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

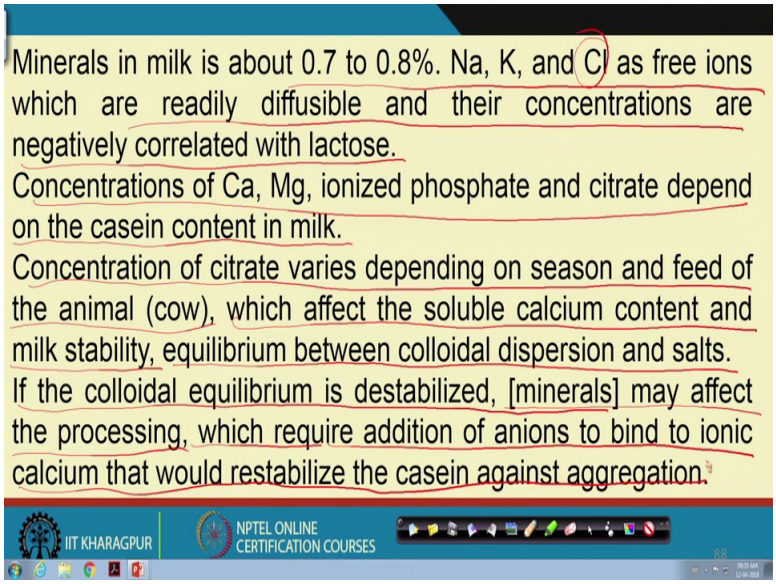
Lecture - 34
Carbohydrates in Milk

So, in the previous class we had been discussing components of milk and we were at carbohydrates of milk, right. So, in this dairy and food process and products technology, in this course I mean lecture number 34 we still do with the carbohydrates in milk, right.

So, we stopped at some place where we saw that the major carbohydrate in milk is lactose, and this lactose we normally called it to be, and if you remember sometime we said that this is the only natural product where the only one carbohydrate is there. The reason being because others are so small in quantity, so they are negligible, and that to since lactose is there and we know the chemistry of that that on hydrolysis of lactose it produces glucose and galactose. So, one molecule of water fuse comes out when glucose and galactoses are fused to for the lactose.

So, lactose on hydrolysis in any case produces that no I am not saying lactose is so easy to hydrolyze into galactose and glucose, but there could be some possibility and also it could be naturally already present there, but the quantity is so less that we consider that milk has a single carbohydrate that is the lactose, right.

Now, let us look into how much quantity it has.



Minerals in milk is about 0.7 to 0.8 percent, 0.7 to 0.8 percent of sodium, potassium, calcium oh sorry; sodium, potassium, chloride which are readily diffusible and their concentrations are negatively correlated with the lactose, right.

So, what does it mean? That their concentrations are negatively correlated with lactose; that means, if lactose concentration goes up then these availability of these minerals are less. So, that is why negatively correlated with the lactose, right. And generally the sodium, potassium and chloride they are available as the free ions. So, they can also as and when required they can also joined with others whenever it is required. So, this free ions sodium, potassium, calcium chlorine chloride rather it should be, so out of which two are anions I two are cations and one is anions. So, they can they can bind with many others as and when required.

Now, concentrations of calcium magnesium ionize phosphate and citrate depend on the casein content in milk, right, so that means, if the casein content is high then we get more calcium, more magnesium and more phosphate these we get more the reason being when we have covered casein you have seen that this minerals they are clubbed with the casein, right. They are clubbed with the casein; they are forming the bond with casein that's why if the casein is high or concentration of casein is high our corresponding this mineral availability is also high, right. So, more casein, more calcium, and more phosphate and more magnesium, so calcium, magnesium, phosphate are related with the casein positively that more calcium more this ions or this minerals we get, right.

Then concentration of citrate varies depending on the season and feed of the animal. So, whatever be the animal if it is cow. Normally that milk synonym we have cow because all almost all of us due drink this cow milk here many a others also due drink buffalo or maybe some other animals like goat or etcetera etcetera wherever it is available. But by and large in general we make that milk as a synonym of the cow that is milk means cow it is the cow milk.

So, it depends on the season and also the feed, right. The citrate concentration availability depends on the feed as well the season, right. It is not throughout the casein, the same concentration of citrates will be available as well if the cow is or the animal is fed with good material then you will have one kind of citrate concentration, and if it is best on the pasture which is available in nature here and there, so the that be then another

kind of citrate concentration he will get. So, these two directly affect the citrate concentration availability in milk, ok.

Then which affect the soluble calcium content and milk stability, that citrate concentration is here, is dictating or is monitoring the availability of the calcium. So, if the citrate is available that is much better because it is also soluble calcium content that will be dictated by the concentration of the citrate.

There is an equilibrium between colloidal dispersion and salts. Normally salts we mean that by enlarge salt we mean that it is soluble in water, by enlarge I am not saying all salts are soluble there are many soluble salts, there are many sparingly soluble salts there are many soluble salts which are not soluble at all, right. Of course, at all cannot be because it is it is it is relative, right. So, whether it is in ppm or pbm means parts per million or parts per billion or even lower. So, that is different.

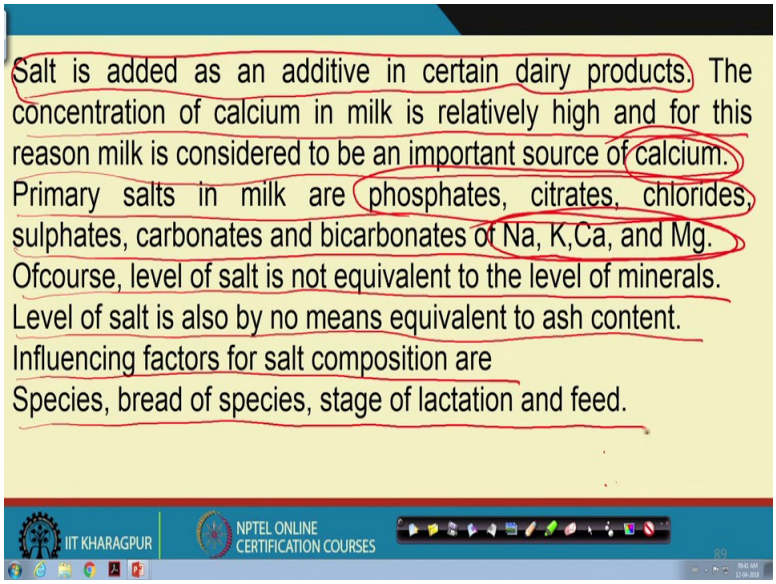
Normally is not to the level of ppm, pbm we say that this is soluble that means, it is having good concentration. So, that is being controlled the calcium, we said that calcium is bound with the casein. So, the casein is dictating the availability of the calcium, but the citrate concentration is also dictating availability of calcium in the soluble pairs, right. So, the calcium availability in the soluble pairs is dictated by the citrate concentration and which may contribute which may dictate or which may control the equilibrium between the salt and the colloidal state, right.

So, if the colloidal equilibrium is destabilized then concentration of minerals may affect the processing, right, obviously, when you are processing milk processing normally it is with respect to heat treatment by and large. So, milk is first heated you you will not see any other that milk without heat treatment it is crude and kept at low temperature. The reason we have said earlier, but since it has come a repetition it could be, but maybe recapitulation for you that the reason is milk contains lot of enzymes, lot of microbes. So, they may spoil milk if they are not deactivated before it is cold. So, that is why the first step whatever you do with milk is the heating, right.

Now, when you are heating, this disturbance of the colloidal solution that may affect the process because if something comes out from the from the from the medium that is milk then your that process may be affected, both in terms of heat or mass transfer. So, in that case you are your destabilization of the equilibrium of the colloidal state is must or is

affecting your process, right, which require that the addition of anions to bind to ionic calcium that would restabilize the casein against aggregation, right.

So, as we said that if casein is I mean destabilize that is casein is in the colloidal state and that to with calcium. So, if the destabilization is taking place and if that is not again brought back will bring back that this ion that is anions which are available. So, citrate is one such anion. So, that anion will help to bind back the calcium interned, interned your casein and the stability of the colloid will be brought back. That is why the concentration of citrate is so important that it will help stabili making the equilibrium between the between this colloidal state and the solution state. So, this citrate is playing and very important role in stabilizing the colloids in the milk, right.



Now, at sometimes salt is also added, salt is also added as an additive in certain dairy products. This salt is added the concentration of calcium in milk is relatively high and for this reason milk is considered to be very important source of calcium. Primary salts in milk are phosphates, citrate, chlorides and sulphates, carbonates, bicarbonates of sodium, potassium, calcium, magnesium, right. So, in as we were saying and the that the stability of the stability of the your this thing, stability of colloid this colloidal stability for that sometimes some salt may be added externally, right. And this external salt addition will help to stabilize the colloidal suspension of milk.

If required, again I am saying if required because when your processing and processing is with respect to heating. So, if heating during that if there is some disturbance in the

colloid then casein will come out. So, losing calcium, losing casein, so there to be brought back to the colloidal state or in equilibrium between colloid and the solution so that can be done by the addition of this salt. And normally milk contains these phosphates citrates, phosphates citrates, chlorides then sulphates carbonates, bicarbonates of sodium, potassium, magnesium, calcium all this, right.

Of course level of salt is not equivalent to the level of minerals. How much salt is added or how much salt is there in milk of course, it does not tell, I mean it is not it is not proportional that so much salt means so much mineral available reason being some minerals could be bound which may not be available for other activities. So, it just cannot be said directly that salt concentration or salt present is equivalent to so much of the mineral availability.

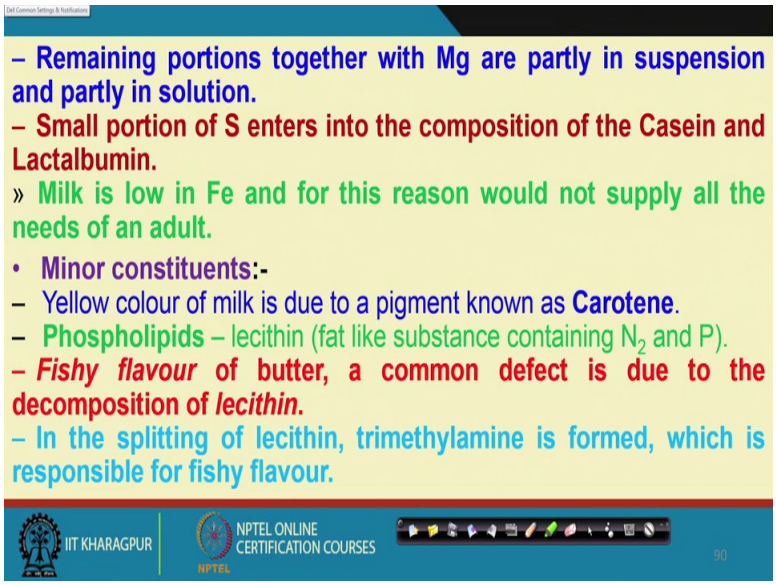
Level of salt is also by no means equivalent to ash content as we said when the very beginning that milk do have basically the nutrients basic nutrients that is fat, protein, carbohydrate, then vitamins, minerals, and water. And this and these vitamins minerals water there not water is shown separately when it is in tabular form, but it is said that water fat, protein, carbohydrate and ash content, right. So, ash content we have seen it varied very widely maybe from decimal to some units, right, so depending on the source etcetera. So, the, but it does not collaborate that if ash content is high that will dictate the mineral content is also high, right.

There are many others for which the ash content could be high, but the mineral content may not collaborate with the high concentration or high availability, high in number of ash content, right. So, that you have to keep in mind. This may be due to the many others which due are not in the family of fat protein carbohydrate. So, they may come crude fiber crude things, so they may come into the ash content. So, this ash content does not reflect the availability of the minerals, right.

So, this influencing factors for salt composition are species, bread of species, stage of lactation and feed, so obviously, salt concentration varies depending on species bread of species stage of lactation and also the feed. Stage of lactation is one vital parameter, feed is another vital parameter though species and bread are also, but feed is definitely a vital parameter because as far as unorganized sectors are there, so individual rearing of these animals are there. So, it is everybody wants that give less, get more.

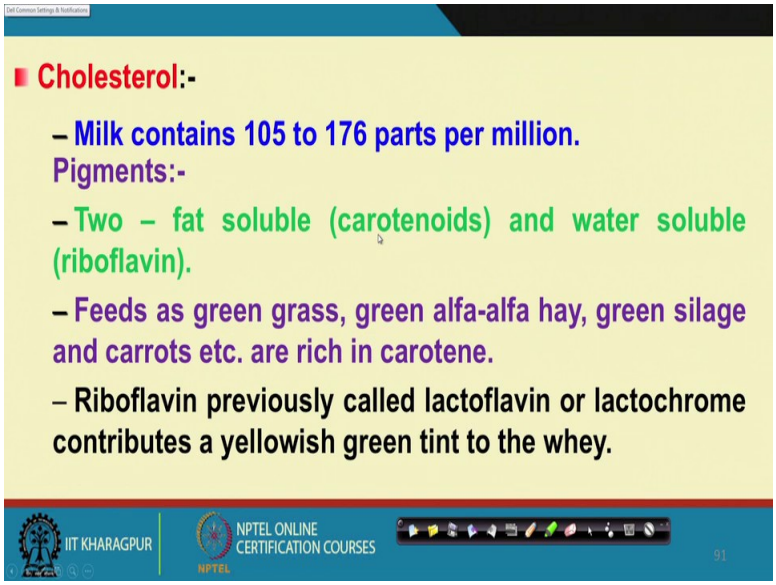
So, the cow is feed with the minimum or from the natural sources and we want maximum output from the top, right, that is not possible, whereas in many many countries in many many I don't say developed under developed because that has no meaning. In many many countries there are that consolidated or concise or collectively the raring of these animals and their feed is well controlled, with all other parameters feed is also well control, well feed and they do give really good quality and quantity because it is not only the quality, but also the quantity that will be dictated by the feed and of course, other parameters like your the bread or the species or maybe the period of lactation or many others, right.

So, this we have to keep in mind that feed is a primary. So, wherever possible, wherever possible try to try to impress on the people who are raring that if they should allow the animal to be with proper feed, right, to be fed with the proper feed that will also give you intern good return of the quality and the quantity of the food of the of the milk, right. So, this you must convey or you must pursue, right, ok.



Now, remaining portions together with magnesium are partly in suspension and partly in solution this remaining portion I am saying that with respect to perhaps the casein content, right. Small portion of sulphur enters into no, this is with respect to wave protein sorry with respect to wave protein, right. So, small portion of sulphur enters into the composition of the casein and lactalbumin oh this is with respect to the mineral content, right. So, this is small portion of sulphur and that enters into small portion of sulphur

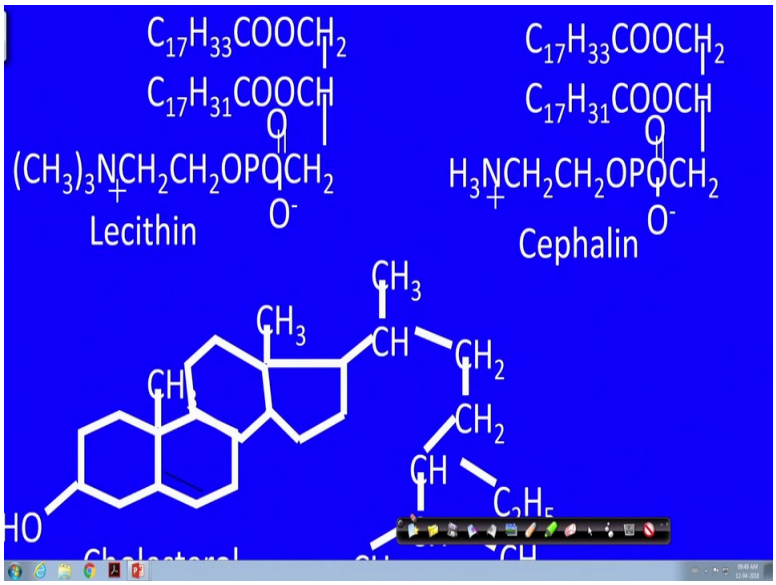
enters into the composition of the casein and lactalbumin, right, all the needs of an adult that is why it is not the complete food, right.



Now minor constituents which are there in milk are minor constitutes which are there in milk are yellow colour of milk is due to a pigment known as carotene that is the pigment which is available in milk, phospholipids that is lecithin this lecithin is the fat like substance containing nitrogen and phosphorus and this lecithin is the is the binder between the fat and water, right. So, this is the intermediate between fat and water and or mediator between fat and water to be in the same platform in the same place. So, that that lecithin is another small constituents of milk.

Fishy flavour of butter, a common defect is due to the decomposition of this lecithin. Sometimes, sometimes there may be some fishy flavour availability or fishy flavour may come up, so that is primarily due to this decomposition of lecithin and subsequently turns to be maybe TMA, that is trimethylamine or TMA or trimethylamine oxide by which normally fish is a recognized or fish is judged whether it is already it has gone wrong or it is it is spoiled or it has started. So, that number TMA, TMA oh helps, but this is the obnoxious smell is primarily due to the decomposition of this lecithin to those amines, right. In the in the in the splitting of lecithin trimethylamine is formed which is responsible for this fishy flavour as we discussed that this fishy flavour is primarily due to the trimethylamine which is obtained by the decomposition of the lecithin, right.

Then some other small quantity small portions of different materials are like cholesterol, right. Cholesterol is also one material which is available in milk. So, and milk contents around 105 to 175 or 76 parts per million, right, parts per million, so 105 to 176 parts per million cholesterol is there.



Just for your just for your rather information I tried to give that is why said as an as an you see how complicated there are. This lecithin is this lecithin is this with a phosphoric acid group, right. And there is also the other one that is you have hydrophilic and hydrophobic both are there, right. And similarly cephalin another is this is also used as your binder that is between fat and fat and water.

So, you see how though it is on the on another another background. So, that's why some portion is not visible, but this is of course, this is CH 3, this is also CH 3. And this is the cholesterol you see how many how many numbers of this your 6 member or 5 member rings are there as well the side chains are also there, so it is complex, cholesterol is also complex, lecithin is complex, then cephalin is complex, these are very complex compounds, right. And I don't expect that he will also remember them. So, big big things are not required because as and when you need you can go back to their and you can tell, right.

So, if we go back to there, so let me bring back this to its original position there is a saying if you have a knife you can use it to cut your hand or you can use it for some good purposes, right, so ok. So, cholesterol is this is what that I reference to this advanced

technology for this interaction with you, this advanced technology when you are using obviously, we have to be also accustomed with that and a little time also has to be given.

So, cholesterol is around 105 to 176 parts per million. Since our time for this class is almost over a will also come back to cholesterol in the next class start with that, but before that let me also tell this that nowadays earlier we had a mind in our mind that cholesterol is bad there is a ldl and hdl. And depending on this high density lipid or low density lipid depending on that, so people use to take their food etcetera etcetera. But recently some scientific investigation I have said that no it is not the cholesterol, so is not so bad as it was thought of that it is like a giant it will spoil you etcetera etcetera may not be.

However that is another part that is not part of our interest at this moment, but our interest is that this cholesterol is also available in ppm level ok. Time is up, let us stop it today.

Thank you.