Dairy and Food Process & Products Technology
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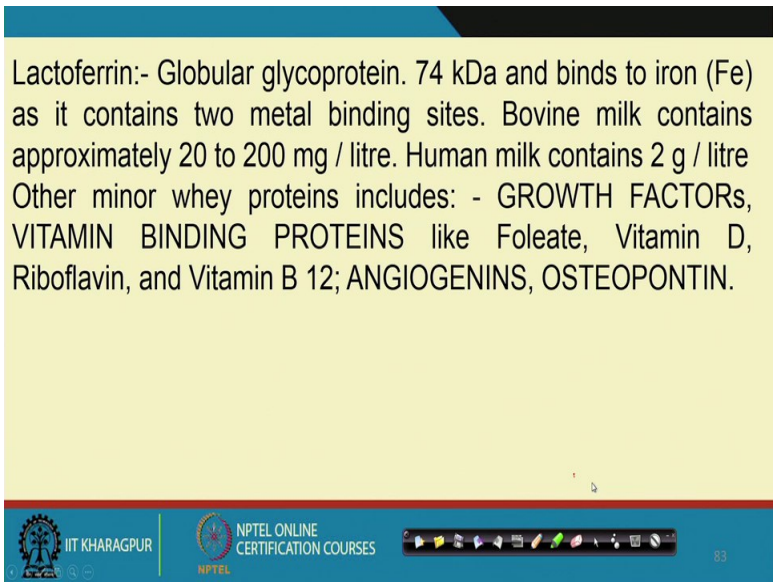
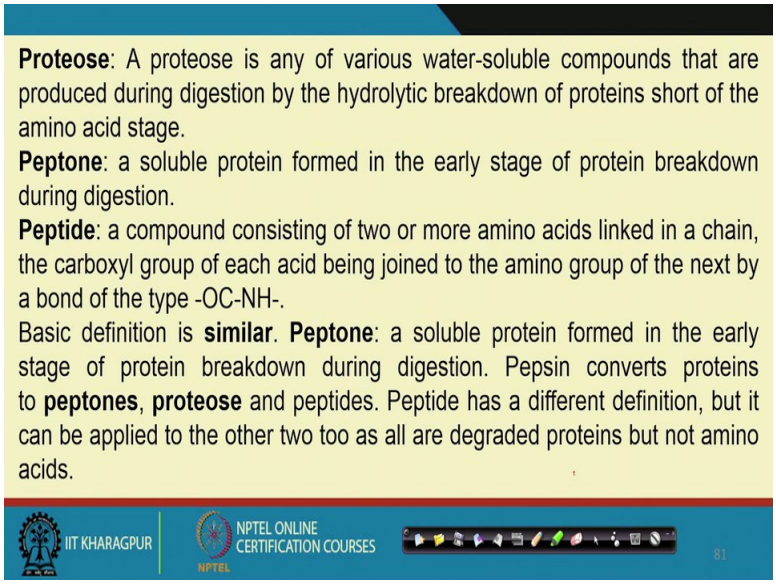
Lecture - 33
Lactoferrin

So, in this class of Dairy and Food Products; Dairy and Food Process and Products Technology in 33rd class we will go to Lactoferrin.

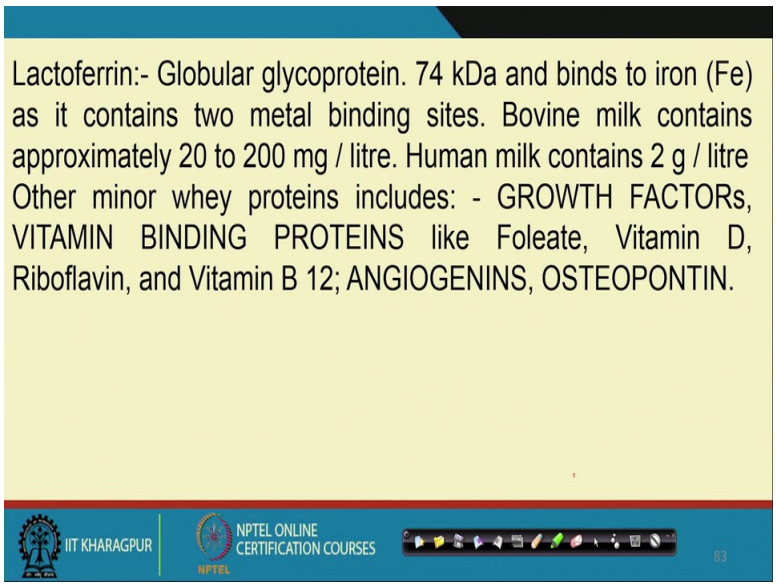


But before we go to the next this thing lactoferrin; I would like to go back a little because I feel you also might have seen you have also might have heard and seen that in the previous class towards the absolutely towards the end, I was feeling a little sleepy a little and obviously, that was not desirable.



But let me go through quickly that we were talking about Proteose, Peptone and Peptide what are they and what are the differences if they have at all right. And we also said that the peptide bond is nothing, but OC-NH right that C N bond is the peptide bond; obviously, it should also have one O with the C and NH right; that is that carbonyl group and the NH group, they are together bonded to CN right. And the basic definition of the all proteose, peptone, peptide are similar.

Peptone is a soluble protein formed in the early basic; early stage of the protein breakdown, during digestion process and pepsin converts these proteins to peptone and proteose and peptides right. So, this if we; if we recapitulate a little and then we go to our today that other protein that is whey proteins are like lactoferrin.



Lactoferrin is another protein; whey protein which is globular glycoprotein, globular glycoprotein of course, from the name glycoprotein you can understand that it is both you have glycolysis; glycosidic linkage and this is glycoprotein in the protein right? And it is around 74 kilo Dalton and binds to iron right.

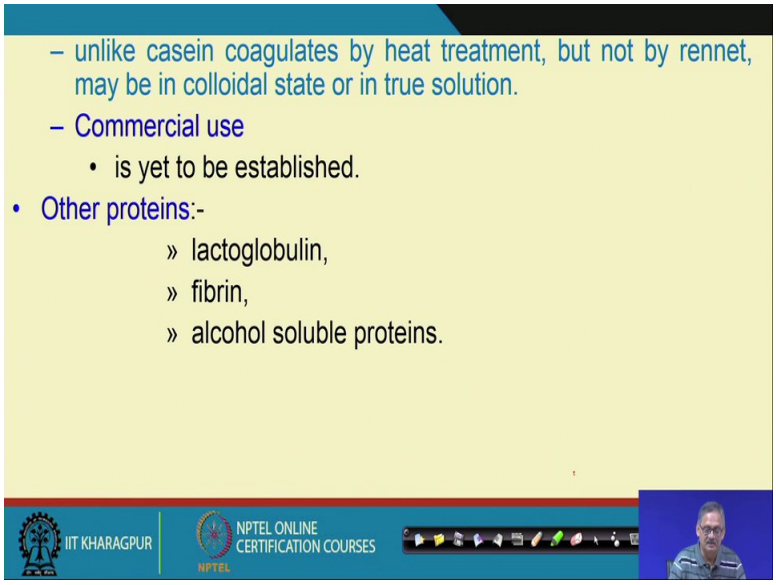
And iron that is the heme one basic constituent of the of the blood is the basic constituent of the blood heme, iron is a NIP; that is why milk which has very low when we will go to the elements or metals or minerals which are present in milk, that time we will see that milk contains many many minerals, but iron is very very poor right.

So, but this iron is also required for binding with the with the with the proteins and that here it is also that globular glycoprotein lactoferrin which is 74 kilo Dalton and by end it is bound through iron Fe right. So, as it contains 2 metal binding sites; bovine milk contains approximately 20 to 200 milligram per litre this lactoferrin, 20 to 200 milligram per litre variations are; obviously, there.

There are many reasons for those and they are; it is not that all reasons are identical, but; obviously, this is a number which is giving the range right. So, depending on the source, depending on the type etcetera etcetera that may vary this lactoferrin content it is around 20 to 200 milligram per litre.

Human milk contains around only 2 gram per litre; so, bovine milk contains much more lactoferrin than human milk right. Other minor protein includes some growth factors; so there are many growth factors in our body system. I repeatedly say that you please also consult that book of biochemistry by Lehninger; so, there you will also see this very very different types of growth factors are also there.

So, those growth factors are also part of this whey protein, vitamin binding proteins like Foliate, Vitamin D, Riboflavin and Vitamin B 12. So, these are also present and also and this one that Angiogenins; angiogenins and Osteopontin; osteopontin these are also present as the whey protein right.

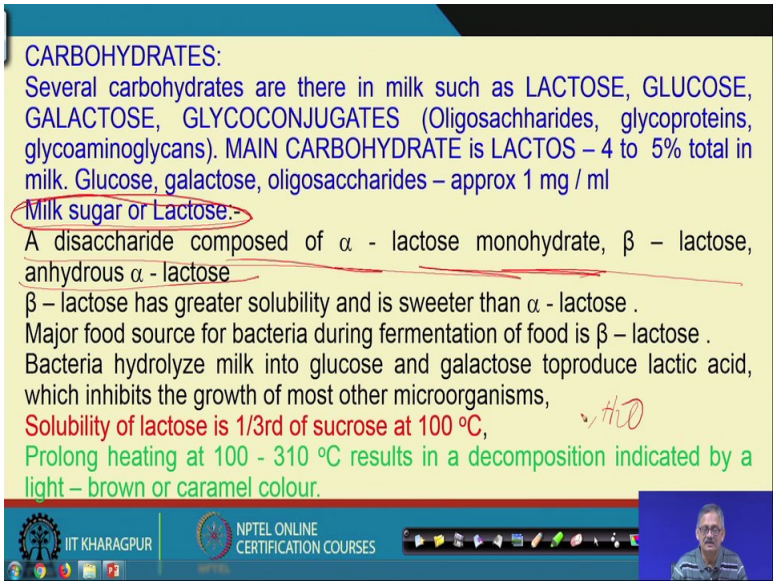


So, after that let us look into that unlike casein; coagulates by heat treatment, but not by rennet right; casein is coagulated by rennin or rennet that is an enzyme which is available in the in the in the in the stomach of the calf right. In the stomach of the calf, this enzyme is available and this is rennet or rennin which that is why we are saying that unlike casein; which is precipitated by the action of the rennet or rennin, this does not right, but it is coagulating by heat treatment.

You remember while we had said that how different ways, we can identify the components of the components of the milk constituents; right how we can identify. There we are said that when you got the whey separated and heat the whey, then you get some turbidity that is what by heat coagulate is called heat coagulation. So, by adding heat; by applying heat you are coagulating this protein or whey protein is coagulated right; so, but not by the rennet, but not by rennet right. Maybe in colloidal state or in true solution right, this may be available in colloidal state or in true solution.

Common use of the whey protein is yet to find out because as I said earlier also perhaps that the recovery of whey protein; whey protein how much you have? It's around 20 percent; 20 percent of what? 4 percent; so, 20 percent of 4 percent is around 0.8 right; so, 0.8 say gram 100 gram of milk; so to recover this if the recovery process is not; is not cheap or cheaper or is not affordable then or after recovery, if the product price is more than the recovery or rather less than the recovery price, then the recovery has no meaning.

And that is why till date people have not tried recovering it much. But again there are many such problems which are for you; so, in future you come across, you come forward and try to separate them and make use of it. Till now it is not a consolidated afford of making the use of this whey protein has been made; like the casein which we have seen innumerable, it has innumerable uses and there caseins are having lot of applications right. Other proteins also lactoglobulin, fibrin, alcohol soluble proteins are also present in milk.



Now, we come to another one which is the carbohydrate family right. The other day I had said that milk is the only one where or only natural product where a single component like lactose is present; carbohydrate. This we say the reason being the carbohydrate which is present in milk is basically all lactose.

Others are very very small in quantity; is virtually negligible that is why by and large milk lower carbohydrate corresponds to lactose only. Several carbohydrates are there in milk such as lactose, glucose, galactose and this lactose is made of glucose and galactose. So, on hydrolysis by any way maybe by heat or by any way if it is hydrolyzing, then it will give that glucose and galactose which are also present in milk, but in very very small quantity right.

Glycoconjugates are like oligosachharides; glycoprotiens, glycoaminoglycans; aminoglycans all these are also present. Main carbohydrate is lactose 4 to 45 percent; total present in milk rather it should, it should have been it should have been maybe

typographical mistake it is 40 to 45 percent or like that total that lactose main carbohydrate is lactose around 4 to 5 not 45. So, it is 5; 4 to 5 percent of the total milk it is present.

So, it is 4 to 5 percent of the whole total milk present is lactose and glucose, galactose, oligosachharides approximately around 1 point; 1 milligram per milliliter, 1 milligram per milliliter right; 4 to 5 grams per 100 gram, out of which 1 milliliter per 1 milligram per milliliter that is your 1000 milligrams per litre 1000 milliliter is 1 litre.

So, 1000 milligram per litre that is 1 gram per 100; 1 gram per litre that is or rather it should be 0.1 gram per 100 gram right, 1 milligram per ml that should correspond to roughly 0.1 milligram or 0.1 gram rather per 100 gram right. So, this milligram you convert it to gram; so it is 1000 grams, 1000 milligram that is 1 gram is equivalent to; is equivalent to 1000 ml that is 1 litre right 1 litre roughly is equal to 1 kg.

So, it is 1 1000 milligram that is 1 gram in 1 kg; that means, 0.1 gram in 100 grams right. So, that's what I am saying that 0.1 gram in 100 gram of milk, it is present right which is very very negligible that is why again and again I am saying that lactose is the main constituent of the carbohydrate present in milk right, others are negligible.

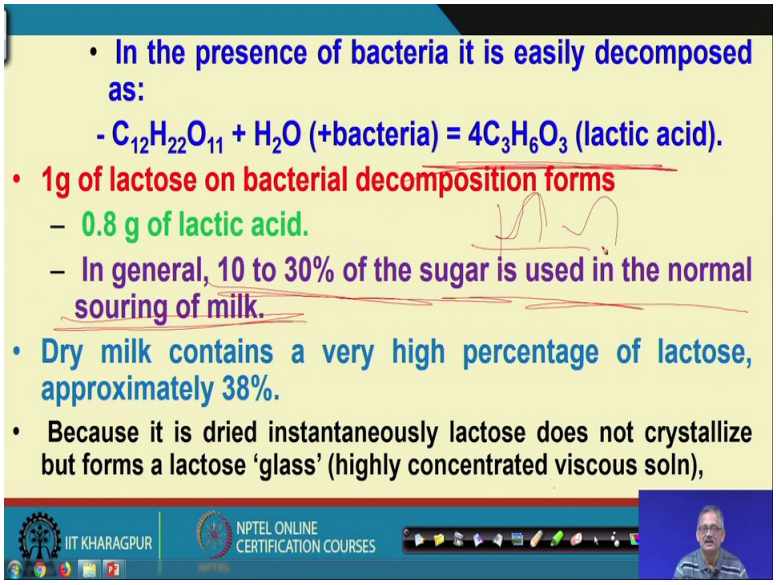
So, though and that it is not that mainly they are glucose and galactose which is the hydrolyzed product of the lactose; so, in any case it could be, but their presence is very very small in quantity. So, milk sugar which we normally know as the milk sugar which normally we know as the lactose right. So, which is a disachcharide and it has it is alpha lactose monohydrate, beta lactose and anhydrous alpha lactose; so, alpha lactose monohydrate I hope you understand right.

So, lactose this with 1 H 2 O has the hydration is the monohydrate right whereas, anhydrous beta lactose means there is no hydration that is there is no H 2 O associated with that right; so, if that be; then beta lactose has greater solubility and is sweeter than alpha lactose. Beta lactose is greater soluble and much sweeter than that of alpha lactose; major food source this is the major food source for bacteria during fermentation of food and this beta lactose is that, that is a major source. Bacteria hydrolyzed milk into glucose and galactose right to produce lactic acid right, which inhibits the growth of most other microorganisms.

Once this bacteria is producing lactic acid from lactose, then that produced lactic acid does not allow many organisms to come forward or to invade the milk and spoil that way, but if it is by lactic acid bacteria. So, if you recall some other day I had said that if you keep milk just like that and if it gets spoiled, then normally we don't consume because we don't know, but if you put lactic acid bacteria and if that produces lactic acid; then if it curdles then you know that it is by lactic acid bacteria and it was lactic acid which curdled.

So, that time it is not that unsafe, but unknowingly if you take then you don't know, but if lactic acid producing organisms are there then or rather if lactic bacteria is converting this lactose to the lactic acid, then that lactic acid does not allow other organisms to grow in the milk right. Because they do not tolerate high lactic acid concentration right; then which inhibits the growth of most of the other organisms; solubility of lactose is one third that of the sucrose at 100 degree centigrade right, solubility is also much lower than that of the sucrose this lactose.

Prolong heating at 100 to 300 degree centigrade decomposes this lactose and which is indicated by a light brown caramel colour, that decomposition is indicated by light brown caramel colour. This you know that light brown caramel colour we said earlier that is primary due to the; due to caramelization that browning, browning reaction by caramelization right.



Then we come in the presence of bacteria, it is easily decomposed as C 12 H 22 O 11 that is the lactic acid plus H 2 O that bacteria is fermenting or acting on it, then it is producing 4 C 3 H 6 O 3 that is the lactic acid 4 C 3 H 6 O 3.

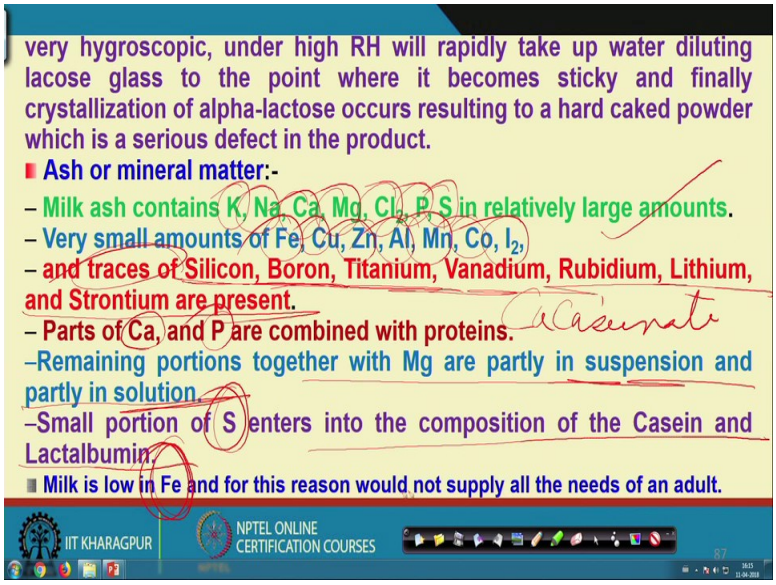
And surprisingly, you will see that 1 gram of lactose by the bacterial decomposition forms around 0.8 gram of lactic acid. You see is 80 percent conversion, 1 gram of lactose is converted into 0.8 gram of lactic acid by lactic acid producing bacteria right. So, this is almost 80 percent conversion and that is why that it is coagulated so easily by this acid producing organisms right.

So, in general around 10 to 30 percent of the sugar is used in the normal souring of milk. So, only 10 to 30 percent because the; for this is not in this our class that in the growth phase, in the growth of the microbiology or microbes; you will see that they follow this kind of growth curve right. So, there is a lag period and then growth period and then it is the; it is the decay period.

So, that growth curve we will see that here it is 10 to 30 percent maximum is utilized for the conversion; normally for souring of the milk that is conversion of lactose to lactic acid. Dry milk contains a very high percentage of lactose because it is with respect to dry basis approximately around 38 to 40 percent.

Because it is dried instantaneously lactose does not crystallize, but forms a lactose glass or that is called the glassy state. That is why again and again I am saying that that is why before you proceed further for processing milk, you must have the idea about the glass transition temperature; that is that transformation of this to glassy state lactose to glassy state without forming the crystal.

So, this glassy state what is the temperature of the glass transition; if you don't know before and then during the processing that lactose may create problem forming the glassy state on the walls of the container or on the vessels or on the equipments, thereby it will act as a protecting agent against heat. So, the necessarily heat or cold whatever it may be, but in if let; if it is glass transition then mostly it will be heat and thereby you are losing the efficiency of the system. So, you must know the glass transition temperature of the lactose right.

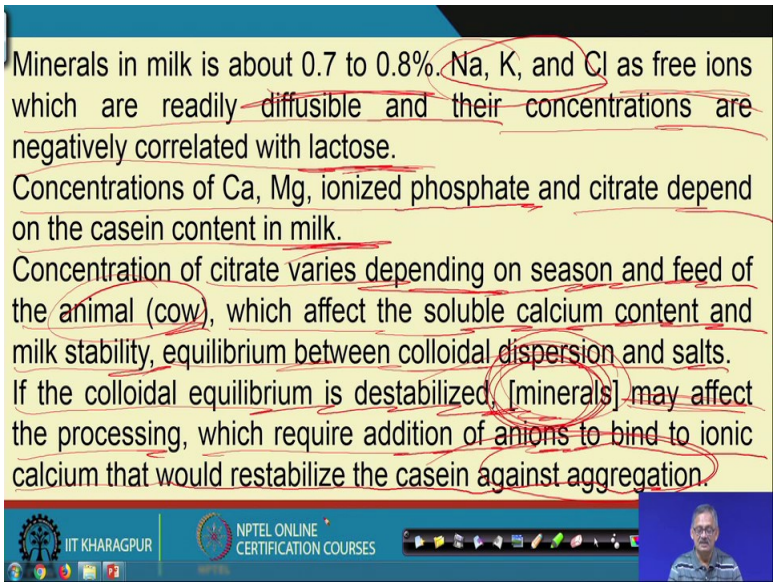


Then we come that lactose is also very hygroscopic under high RH, will rapidly take up this under high RH; let me clear up this lines, yes under high RH will rapidly take up water diluting lactose glass to the point where it becomes sticky and finally, crystallization of alpha lactose occurs resulting to a hard caked powder; which is a serious defect in the product ok.

Then the other things which are present in milk are the ash or mineral content; ash or mineral metal that is how it is expressed, but subsequently we will see that the mineral contents are not the ash content right. However, milky ash contains sodium; milk ash contains sodium, potassium, calcium, magnesium, chlorine or chloride phosphorus, sulphur and in these are relatively in large amount; large quantity; very small quantity iron, copper, zinc, aluminium, manganese, cobalt and iodine and traces quantities of the; these are the intermediate that in your in your periodic table, you will see that transition elements many of them not the silicon silicon boron they are below that.

Silicon, boron, titanium, vanadium, rubidium, lithium and strontium they are present in traces quantities. Now parts of this calcium and phosphorus are combined with proteins calcium as calcium caseinate right calcium as calcium caseinate and phosphorus also as phosphoprotein right. So, they are mostly associated with protein calcium and phosphorus; remaining proteins together with magnesium are partly in suspension and partly in solution.

Small portion of sulphur enters into the composition of the casein and lactalbumin. Milk is low in iron very low in iron and for this reason would not supply all the needs of an adult right; that is why milk is not complete food because of the deficiency of the iron; had it will that iron is not so deficient, then it could have been a complete food right. So, if it has to be made complete; so iron has to be supplemented or augmented right. So, iron has to be given to the milk then only it becomes a complete food.



Right then minerals in milk is about 0.7 to 0.8 percent, it is around 0.7 to 0.8 percent minerals in milk; whereas, sodium, potassium, chloride they are present as free ions sodium, potassium and chloride represent in free ion which are readily diffusible and their concentrations are negatively correlated with lactose. The concentrations of calcium, magnesium, ionized phosphate and citrate; this depends on the casein content of the milk.

Concentration of citrate that varies depending on the season and feed of the animal cow or whatever the mammalian is mostly true; which affect the soluble calcium content and the milk stability.

Equilibrium between colloidal dispersion and salts also influence on that; if the colloidal equilibrium is destabilized, then this is destabilized by the concentration of the minerals may affect. This concentration of minerals may affect processing which require addition of anions to bind to ionic calcium that would restabilize the casein against aggregation; that is casein is not allowed to aggregate right.

So, we are at the end of the class this. So, we must thank and complete it today.

Thank you.