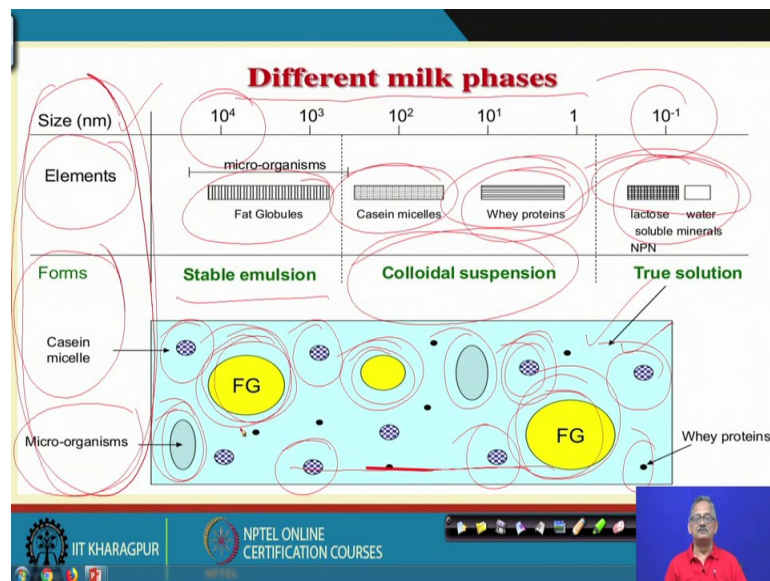


Dairy and Food Process & Products Technology
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Lecture – 24
Milk Fat (Contd.)

So, in the last class we were discussing in this dairy and food process and products technology, right. We were discussing about the milk fat. So, today we also continue because it was not over, so it is continued on milk fat. So, what we have seen that there are many factors which controlled the come both the quantity and also the quality of the milk fat that is the compositional behavior or compositional variation in the milk fat that is being controlled by many many factors we have discussed, right.

Now, let us look into another thing very important and very interesting that is this that milk is such a this of course, I have taken from some source may be from some net. I forgot to write that references here should have been. Ah



Here you see that milk fat or the milk rather it contains different phases. For example, you see we have given in this rather in this pictorial view size in millimeter nanometer, size in nanometer it is given and elements they are given forms what forms they are available and whether it is what element and in what form they are present that is being depicted in this picture, right.

You see here it is from 10^4 to 10^1 , right; 10^4 to 10^1 in nanometer it is there, right. So, there you see that fat globules are like this so big, fat globules are like this it is around say 10 or maybe 100 between 10 to 100 nanometer size. So, that is around maybe may be 1 to 10 micron, right. So, depending on the size becomes fat globules are also shown in smaller size, this is a bigger size, this is a in between size though they are pictorially. So, it does not mean that this comes 1 only 10^4 . So, 10^4 nanometer; that means, 10 micron, right. So, that is the fat globule size.

Microorganisms they can be very small depending on the size. So, they are also maybe 1 or even half micron or 0.5 micron or even lower or may be a little bigger depending on the organism. Then this is a microorganism scale ok, fat globules are of this size caseins are of this size and whey protein are of this size, and lactose and water they are of this size, right. So, what we see that if this be a true solution, right then the smaller units are whey proteins, right which are smaller in size, whey proteins then we also have, so this kind of thing where this is casein, right. So, this are casein micelle and these are fat globules and these are microorganisms. So, this is one milk unique as we have said earlier also.

So, this is a true solution of lactose or soluble things true solution this is also a colloidal suspension of this casein right. This whey protein normal it is soluble. So, caseins which is in oh sorry not that caseins which is this that is in colloidal suspension and a stable emulsion that is the fat globules, they are in stable emulsions these are fat globules. So, it contains all 3, all 3 phases that is true solution colloidal suspension as well as emulsion by the respective components elements which you have said, right. So, they can be like your salts they are in solution maybe organisms, if there in solution then they can be whey protein in solution or there are caseins which are in suspension and that is called colloid or colloidal suspension and some emulsion that is fat which is present in milk.

So, this is a unique system where all 3 phases that is true solution, colloidal suspension and emulsion all 3 exist and is a stable, that is the primary thing and the entire thing is stable, right. So, by since in the stability and all these phases are coming up. So, in this regard let me also tell or exchange share one information that today whatever milk is has in the some class I say took the reference of Dr. Kurien who is renowned and who is the I mean who is regarded as the white revolutionary person and who brought a white

revolution. And ah, but even then even then today we are having lot of milk problem because population is growing up, but the production or availability of milk is not going up.

So, in that case what is happening day by day the price of milk is going up and since other cost, like fuel cost transportation cost these are also going up someday it will come that the price of milk is very very high, price of milk is very very high someday it will come up and when it will come up that time this will be a major problem. Now, what you are doing? You just think from one place say Gujarat to say Bengal you are transporting milk say somewhere around say 2000 kilometers. So, this 2000 kilometers you are transporting say 1000 litre or say 10000 liter of milk in a container. You have every other thing that is maintenance of temperature etcetera all other things are fine.

But since you are bringing 10000 liter from Gujarat to Bengal your transportation cost whatever if we that is being added to the price which you have bought from Gujarat, right. And obviously, as it is being seen that with time this price is going up because transportation cost is also going up. But technological or scientifically you think that what you are bringing from Gujarat around 80 to 90 percent of water and rest is the solids that is total solid in terms of solid not fat and fat. Now, by some means that by some means is a technological challenge, by some means if you can bring down this water content from 80 to 90 percent to 30 to 40 percent, or even lower without mind it without changing the characteristic behavior of the solid milk solid total fat and non fat than you are bringing down your transportation cost whatever it was for 80 to 90 percent moisture down to 10 to 20 percent.

So, huge quantity of milk you are bringing which after reaching you rehydrate and make it like that whatever milk was, because in milk we said that it is a it is a unique stable all 3 all 3 phases are their solution colloid as well as emulsion and liquid that is water being the primary or the that continuous phase. So, any property change by addition extra will be with respect to water because that is the continuous phase.

So, when you are adding water there it is also they are getting diluted. So, from a concentrated milk you are now, diluting the primary challenge to you as scientist of technologist is that how without changing the quality of the food components that is milk

fat and on solid not fat and without increasing the price. If the price of that is more than your transportation cost nobody will take, right.

So, till date science is getting this challenge till date if solution has not come up. I hope someday you as student will come forward and do this miracle and then definitely another we are this thing another your white revolution will come up, right. White revolution not only by production, but also by utilization you can make right. So, this you keep please keep in mind and in someday we are trying in our lab the what I was why it has come up, because that it is a though it is a stable, but it is a true solution colloidal suspension and emulsion all these 3 together when you are trying to separate water by some means then it is very difficult keeping all this 3 stable and you can extract water, right.

The moment you are extracting water it is not only fat and casein that is the colloid some lot of lot of soluble solids are also there. So, they also will come out with the with the water. So, this is a great challenge, and also imposing to you if some solution you can as engineer scientist or technologist whatever you call if you can come forward it will be a great help to the dairy people or to the as a whole nation and you can make a revolution in that, ok. So, it is a true solution cum it is a colloid and it is a emulsion, right.

What is protein?
Protein is a macronutrient that is essential to building muscle mass. It is commonly found in animal products, though is also present in other sources, such as nuts and legumes.

There are three macronutrients: protein, fats and carbohydrates. Macronutrients provide calories, or energy. The body requires large amounts of macronutrients to sustain life

Meat, seafood, poultry, grains, beans and dairy products are good sources of protein.

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Relative sizes of particles in milk.

| Size (mm) | Type of particles |
|------------------------|---|
| 10^{-2} to 10^{-3} | Fat globules |
| 10^{-4} to 10^{-5} | Casein-calcium phosphates |
| 10^{-5} to 10^{-6} | Whey proteins |
| 10^{-6} to 10^{-7} | Lactose, salts and other substances in true solutions |

So, relative size of the particles are like this from there we have seen let me clear out this, right. So, relative size of the particles in milk are in millimeter between 10 to the power 2 to 10 to the power minus 3 that is fat globules, right. Between 10 to the power minus 4 to 10 to the power minus 5 it is casein or calcium phosphate together combination, casein calcium phosphate combination between 10 to the power minus 4 to 10 to the power minus 5 millimeter in size. Between 10 to the power minus 5 to 10 to the power minus 6 millimeter in size this is the whey proteins and between 10 to the power minus 6 to 10 to the power minus 7 it is all other soluble size lactose, salts and other substances in true solution, right.

So, milk contains variable size of particles ranging from 10 to the power minus 2 millimeter to 10 to the power minus 7 millimeter, right. So, such a wide variation of the particle size out of which fat globules between 10 to the power minus 2 to minus 3 millimeter, right. And casein between 10 to the power minus 4 to minus 5 , whey protein minus 5 to minus 6 and the soluble fractions that is lactose, salts and many other soluble parts in water between 10 to the power minus 6 to 10 to the power minus 7 , right.

So, if we now, recapitulate what we had said earlier that the problem of fat in milk is primarily due to the species, primarily due to again the feed, this to if species and the feed you have the control you can both increase the fat content as well as the quantity of the milk which comes out, right. So, quantity of milk which comes out that also you can produce you can take more if you have a true control in it, right.

So, we can say that if we can reduce the transportation cost, if we can produce more quantity of milk, if we can produce good quality of milk fat then we can cater the nation much much better way, much much finer way. In this respect what I just referred earlier that we have been also doing yes we are trying there is a process, there is a engineering process by which it is called the separation by freezing, right. So, that is concentration of milk with freezing, right.

So, that if we can adopt we are trying when it is getting frozen I of course, this is not part of this class freezing, but still let me tell that when you are freezing what is happening, you are depending on because freezing is primary dependent on the rate at which you are removing the heat the temperature difference between the refrigerant and the material to be frozen and also on the degree of super cooling. I don't know whether you know it or not that if you look at the freezing curve then from initial point wherever you are studying say maybe room temperature, when it comes down to the at a temperature where still it is not freezing, but lower than the initial freezing point and that point is non as degree of super cooling.

So, after the super cooling it goes and it goes and forms the nucleus and this formation of crystal being exothermic that temperature again goes up to the initial freezing point and then hypothetically there is a plateau. Hypothetically, why? Because they are also your Raoult's law come into that as the concentration as some quantity of moisture gets frozen, remaining solution is getting concentrated. So, the more concentration it is happening by Raoult's law the lowering is the freezing point temperature or depression of freezing point that is from the Raoult's law, right.

So, when it is happening that time your change is temperature or change in the freezing point is continuously happening. That is why in practice it is not a plateau or theoretical plateau which can be the like if you if you just draw it is like this that if this is the freezing curve, and if this is the temperature and if this is the time, then the time temperature communication comes like this and then this like that, right.

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Since it is with this kind of pen. So, this is that this plateau is normally not possible, this plateau is normally not possible because the moment you came here this is called the degree of super cooling, right. This is called the degree of super cooling.

So, when your super cooling to that temperature, right. And this is corresponding to the temperature here, right. So, and this is a initial freezing point. So, this is a T_i and this is the T super cooling, right. So, when it is arriving at that super cooling point, so because here it is forming the starting beginning of the nucleus formation. So, crystal formation takes places. So, there is a exothermic, so the temperature goes up to this and then theoretically all whatever fusible water is there that is getting transformed into water at this temperature constant theoretically, right.

But practically what is happening? The moments sum as already taken care of already have frozen then the initial freezing point here and remaining part concentration part goes up. So, it went down, right. It went down. So, from that it comes like this and then it follows this, this is actually the real time real this one is the real, but this is the not hypothetical I should say ideal, right. So, whatever be when you are freezing, so what is happening? You are making that ice, right.

Now, in milk it being not only a solution, but also emulsion also a colloid. So, taking out what and all are in combination it is not that they are isolated you take if this be the glass of milk, right. You take one drop and then analyzed its composition whatever it is you take another drop find out its composition it will have the same, right. That is it is a

homogenous mixture, right. So, if from that homogeneity if you are going to disturb by maybe freezing or maybe some other method then it is very difficult to break that and take water away from that that is why whenever we could have achieved around from 90 percent moisture to around say 70 percent, but in the end process we have lost a little both fat a little your casein as well the soluble solids these we have lost.

So, initially whatever composition we have started with 90 percent, say 10 percent soluble solid or total solid not soluble total solid. Now, when we came back when we could arrive around 70 percent, that time it is not that this 70 percent also contains equivalent to that 10 percent total solid it is less than that, right. Because we go whenever we you are making that ice these ice is also carrying soluble solids some fact some casein, right.

So, it is a very challenging one by which you can separate this water from the rest. But again I am telling today is what is impossible tomorrow is the best thing it may be possible, right. So, 100 years back we did not people I do not know nobody is alive or if they are they cannot remember, but if you see the history whatever 100 years back things were not imaginable now they are at your hand.

Now, whatever now, is not imaginable may be after some days they was at in your hand. So, who knows who can break this, and if really any one of you or I am not only saying you if anyone can make and break this that the price of the transportation cost if that can be minimized you make a breakthrough. This is a real day in the dairy science their engineering, this is a real breakthrough that you can make, right. So, this you keep in mind.

And not only that pass it on, this is not a not a dairy problem this is a more engineering or science problems than any other as well economic problem because from now onwards next after decade when you will become sufficiently grown up you will be doing your normal family life that time you will see now you are buying milk may be 40 rupees a litre. So, that time maybe after a decade it will come out to some 80, 70-80 rupees a litre and it is not that if you are getting today some say 1 lakh rupees month salary and they are you will get 2 lakh rupees a month salary. So that never; when this price of this commodity increases the salary or corresponding earning that does not increase in the same proportion, so you will also have the same problem.

You will also face a similar problem until and unless this solution is made, because day by day the most of the vacant plane is being occupied by the human being only because population is also growing. I do not say I do not know whether it is exponentially or not, but definitely it is increasing every year, year by year, right. Whether the nature is exponential or curvilinear I have no idea, but it is true that it is increasing and this increase is not as per with the increase of other associated things.

So, this challenge I put to you that you come forward with some solution that how you can eliminate the transportation of water in the milk. So, that the more quantity of very concentrated milk you can shift from one place to other place reducing the transportation cost, there by you are reducing the price of the unit of the milk that is per litre it will be it can be brought down drastically. Then only it will be a breakthrough, then only you can bring another white revolution in the country, right.

So, this you just think and if you have any solution, you can pass on to us you can pass on to anybody you can do it yourself or you can take help of some people, but the idea should come and that is where you need to know some other subjects as well the engineering, that is a very fundamental the engineering parts also you must know along with the science part, ok.

So, this we stop today we are finished the fat. Next we will go to protein, and everywhere as we are saying that we start with the beginning or preliminary things. So, that associated things sciences is also recaptured or recapitulated or brushed up so that we will also try for protein, ok.

Thank you.