Dairy and Food Process & Products Technology
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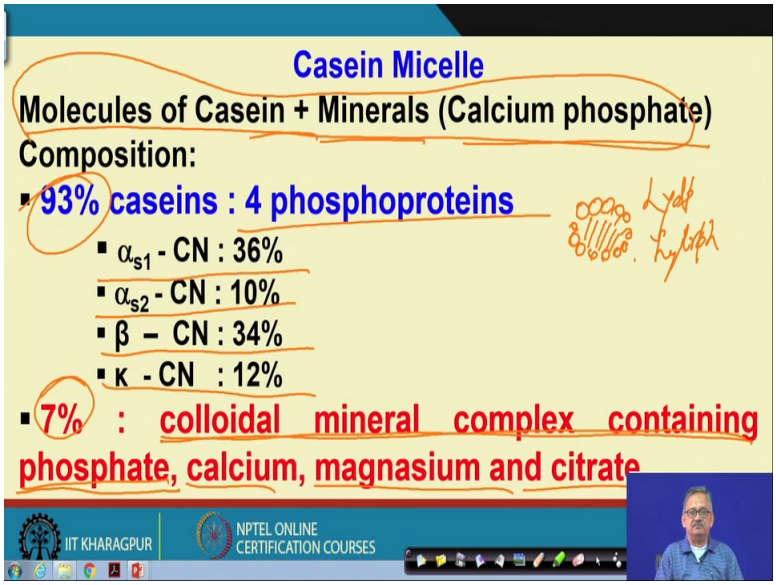
Lecture - 30
Casein Micelle

So, as we said that casein contains alpha, beta, gamma and kappa casein and reasons for the hydrophobicity we have discussed right. We also said that we will may be coming across though we have completed earlier what is micelle, protein micelle all these we have said, but casein micelle we will have a little discussion on that also. So, in today's yeah in today's our this course that is Dairy and Food Process and Products Technology in 30th lecture, we will start with Casein Micelle right.



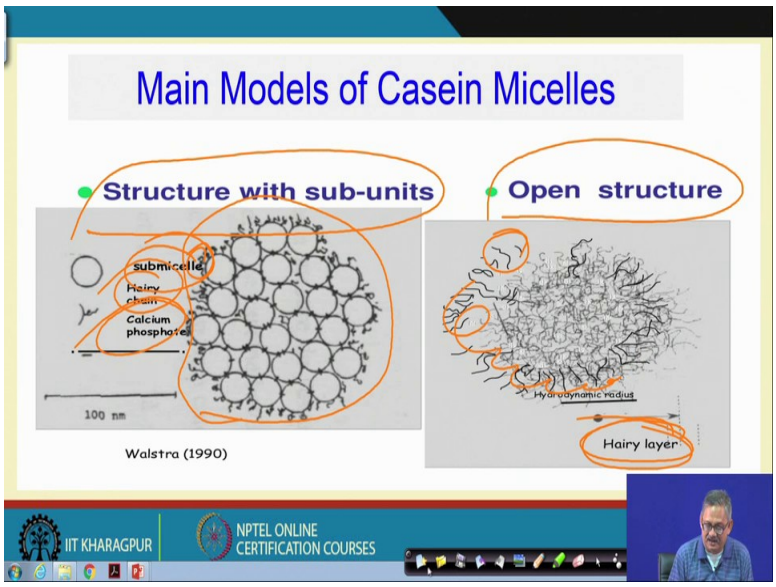
So, casein micelle is what? Is that, that the molecules of casein plus minerals that is calcium phosphate right. So, casein micelle is molecules of casein plus mineral that is calcium phosphate together is forming the micelle right. You remember in micelle we had given this kind of a pictorial view right, where we had shown that so these are having some thread like linking where we have 1 hydrophobic and 1 hydrophilic hydrophobic and 1 hydrophilic end right so those we had said earlier.

Now, it is casein micelle is that where molecular casein or molecules of casein plus minerals in the form of calcium phosphate they associate or agglomerate or they form this bonding and that is the micelle. Out of which the composition is 93 percent casein is

to 4 phospho proteins right; so, 93 percent casein in 4 phosphoproteins right. In which alpha s 1 casein is around 36 percent, that is alpha s 2 form is around 10 percent, beta casein is around 34 percent and kappa casein is around 12 percent which we had said earlier also.

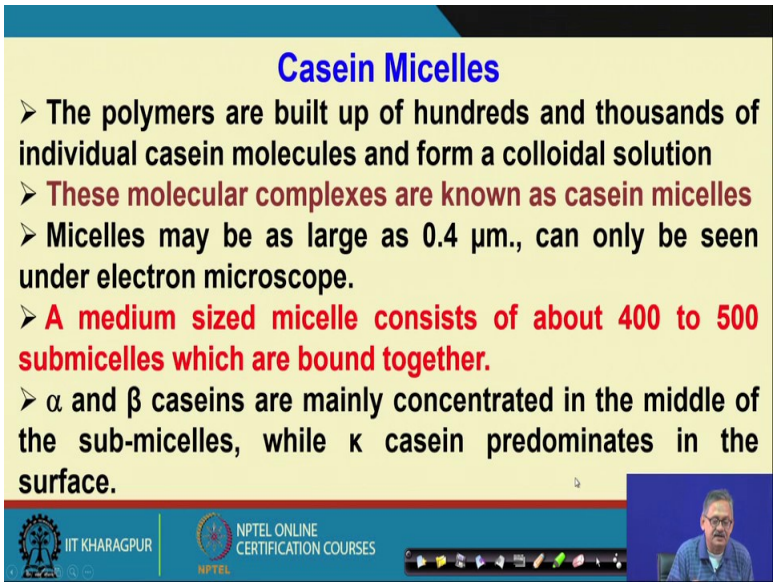
Now, 7 percent colloidal mineral complex 7 percent colloidal mineral complex around, so 93 percent was casein where 4 phosphoproteins were there and 7 percent colloidal mineral complex is there where phosphate, calcium, magnesium and citrates are present.

So, the casein micelle as we said is comprised of the casein molecules plus the phosphates, now this phosphates are around 7 percent or the minerals are around 7 percent may be in the form of calcium or phosphate or many others and 93 percent is out of the casein and out of which we have given the distribution of alpha beta kappa and alpha s 1 alpha s 2 right. So, these distribution we have said and the the minerals are calcium phosphates ok phosphate calcium magnesium citrate, they act like the minerals and they all put together forms the casein micelle right.



Then if we look at this is one of the simplest model of the casein micelle, there are n number of rather this kind of casein micelle models are there. In earlier class I had shown 1 here also I am showing you another there are submicelles subunits, heiry chains calcium phosphates this are there. So, hairy layers are that this is called the Structure with subunits where the subunits are there and this is called the open structure, where things are hairy like this is this appears to be like here right. So, this is the one model

which is there are I said n number of similar models are there and as from it is appearing it is very very complex right this given some reference also, so that we can cross refer if required right.



Now, this casein micelle which we have just seen is what, that is the polymers are built up of polymers are built up of hundreds and thousands of individual casein molecules, and form a colloidal solution now we know that casein is present in the colloidal form.

So, this colloidal form where hundreds and thousands of casein molecules or individual casein molecules they form this colloids or colloidal step in the milk right. These molecular complexes are known as casein micelle and this micelle may be as large as 0.4 micrometre right as large as 0.4 micrometre and can only be seen under microscope, because that is why it is called micrometre, that is you cannot see in naked eye it has to be seen under microscope 0.4 is very very small right.

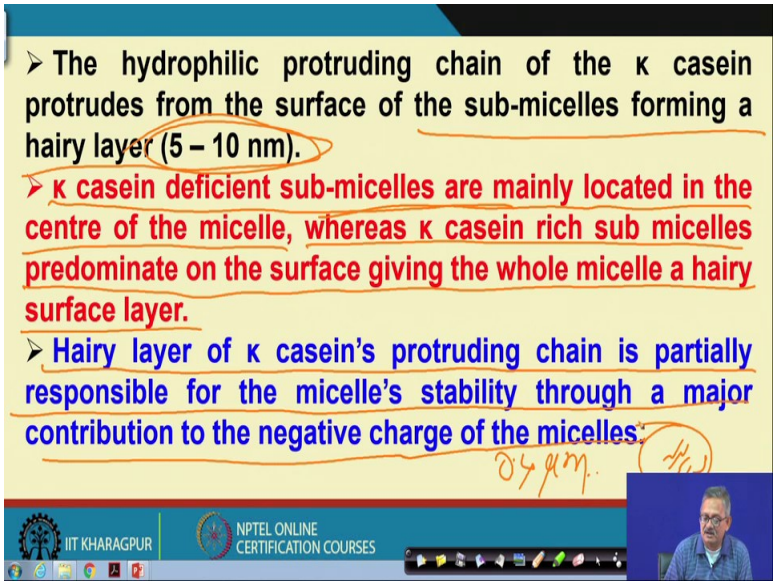
You remember the other day we said that dancing of fat globules can be seen under microscope high resolution microscope and there the globular size is around 2410 this kind of microns, but it is one tenth of that. So, 10 times magnification if you have even then you can see 10 times magnification of the microscope which you saw with for the fat globule. So, 10 times of that magnification if you have in your microscope you can see the protein micelle also.

So, it is as large as around 0.4 micrometre right. A medium size micelle consists of about 400 to 500 submicelles which are bound together, this from the pictorial view we have

shown that these submicelles they agglomerate, they form the chains and these chains are there around how many 400 to 500 subunit submicelles are there.

So, alpha beta caseins are mainly concentrated in the middle of these submicelle, while kappa casein predominates in the surface. So, can you give an why it is so because, when we discussed about alpha beta gamma kappa caseins that time we have shown we have seen rather or we have told that alpha beta are more hydrophobic or hydrophobicity is there in alpha beta. Whereas, kappa is much less hydrophobic or varies less hydrophobic so those which are hydrophobic they are inside interior not in the outer periphery, so that the water that is hydro part is away from them whereas, the kappa casein which is not.

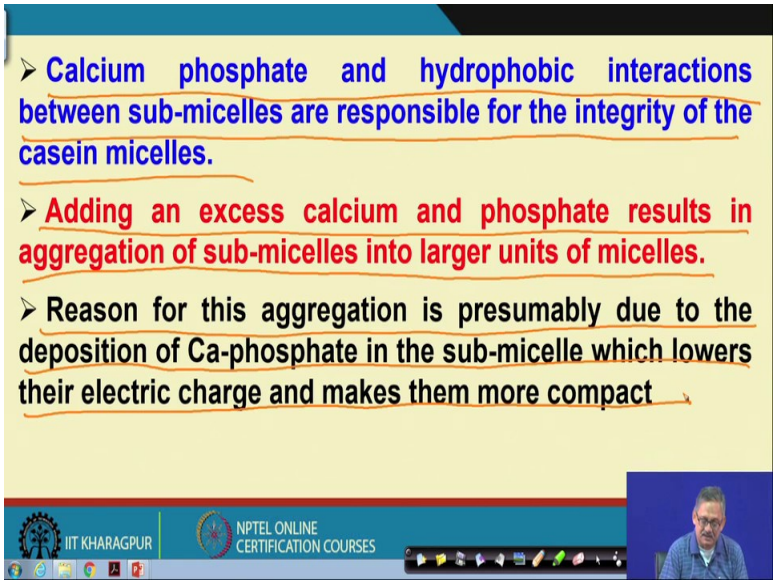
So, hydrophobic is on the surface on the periphery. So, that that water molecules are not so much so much repelled, otherwise what will happen everything will come down and the colloid will be disturbed and if the colloid is disturbed then it will drop down. So, that is not happening so how the mechanism is that alpha beta those who which are hydrophobic they are in the interior of the micelle; whereas, in the exterior of the micelle that is in the surface or periphery part this is the kappa casein which is there, for which the stability of the that colloid is there in the milk right.



The hydrophilic protruding chain of the kappa casein protrudes from surface of the sub micelle forming a hairy layer which is around 5 to 10 nanometre in size, this hairy layer which we have seen here like that. So, these hairy layers are around 5 to 10 nanometre in

size right, you remember we said the micelle is around 0.4 micrometre right and this hairy sub micelles are around 5 to 10 nanometres right.

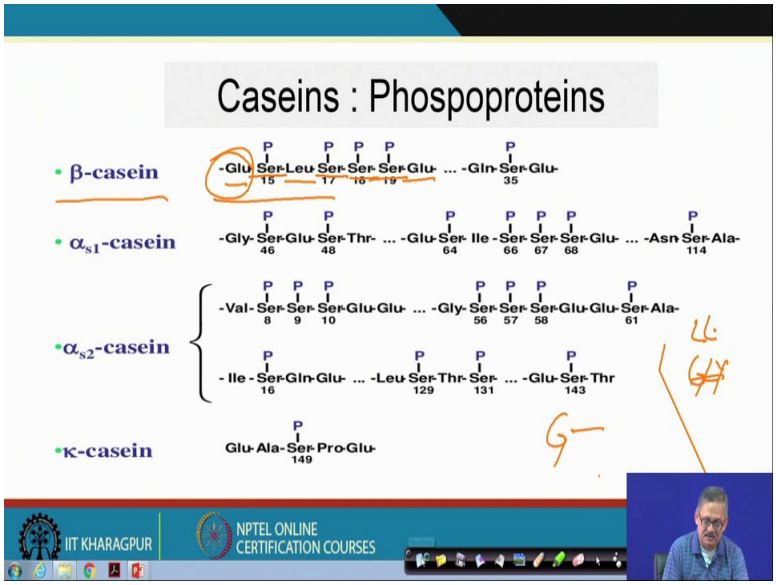
Kappa casein is deficient sub micelle are mainly located in the centre of the micelle, whereas kappa casein rich sub micelle predominate on the surface giving whole micelle a hairy surface layer right. So, those which are not so bad with water they can they can stay with water, so they will be on the periphery on the surface whereas, those which are hydrophobic they are in the interior of the micelle and they are hydrophobic in nature. Hairy layer of kappa caseins protruding chain is partially responsible for the micelles, stability through a major contribution to the negative charge of the micelle.



And calcium phosphate and hydrophobic interactions between sub micelles are responsible for the integrity of the casein micelle right. So, this phosphates which are present in casein they are hydrophilic, so they counter act the hydrophobicity right. So, they counter act the hydrophobicity and more phosphate groups are there better the colloidal stability, so now adding an excess calcium and phosphate results in aggregation of sub micelle into larger units of micelles.

So, if you have more calcium that is binding material, which binds the sub micelles. So, when you have those binding materials like calcium or phosphates, so they bound or they bind rather the sub micelles and they form larger units the sub micelles then form larger units and more and more stability towards the that colloidal suspension of the or colloidal nature of the protein in milk. Reason for this aggregation is presumably due to

the deposition of calcium phosphate in the sub micelle, which lowers their electric charge and make them more compact right.

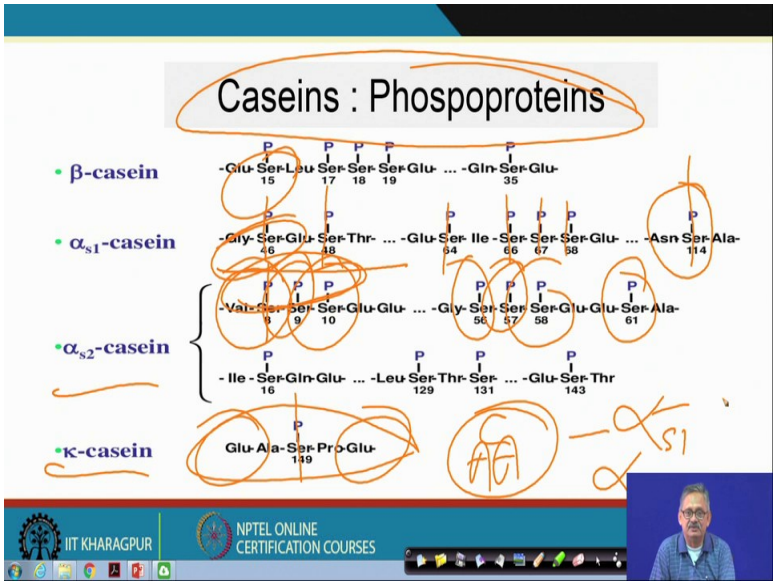


Then this is how the casein phosphoprotein these are helping in stabilizing the micelle. You see the earlier, I said in earlier class that the this amino acids this amino acids are in the sequences right. Here also you see in beta casein, we have the you say this glu that is glutine or glutane and then ser then L e u then ser then Ser then ser then glu that is different and I did not show you that one, I have seen that how in the next class I ok will show you, that how that glycine glu could be glycine. So, this glycine or no glutamic acid this could be glutamic acid or glutamate right. So, glycine glutamate how they are abbreviated or how they are getting that coding, this I will tell you in the subsequent class ok.

However we see here that this is like that. So in the 15th position this is the 1 phosphate in 17th position, another phosphate in 18th position another phosphate in 19 position another phosphate like that in 35th position another phosphate. So, these are normally in the beta glycine or beta casein.

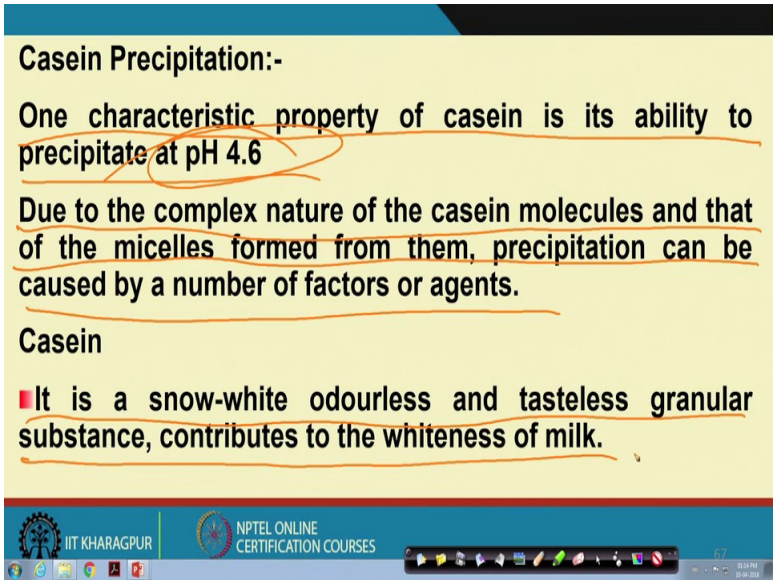
Then in alpha s 1 casein it is more it is 46 position one phosphate 48 position one phosphate 64th position, another phosphate then 66th position another phosphate, then 67 68 like that even 114 position some phosphates are there. This is the how casein and phosphates they are linked. Then alpha S2 casein in that it is S2 we if you remember in

earlier class we had said that alpha S1 is more hydrophobic than alpha S2 right; alpha S2 is much less



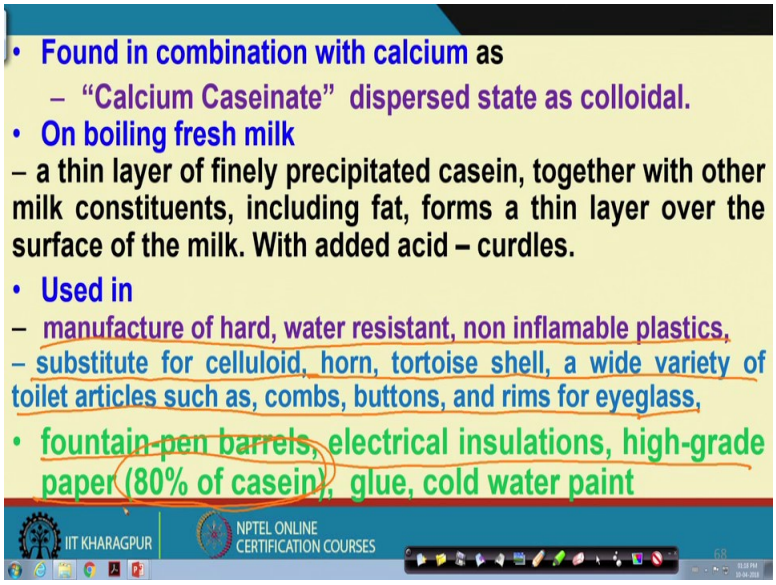
Here you see the reason is that; here it is from 8th position 9th position tenth position where it was 15 46 is this positions right.

So, up to 61 56 so many so because of that this alpha S2 are having your lot of hydrophilic nature, than that of the alpha S1 right, so because of the presence of the phosphate groups right. Similarly kappa casein this of course is having very less phosphate because kappa casein otherwise because of the because of the chain or because of the composition of the this your; the this carbon chain not only carbon chain that because, of the composition of the your acid this what we called or just now we said that because of this composition of the amino acids; this amino acids because, of that how they are linked by which of the amino acids the kappa casein is having more hydrophobicity a less hydrophobicity or more more hydrophilic nature right, so this is how they are coming.



Now, let us look into that casein precipitation. Casein precipitation happens 1 characteristic property of casein is it is ability to precipitate at pH 4.6 that is isoelectric point of the casein is 4.6 right. You remember that we had said that these caseins they do have charge right and when you are adding this acid; that means, you are adding some more charges.

So, they are neutralizing so when it becomes that isoelectric point 4.6, then that corresponds to the sedimentation of the separation of the casein that is how casein precipitates right. Due to the complex nature of the casein molecules and that of the micelle formed, from them precipitation can be caused by a number of factors or agents right number of factors or agents. So, that is responsible for the precipitation of the casein right. So, now let us look into the other part of the casein; that it is a snow white odourless, tasteless, granular, substance, contributes to the whiteness of the milk.



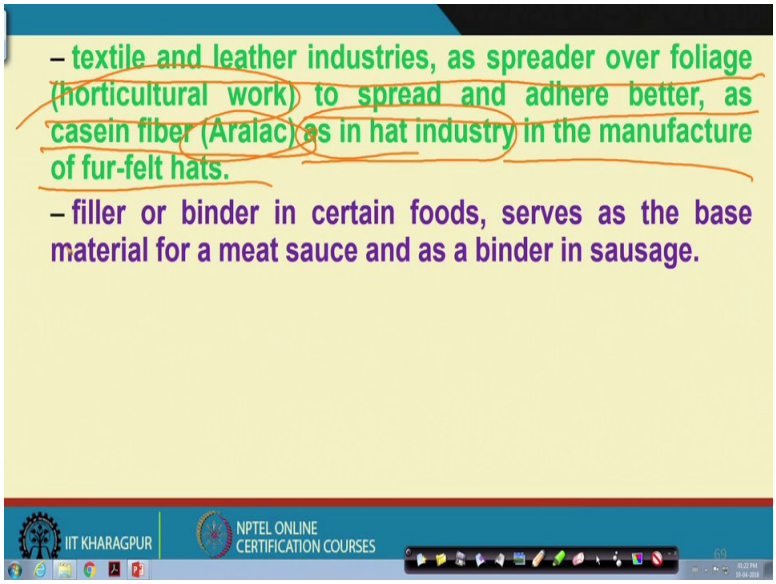
This is one property of casein, found in combination with calcium as calcium caseinate, dispersed state as colloidal suspension, on boiling freshly milk thin layer of finely precipitated casein together with other milk constituents including fat forms a thin layer over the surface of the milk with acid added acid it curdles. This we said also earlier that when mummy and others we have seen, when they are boiling milk that what is happening this casein or the protein both soluble and insoluble because, that high temperature you are boiling. So, the whey protein also becomes insoluble.

So, both whey protein and casein they come out not only the these 2, but also along with that fat and many others they do come out form a fine layer or crust on the surface of the milk, a which does not allow the vaporization of the water from inside thereby is giving our upper ward thrust for which the crust becomes swollen and then ultimately it spills over right. So, this is how the spilling of the milk during boiling is occurring right and if there is high acidity, then it curdles that is also already discussed right.

Now, where it is used? Casein is main used mainly in manufacturing of hard water resistance non inflammable plastics right, high quality plastics like celluloid's those were photographs have been taken they are made of casein because, casein and a great a great quantity of casein is used there. High quality of comb there also casein is used high quality of this glass frames there casein is used right. So, casein is of really having very wide utilization or it usability right this is substitute for this celluloid horn tortoise shell a wide variety of toilet article such as comb button or rims for eyeglasses.

Fountain pen barrels electrical insulations high grade paper around 80 percent of casein is used. The we see paper qualities of different type right not only the paper on which you we are writing normally, not only on the leaflets which are of very poor quality, but also we get very very great quality of papers where good good photographs and other things are impregnated or printed right.

So, those high grade high quality papers they are also made of protein this casein and to the tune of 80 percent of the casein is used for that right. So, for very great quality of paper manufacturing you need very good quality of protein or good quantity also of protein. Then in forming glue or cold water paint this protein is also used or casein is also used right.



Then we come to the other use that is it is also used in textile, it is also used in textile and leather industries as spreader over foliage that is the horticultural work or to spread and adhere better as casein fiber or aralac is there or it forms as in hat industry in hat in the manufacture of fur felt hats right. In typically those where cold systems are there right cold weather is there, there we have seen people are using lot many fur hats right those fur hats they are also being produced from the casein.

This casein has a wide, this casein has a wide variety wide application and fortunately the casein availability is also there that is why the price could be control, but mind it all this protein is coming from milk. So, at the cost of defatted and then you are deproteinated milk you are using because, this casein you are getting separated right this

casein you are getting separated from the milk, so you are left with whey right. So, unless casein you are precipitating they are not you are not also getting the casein, so that means that milk which is say 100 millilitre or 100 gram out of which 4 gram only protein you are getting right.

So, you are 100 millilitre 100 m l millilitre of milk you are wasting for 4 gram of the casein because of this kind of use. So, as a dairy person or as a part of the dairy you will obviously not 1 unless and until you have enough quantity of milk produced you will not be allowing this to happen that use of casein for some more other purpose, because again as we have seen that in the milk fat it is more assimilable that many other fats.

Similarly this milk protein is better assimilable in the body system than many others right. So, everything we cannot just tell on the blackboard or on the board itself because that does not encompass in our course curricular otherwise we will not be able to finish up right.

So, the last use is that filler or binder in certain foods and serves as the base material for a meat sauce and as a binder in sausages. So, we have seen at home also, that in many cases that binders are being used for binding. For small example that many times you might have seen that mummy and others they are making dishes may be from the peel of some of the vegetables. These peels you cannot fry in they become individual you cannot make them complex or compact.

So, to make them compact you have to have some binder, so this binder this casein can be acted as the binder or filler agent filler that is filler unit. So, that binding or filling this come this can be done with the help of this casein and this helps in making different dishes like sausage or sausages many such kind of things are being done with the help of the casein right.

So, with this let us stop casein today, as I promised that in the next class I will show you how the naming alpha beta A, B, C, D, E, F how this naming for the amino acids are being done right.

Thank you.