilus, Lactobacillus casei, Lactococcus species so different type of things.

Now one very interesting thing is that different lactic acid producing bacteria they develop the different acidity in the reaction mixture, so depending on the type of acidity that you require whether you required high acidity and low acidity you can choose your culture.

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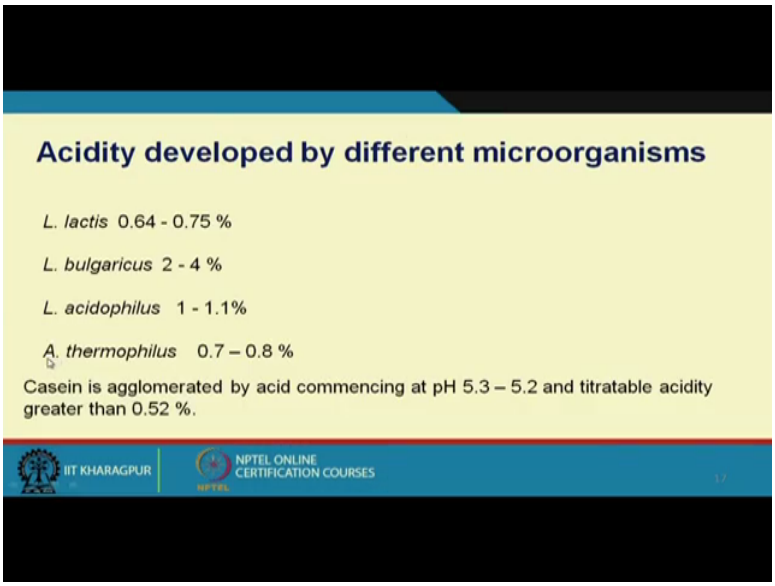

I can give the example that lactobacillus lactis, lactobacillus bulgaricus, lactobacillus lactis if you use then acidity developed is about 0.64 to 0.75 percent. Lactobacillus bulgaricus it is quite high 2 to 4 percent, lactobascillus acidophilus is 1 to 1.1 percent, lacto this is this is a thermophiles this is 0.7 to 0.8 percent, the casein is agglomerate by acid commencing at pH 5.3 to 5.2. So when pH reaches 5.3 to 5.2 the casein which remain which is the major protein that present in the milk that is case precipitated and testability of acidity is greater than 0.52 percent.

So you know that this is the thing if the acidity increase 0.52 percent then the precipitation of the proteins that will take place in the in the in the milk.

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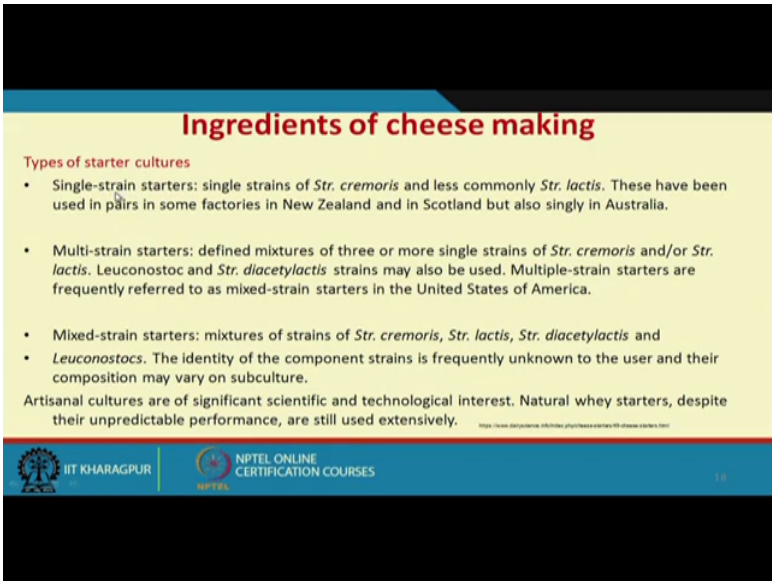

So this is the type of starter. Single strain starter, multi strain starter, mixed strain starter that we use I already point out that that we prefer the mixed strain starter to avoid the phage contamination problem that this is.

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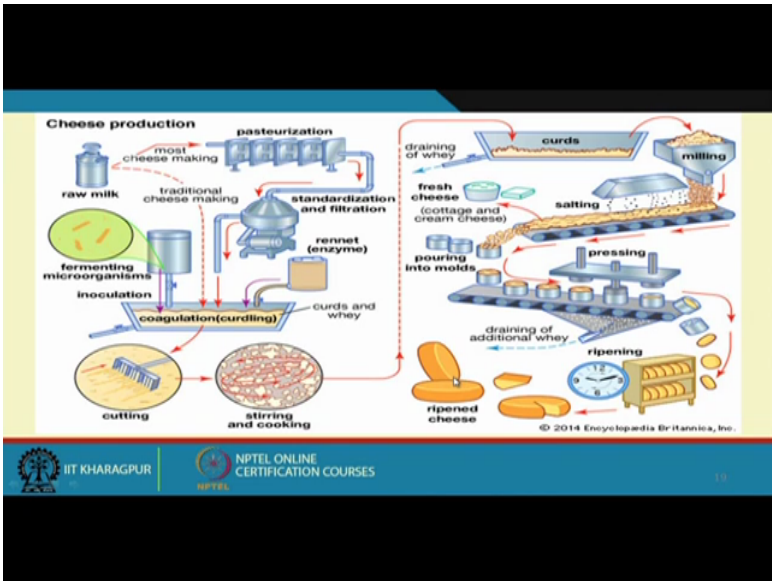

And this is the flow kind of flow diagram of this process this is the raw milk you see that and then we we take it here we do the pasteurization of the milk this is very important because pasteurization means it is killing of pathogenic organism, then we standardize and filtration. Standardization means we add different components here as per the requirement, I told you calcium chloride is very important ingredients in the curd making because it make the structure of the curd very hard and then we we do the culturing we add rennet or use culture here to form the curd.

And this curd this is this is will be hard so you can cut this you know that I told you that due to the presence of calcium chloride the structure is a little bit harder so you can make in the form of blocks, then stir it and cooking it, cooking is done at different temperature then you give the liquid you can separate the liquid what is called whey and this you do the milling uses the kind of you know mix that you know we mixing is there and then we put some kind of salting here and then we put it in the in the different package.

So then we have we do the ripening of the cheese, this is the kind of flow diagram that we have and this is different molds we can see different molds means different structure we can give as per our requirement.

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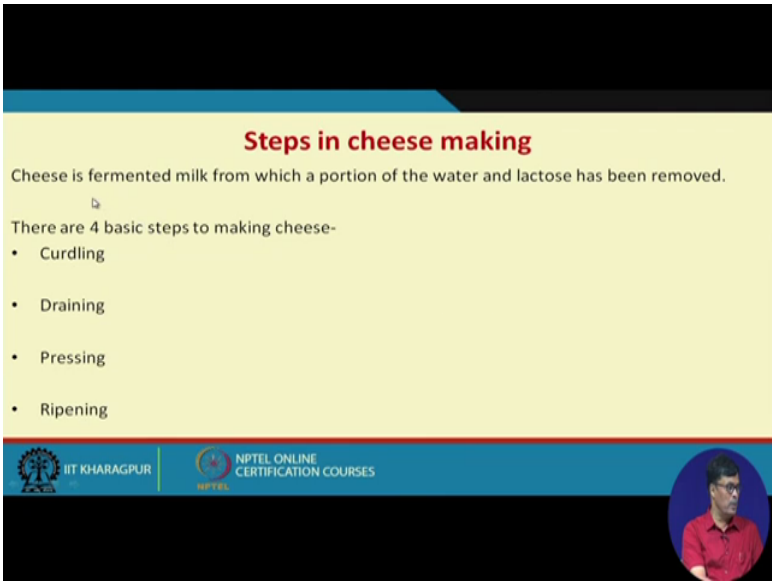

The cheese is a fermenting milk which a portion of water and lactose has been recovered, four steps are there one is curdling, draining, pressing and ripening. So these are the four important steps involved in this.

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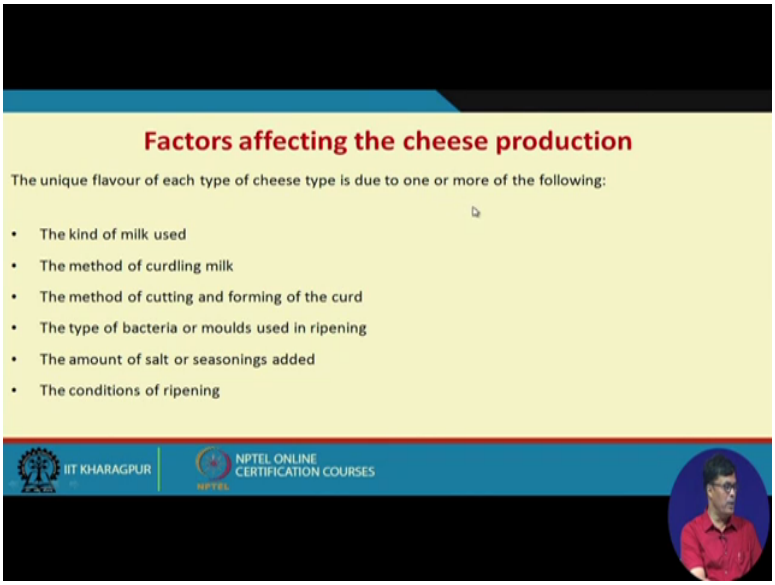

So as I as I pointed out it depends on the kind of milk used, method of curdling of milk, method of cutting and forming the curd. Type of bacteria of or mold used for ripening and amount of salt or seasoning added and condition of ripening. These are the different factors the affects the cheese making process.

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Now I already talk about the milk that plays very important role and this the composition and quality of the milk that plays very important role in the and you know one thing I forget to tell you that I was talking about that in case if you if you want to reduce the fat content from the milk you do the churning process but in case suppose you want to increase the fat content in the milk, then how will you do that, so what you do as I as I pointed out the fat is insoluble material it is not soluble in water.

So you have to pass you have to you have to uhhh that fat you have to pass through the homogenisation process so that you can you can you can disintegrate the fat fat particles to the to the very small sizes so that it can remain in suspension in the milk, this is how we can increase the fat content in the milk.

So this is the sterilization we have we we we used to do we can use the raw milk pasteurized milk, ultra pasteurized milk as per our requirements we can do that. Use of milk I already discussed what should be the quality of the milk.

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And this is how the curd making process is taking place here in open vat. I think in the in the next part of this lecture I shall I shall discuss the process of cheese making in details, thank you very much.