Dairy and Food Process & Products Technology
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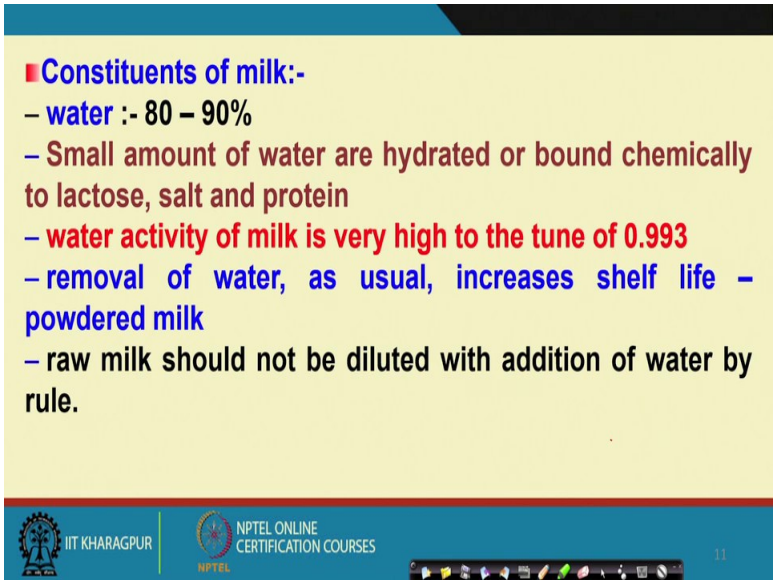
Lecture - 19
Milk - Constituents

So, keep in mind in the previous class we said that don't consume that curdled milk if it is curdled by nature right, by nature means just keeping it for long time outside, then don't take it ok. Now again in this class of the Dairy and Food Process and Products Technology, we are in the lecture 19. So, what are the constituents of milk? We have seen how it is, how it is a looking, what are the taste, etcetera, etcetera.

Now, we will come to the constituents of the milk ok, that we will come and we will see that how acidification and others ok.



Now constituents of milk are like this, water it contains around 80 to 90 percent; 80 to 90 percent water, as we have said in some class that depending on the source, depending on the type, depending on the species, this composition varies widely. So, that is why we are saying 80 to 90 percent roughly; again it it is it is not that any milk will contain either 80 or 90 percent depending on many many factors, this varies between that this is a representative number right. Small amount of water are also associated in milk as hydration. I hope you have seen in school chemistry that hydrated right say copper copper sulfide hydrated right.

So that means it contains may be 2H 2 O, 5H 2 O as hydration, so like that hydrated way some amount or some very small quantity of water may be also associated as hydration or they may be bound chemically right. As may be to the lactose or may be to salt or may be to protein depending on case by case right; so, that is how some water is also there.

Generally the water activity another term which may be we have said, but if have not let me also tell here water activity. This is a parameter by which we tell how much water is available for the organisms to grow, how much water is available for the organisms to grow by definition, we call it to be water activity as ratio of vapor pressure of water in the food material at a temperature to that of the pure water at that same temperature, this is the definition of water activity right.

So, milk contains high water activity because we have seen that it is around 80 90 percent of water. So, it is water activity is almost 0.99563 depending on case by case, but it is very high more than 0.9 right and if I have said then could be a repetition, but still better to repeat that water activity if it is around 0.9 onwards above rather water activity varies between say 0.1 or even say 1 to 1 to 10 rather 0.1 to 1 it is upto 1 right or 0 to 1 we can say though it is not 0 since 0.1 or even lower is there. So, that depends on the ratio of the vapor pressure in the water as well as in the pure water, so at a temperature given temperature so that ratio can be very close to 0.

So, that is why it is between 0 to 1, 1 is the maximum right, so if it is 0.999 like that then it is close to 1. So, anything beyond 0.9 that is good for organisms like bacteria to grow. So, bacteria grows around 0.9 water activity and above, 0.8 water activity and above is for the yeast, yeast to grow. if we if we classify the organisms in 3 classes bacteria yeast and mold, I hope I have said in earlier class bacteria yeast and mold.

And in that case yeast is around 0.8 and mold is around 0.7. So, 0.7 onwards mold can grow, 0.8 onwards yeast can grow, 0.9 onwards bacteria can grow. Obviously 0.9 not only bacteria bacteria yeast mold all 3 can grow, but if it is 0.8 bacteria cannot grow, yeast mold both can grow; if it is 0.7, then yeast cannot or bacteria cannot grow only mold can grow.

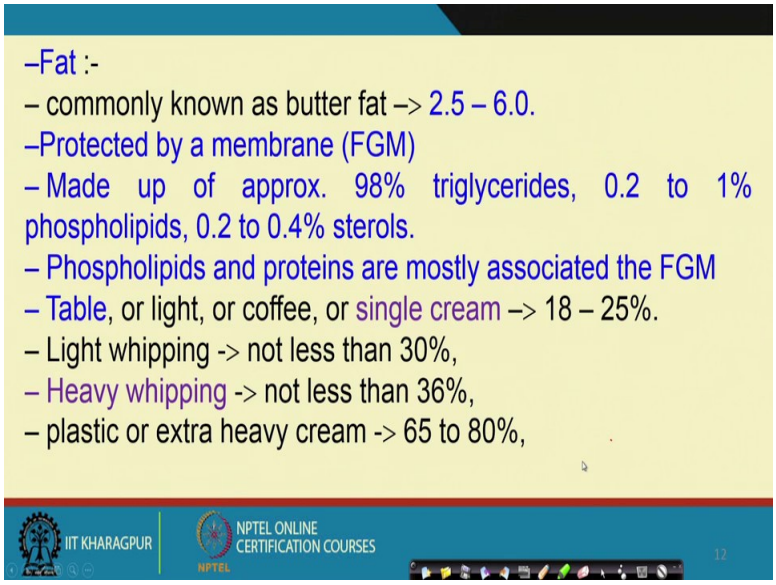
So, if it is less then 0.7 then bacteria I am from the microbiologic point of view or typically it is 0.6 because, there are some which are evens even can tolerate at this low water activity of 0.7. So, 0.6 or below is good enough for the elimination of the bacteria

or organisms, so in that case the milk has very high water activity, that means it is very much susceptible.

So, I just said you in the last class that don't take milk if it is curdled just like that because, it is having so much high water activity that not only that curdling organism, but also many other which may for undesirable end product may also develop and which may be very bad if it is consumed. Say again and again there is there is very very high chance of getting the infected by consuming them or by because of the end product which is not desirable right.

So, this is why those organisms make grow in and that may be some is some may be some mold, that may be some bacteria may do something and you will not be coming to know what is the product which has been developed by the organism right. So, removal of water as usual increases the shelf life by and large we earlier also we have said by removal of water is one of the technique by which we extend the storage life of the food material, in milk also it is like that milk powder example. Milk powder for example, is also an a highly water I mean highly stable product, where the water content is very very low right; raw milk should not be diluted with addition of water by rule.

So, it is that in many cases we have seen that the milk man the they if by chance a milk is a spilled over or if the demand is high, then those milkman they do add this water externally and by law this is adulteration and you have should not you cannot. So, if you come across protest or don't allow to do that, this is by rule by law it cannot be added just like that, so water is one of the major constituent of milk.



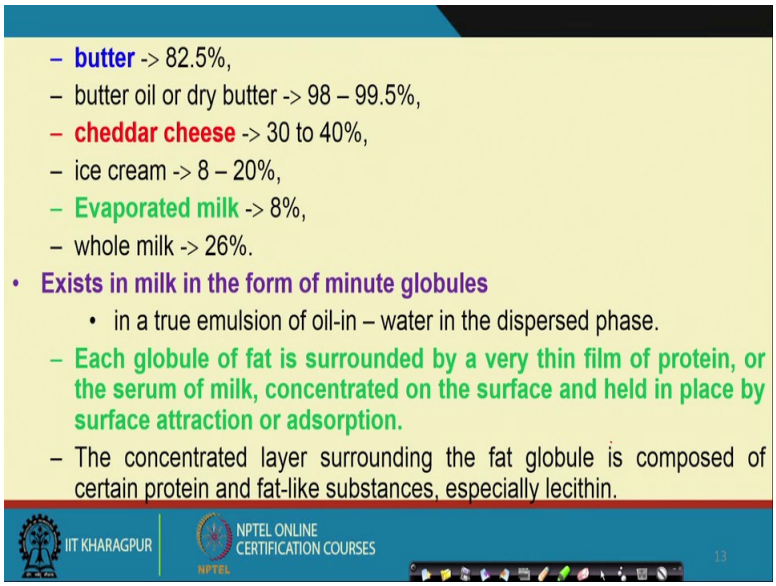
Then fat commonly known as butter fat, this fat is commonly known as butter fat and this fat varies in milk may be around say 2.5 to 6 that we have seen in the previous earlier classes, that it varies very widely depending on the source depending on the species place for all the purposes it is like there. Why I remember when we had given, so I also said that people who are at the high altitude. Yes some animals are there and their fat content is so, high that the consuming those milk the young gets lot of energy to fight against the nature of cold right.

So, that is for high fat where and where this temperature is very high, there that fat content will be very low because, again that digestion for these young will be easier if the fat content is also low in that area right. So, this is what; then protected by a membrane and called Fat Globule Membrane or FGM right protected by a membrane called Fat Globule Membrane or FGM.

This membrane is generally made of approximately 98 percent triglycerides 0.2 percent to 1 percent phospholipids, and 0.2 to 0.4 percent sterols right. Generally not the membrane this fat is that is milk fat is made of around 98 percent triglyceride 0.2 to 1 percent phospholipids and 0.2 to 0.4 percent sterols different kind of sterols are there right, cholesterol is what such which we come across right. Different types of sterols are also there. This phospholipids and proteins are mostly associated in the FGM that is Fat Globule Membrane right.

Fat globule membrane contains lot of protein some phospholipids and this is how when we come across with the fat globule, that time you will see that this membrane which is around say plus minus 10 nanometer in size thick rather plus minus this membrane is around 10 nanometer in thick. And that contains some proteins some phospholipids, some others some enzymes etcetera are also there right.

So, that when we come across with the globule fat globule that time you will tell in more a in detail. So, this fat or milk fat is termed generally if it is table or light or coffee or single cream then the fat contain is around 18 to 25 percent. If it is light whipping that is not less than around 30 percent, if it is heavy whipping then it could be around 36 percent or if it is plastic or extra heavy cream then it is around 65 to 80 percent. By the by though the milk is normally known as butter fat, butter also do have high concentration of fat high percentage of fat, it's around 82 to 83 percent of fat right milk fat right that is why this fat or milk fat is also known as butter fat right yeah.



Butter contains around 82.5 percent roughly 82 to 83 percent, butter oil which is a dry butter is around 98 to 99.5 percent fat 98 to 99 percent as minimum water as possible there, this is very very 98 to 98 point depending on the purity is a fat is there that is the butter oil.

By the by the by definition oil and fat they may be the same, but normally from the chemistry point of view we call if fat is solid at room temperature, then that is called fat or if it is liquid at room temperature then that is called oil. So, the difference between fat

and oil is that, if state physical state that is whether it is solid at room temperature or liquid at room temperature, depending on that it is call fat or oil. So, that's why butter is solid, but butter oil is liquid right, though the fat content for both are very very high right.

So, this is by the by we are say by the not by the by as an accessory we are saying right, that the difference between butter and fat is that I sorry fat and oil is that, fat is solid at room temperature and butter is liquid at room temperature. So, there are many other formulation percentages of fat present in many other milk products.

For example, if we look at cheddar cheese another a variety of cheese that contains around 30 to 40 percent fat, milk fat cheddar cheese contains. Ice cream it also contains around 8 to 20 percent depending on the ice cream it varies so, widely it fat content is 8 to 20 percent. Evaporated milk it contains also fat around 8 percent or whole milk whole milk normally it contains very high percentage of fat and whole milk normally we call it to be dry.

Now, when it is dried, then it becomes based on dry basis hopefully, we also can differentiate between wet basis and dry basis right. So, whole milk generally powder so it is said in terms of dry basis and that is why the percentage of fat is so high though in the whole or in the wet it may be much lower. And it exists in milk in the form of minute globules, very very small globules are there fat globules, generally the globule diameter varies may be from decimal to up to 25, 30 micron in size. The fat globule obviously the moment we are saying globule that means, it is spherically in shape that is in spherical globule means spherical in shape right.

So, it will have diameter so the diameter is may be less then 1 to around 30, 25, 30 micron in size right in varies widely right; obviously, the bigger the size; less is the number and the smaller is the size more is the number in globules. And subsequently we will see in 1 drop it contains around 10 to the power 8 number of fat globules, in 1 drop of milk contains around 10 to the power 8 number of fat globules right.

So, you imagine and that's why I said that the bigger the size, small is the number of fat globules, the smaller is the size more is the number of fat globules in terms of numbers right. So, in a true emulsion of oil in water, in the dispersed phase. In milk fat typically in milk this fat is present as a typically emulsion where it is fat in or oil in water that there it

is not said fat; it is said oil in water o w that emulsion is where oil is in the dispersed phase and water is in the continuous phase.

Because the fat content is very low may be around 5 6 7 percent, whereas water content is around 80 90 percent. So, that is more in quantity; so, it is in continues phase and the other 1 is in the in the dispersed phase, that is fat is in the dispersed phase. And the emulsion is called oil in water oil is in the dispersed phase and water is in continuous phase. The reverse if it is butter where the fat content is around 80 to plus percentage say around 82 percentage, there it is water is around say 17 15 to 17 percent or 17 plus minus percentage above water is there, so water is much low compared to that of fat.

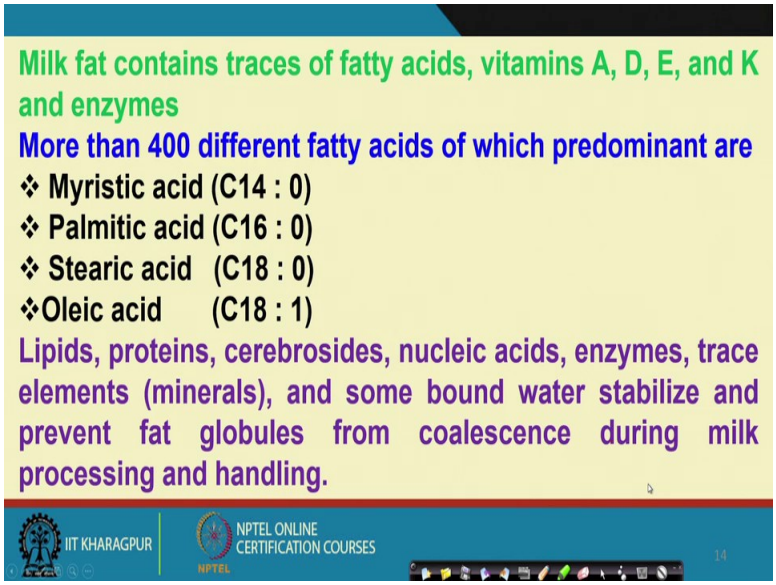
So, there it is call the emulsion is call water in oil that is water is in the dispersed phase and oil is in the continuous phase, so there it is the emulsion of water in oil right. Each globule of fat is surrounded by a very thin film of protein or the serum of milk concentrated on the surface and held in place by surface attraction or adsorption. As you said that this fat globule or membrane fat globule do have a membrane and this membrane is generally around 10 nanometer thick which we have said. The concentrated layer surrounding by the fat globule is composed of certain protein and fat like substances especially lecithin right.

In this case, fat is not soluble in water right and this fat and water the relationship which normally jokingly say that the relation between saas and bahu right; though I am not saying bad or anything, but generally the relation is like that that none of them can tolerate each other. So, here also that fat and water or oil and water they cannot tolerate each other right that is why you cannot mix oil with water. So, one very good thing that people cannot in a cannot adulterate oil with water if oil would have been mixable with water then we don't know where we would have landed up right. So, like milk water could have been freely added to it.

But it is not so right because oil is not mixable with water. So, what happens how they are then together? Because, if they are not possible if they are not possible to stay together then how they are. So, this fellow what we just said lecithin right especially lecithin that we said at the end, this lecithin is one mediator, this is one mediator between fat and oil rather fat and water or oil and water right lecithin is a acting as a mediator where it has 1 hydrophobic and 1 hydrophilic end.

So, one end which is hydrophilic that is water loving and another end which is hydrophobic that is water repelling end. So, this water repelling and water loving ends together is the lecithin. So, the hydrophilic end goes towards the polar end that is the water and the hydrophobic end that is which is going to the oil end or fat end.

So, the hydrophobic end couples with the fat end and the hydrophilic end couples with the water end by that way water and oil are together on the same milk right; on the same milk both oil and water are together, because of the presence of lecithin which acts as the mediator right.



So, milk fat contains traces of fatty acids. It contains traces of fatty acids vitamins A D E and K and lot many enzymes, this milk fat contains traces of fatty acids then comes what is fatty acid? Fatty acids are those which can add to glycerol forming glyceride or triglycerides.

So, normally by an theoretically it is H COOH that is the formic acid it is also having a carboxylic acid. So, any carboxylic acid if it is forming with the glyceride with the glycerol, then that could be called a fatty acid but formic acid does is one which is not like that or the second one right, that is H COOH or C H 3 C OOH that is 1 membered 2 membered generally 3 membered or 4 membered onwards 4 membered onwards we are we call it to be fatty acid, 4 membered onwards it call it to be long chain fatty acid or short chain fatty acid.

The more the number of carbon more is the long chain and the less the number of carbon less is the short chain or it is called short chain right. Generally it is myristic acid C 14, 0 means there is no double bond, palmitic acid C 16 no double bonds, stearic acids C 18 no double bond, oleic acid C 18 with 1 double bond right more then, so 400 different fatty acids are there and and out of which the predominants are myristic palmitic stearic oleic all these are right they are predominant.

But lower number fatty acids are also they are let us C 4, C 6, C 8, C 10, C 12 they are also present. And we will see subsequently in future class that this lower number they are volatile fatty acids, whereas the higher numbers they are non volatile right. So, the volatility also depends on the number of carbon atoms presenting in the chain, if it is short chain then normally they are volatile, if it is long chain normally they are non volatile right.

When we go into detail then we will also come across of course, as I said as and when we are coming across normally I try I am trying to explain so that the understanding becomes much better. Lipids proteins cerebrosides rather cerebrosides nucleic acids enzymes trace elements like minerals and some bound water stabilize and prevent fat globules from coalescence during milk processing and handling. By the by since the word has come lipid, here also we much know that there is a difference between lipid and fat. In general or not in general it is that all fats are lipids they are on the lipid umbrella, but not all lipids are fats.

Because there are many lipids which have non fat right, where the lipoprotein or glycoprotein these are many there which are not fat, but they are lipid right like lecithin right phospholipids. So, this is there this is not fat; fats are only the triglycerides or diglycerides or mono glyceride or glycerides of fatty acids with glycerol. Gycerides of fatty acids or glycerides or esters of fatty acids with glycerol. Glycerol is the basic that is C H 2 O H; C H O H; C H 2 O H.

So, this which is adding with acid and we know acid alcohol they put a together from the ester and this is called as esterification. So, this esterification if it is single then called mono if it is double then call di or if it is all 3 then call triglyceride, generally major portion of the glycerides in milk fat is triglyceride; we are running short of time now.

Thank you.