Dairy and Food Process & Products Technology
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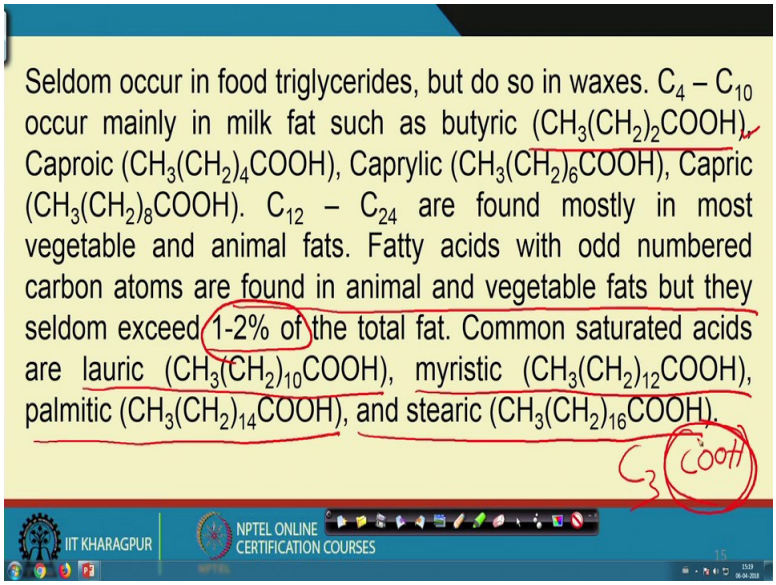
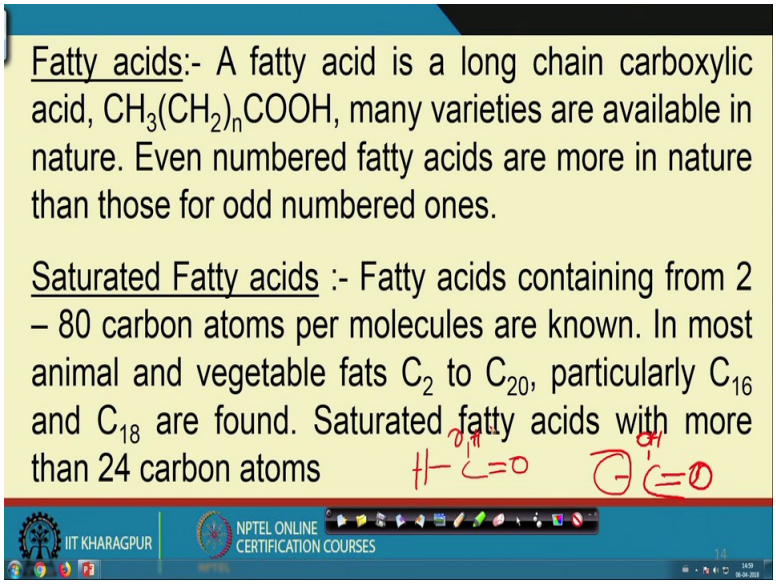
Lecture - 21
Milk Fat

So, in the previous class we are discussing with the Milk Fat right. So, in this class of Dairy and Food Process and Product Technology, so on the lecture number 21, sorry in the lecture number 21 we are coming to this the Milk Fat right. So, we said milk fat is the esters of fatty acids of alcohol or glycerol typically used esters of fatty acids of glycerol right, it can be mono di or tri.

Now, then it comes obviously what is fatty acids? Right, a fatty acid is a long chain carboxylic acid right, general formula it can be CH 3, CH 2 whole n COOH, obviously carboxylic acid is COOH right. So, it has I do not know whether you still know it or that carbon has 4 hands like that means, 4 valency right.





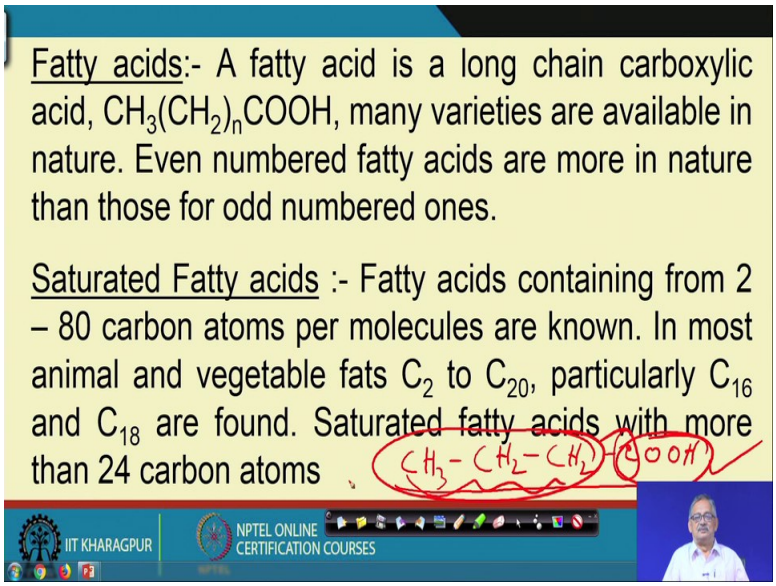
So, it can combined with 4 out of which CH 3; 3 are taken out so 1 remains right, or C O H in there also C O O, and O H hopefully, we know that how C O O H is written right. So, this is C this is double one O, and this is one, hand free, and this is H right, this is O H sorry this is O H right. This is O H. So, if we C O, I bars O double bond and free hand this is O H right. So, if that be true then this hand becomes free right. This is what the valency that becomes free, so this if we substitute with 1 hydrogen that is H C double bond O O H.

Now, this also can react because this is also an acid, this also can react with the glycerol right. But normally formic acid is 1, which up to 1, 2 or 3 carbons normally it is not said to be fatty acid. It is the chain means CH 3, CH 2 whole n COOH, if we make a n is equals to 1 then it becomes CH 3, CH 2, COOH, which is nothing but if had it been CH 3, C O O H from formic acid, then it is acetic acid, then it is propionic acid right.

So, CH 3, CH 2, C O O H would have been propionic acid, but normally up to 3 it is avoided. Normally it is because that is the natural occurrence from the nature the occurrence of the fatty acids is seen to be from more predominant from 4 C 4 right. But C 4 constitutes of all right, let me clear it of C 4 means your here CH 3, CH 2, CH 2, COOH right. This goes off eraser highlight eraser, so these goes off right, this goes off it is CH 3, CH 2 like that. So, in that case this is the butyric acid right.

Subsequently you will see in our class or in books also you will see this COOH though there is a carbon, this carbon and along with that acidic group carboxylic acidic group,

they are taken aside. Normally, the number of carbons they are set in terms of this, that is how many carbons are there CH 3, CH 2, CH 2 that is 3 carbon, C 3 right. Because C O O H count every all carboxylic acid, so C 3, C 5, C 7, C 9, C 11. These are all odd numbers of carbon chain, and C 4, C A, 6 C 8, C 10, C 12, C 16, C 18, they are all even number of carbon chain right, and because carboxylic acid is common to everybody right.



So, that is why the though the general formula is CH 3, CH 2 whole n, COOH and in that if n becomes 1 then it would have been propionic acid the, but occurrence of the mono or di whatever the glycoride occurrence of the ester of glycerol with the propionic acid or acetic acid or formic acid is very very negligible or not there right.

So, that is why they are said not to be the fatty acid right, so fatty acid then we tell carboxylic acid with carbon chain where the chain length is minimum for with the carbon without carbonate could be 3. So, normal this 3 onwards we take there could be normal it is said C 2 and onward because officially you see, we if we put n is equals to 1 then it becomes CH 3, CH 2, C O O H, so it is 2 other than carboxylic acid.

So, 2 to 80 it can be, but that is maybe one in C 80 or C 70 may be in one in thousands or lakhs of sources you may get. So, that cannot be taken as, but commonly mostly it is between C 4 to C 20 within this range most of the fatty acids they are in nature. So, we call accordingly C 4 to C 20 right, so many varieties are available in nature even numbered fatty acids are more in nature than those for odd numbers ones.

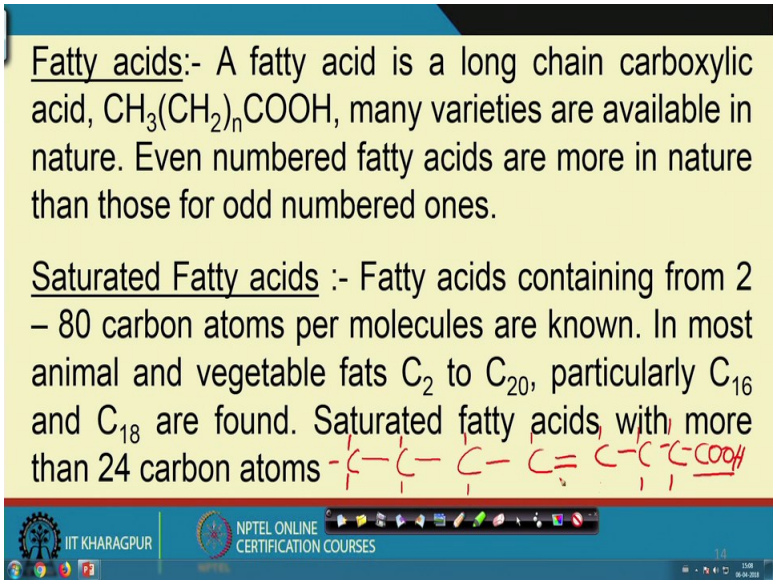
Now, the even numbered and odd number as we have said this is don't make the confusion because subsequently you will see that it depends on the books how they are following, the writer I am talking about the basic books, I am not talking about the books which are I don't say copied, but at least which are edited or lot of writers are there. If it is single author book normal we take that to be more prominent more informative etcetera or reliable.

So, in that case if you look at books like as you said Fennema or Meyer; these are some of the food chemistry or this oriented or technology oriented books are there. So, if you look at them some books may also follow that the even number is with the fatty acid. Some books may say you know since fatty acid is always there in that acidic group is always there.

So, if we remove that and tell about the chain length in terms of number of carbon atoms then it becomes more convenient. So, that is why even or odd that is subjective, so, if you are considering the carboxylic group also as one of the member then even numbers are more prominent or more available in nature than the odd numbers, but if the reverse if keeping aside the carboxylic acid group then we say that odd numbers are more available in nature then the even numbers right.

So, you can you don't make it confusion this is absolutely clear that even number with carboxylic acid group, then it is the more occurrence in nature, but odd number to carboxylic group living aside the carboxylic group, carboxylic acid group that if that be there then that is more occurrence, more occur it occurs more with the even odd number right.

So, if you leave a the carboxylic acid group. So, even or odd that is subjective, so until and unless you specify don't get confused right. So, even number fatty acids are more in nature than those for odd numbered ones then comes saturated fatty acids right.



Now, out of these fatty acids now like this one which we have shown let me erase it this one, now you suppose we have carbon like this carbon, like this carbon, like this go on right, C COOH this is the carboxylic group right. Now, if whether all of them are with hydrogen, so then it becomes alkyl right, if all of them with hydrogen then it becomes a alkyl group whatever be the name.

So, if out of that one is replaced if out of that no not the this one see out of that if one is replaced with a double bond right, then it becomes unsaturated because unsaturated means there has to be a double bond, if there is a single unsaturation then single double bond.

If there are multi unsaturation then there are multi double bonds available, but if the double bond is not there as in the earlier case we have shown that all the valencies are occupied by the hydrogen. Then or may not be all the time hydrogen may be if they are grouped right. I show that also can be so depending on how they are attached, but if there all with some or other kind of valency with hydrogen or equivalent substitution then they are saturated right.

So, then we call it to be saturated carboxylic acid, now this saturated carbolic acid when it reacts with the alcohol that is glycerol; then the esters which are formed may be again mono saturated mono or di or triglyceride depending on how the how many number of alcohol groups are esterified right. So, between C 2 fatty acids containing from 2 to 80 carbon atoms per molecules are known in most animal and vegetable fats C 2 to C 20

particularly C 16 and C 18 are found, saturated fatty acids with more than 24 carbon atoms are not commonly encountered or is not available right.

Seldom occur in food triglyceride beyond that's what I was saying that though theoretically it can be that C 2 to C 80 right. Theoretically it can be, but for all practical purpose those which are available in nature in out of that it is mostly sin that between 2 to 20, it is varying and that too it is also said where C 16, C 18 are more occurrent in nature that is their availability in nature is much more.

But beyond C 4 24 it is seldomly occurring in nature artificially you can do anything that is altogether different artificially you can produce anything right. Now artificially people are polymerizing those polymers and that polymerization you can do as much you can polymerize depending on the different-different products are coming up, every now and then somewhere other kind of polymers coming in the market, but they are all manmade, they are not natural.

So, natural this polymers or rather poly chain right chain of this carbons in the fatty acids; They are between 2 to 20, and out of that 16 and 18 are more occurent than any other and beyond 24 they are seldomly sin right, but do so in waxes yes if it is more than that instead of fatty acids instead of esters of glycerol or glycerides it forms wax right.

Wax is also kind of this comes under the lipid family right, This also comes under the lipid family, but there are the number of carbon atoms are more than 24 and they are high chain long chain carbon atoms and they forms waxes between C 4 to C 10 the occur mainly in milk fat such as butyric acid, the their as you see we are giving here that CH 3, CH 2 C whole 2 CH 3, CH 2 whole 2 COOH that is 1 3 4 including the carboxylic acid it is 4 butyric acid right. Again I say the subsequently at some point you may say that without the carboxylic acid this number will be C 3 right. So again and again this confusion you don't keep you have to be very specific that is why explicitly I have given the formula for butyric acid with C 4 right.

But if I say that butyric acid is C 3 then it you have to keep in mind that COOH is omitted right. This is excluded excluding that C O O H butyric acid is C 3 right, in that case it becomes odd number right. Though it corresponds to butyric acid which is including the carboxylic acid is the even number right. So, don't make confusion you

have to be specific and the moment you are specific you can write like this that yes butyric acid is this.

Similarly, are some other gaseous like capric acid that is CH 3, CH 2 whole force COOH that is 4 and 1 5 and then COOH that is 6 it was 4, C 4 ,8 C 6 caprylic that is CH 3, CH 2 whole 6 COOH then capric, there is CH 3, CH 2 whole 8 COOH right.

So, all these are occurent in milk all these are fatty acids occurent in milk between C 4 to C 10 between C 12 to C 24 are found mostly in most vegetable and animal fats. So milk contains mostly between smaller chain that is 4 to 10, 12, 1 was up to 24 it can be available mainly in some plant origin vegetables or may be some animal origin fats. So, depending on that whether it is plant origin or animal origin depending on that this number also may vary we will also come sometime may be lard that is 1 which is a animal fat and the price of animal fat is much much lower than that of the either milk or vegetable fat right.

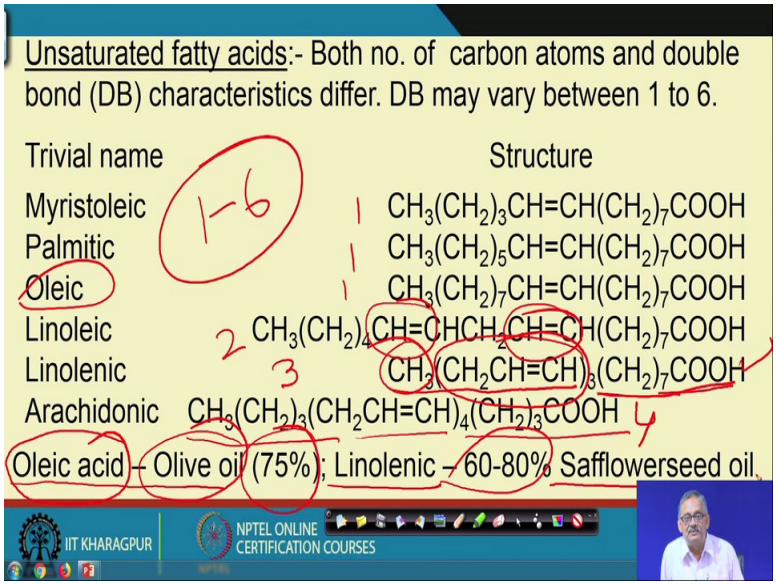
Much much lower and the quality is also much much lower quality in the sense the assimilability in the body and the consumer is much much lower that is why their price is also very low you can easily see if you go to any slaughterhouse write lot of animal fats are there right. And those animal fats either been thrown away or people buy with very very limited money a very small I mean amount of money they buy the 1 of the reasons that is not true even if you go and if you do not need to separate fat just the whole milk if you buy is much much higher right.

Though you are getting along with milk fat you are getting protein and carbohydrates and many others, but if it is separated then the price will go even higher much more higher right. So, that is why the fats are in milk it is small chain carbon between C 4 to C 10, C 12 onwards is normally available in vegetable fats, or animal fats. Fatty acids with odd number carbon atoms are found in animal and vegetables in odd numbers that odd number includes this COOH right, this COOH is included , but they seldom exceed between 1 more than 1 to 2 percent of the total fat right.

The total fat which is present out of that this odd numbers are only around 1 to 2 percent. It is mainly the even and this even one is including the carboxylic acid group, and the odd one is also including the carboxylic acid group. So, the odd numbers are rarely found is small in quantity less in quantity and percentage wise as we said that is around 1 to 2

percent and mostly occurent in the higher of course, higher carbon chain C 12 to C 24, that is available in plant origin and animal origin fats right.

The common saturated acids are lauric acid which is CH 3, CH 2 whole 10, COOH Myristic acid that is CH 3, CH 2 whole 12 COOH, Palmitic acid that is CH 3, CH 2 whole 14, COOH stearic acid CH 3, CH 2 whole 16 COOH right. So, these are common saturated acids which are there.



Now, out of that out of that let me see yeah, so perhaps one blank came. So, out of that we saw that up to 16 we have said that is Palmitic stearic acid right, and there are unsaturated fatty acids also and these unsaturated fatty acids they do have double bonds and depending on whether it is a single unsaturation or multiple of unsaturation or multiple unsaturations depending on that they are also name differently. Like you might have heard that there is a term called PUFA; that is poly unsaturated fatty acid, you will see in many advertisements of fats and oils they do claim that it is a having very unsaturated fatty acids.

And by the by that many this unsaturated fatty acids are not normally synthesized by our body or body are not able to synthesize that is why from the external sources they are being supply that is why the advertisement it is it is being highlighted that this contains poly unsaturated fatty acids and this is much more better for your body that is what it being claim. So, what is that unsaturated fatty acids that both number of carbon atoms and double bonds characterized characterizes this right.

Though there the double bond may vary between 1 to 6 right, usually 1 is there, but you can be more than one crop to maximum 6 are naturally occurring unsaturated fatty acids available in that some of the names are like this Myristic acid or it is Myristoleic acid Myristoleic acid is CH 3, CH 2.

Myristoleic acid is CH 3, CH 2,CH3, CH 3, CH 2 whole 3 CH double bond CH C H 2 whole 7 COOH right. So from the left from the carboxylic acid group side it is C8 where the between C 8 and C 9 the double bond is right, this is number 1 and from their 7 8 and this is 9 so 9 and 10 sorry this is 7 8 9 and 10 between that it is Myristoleic acid.

Similarly, in Palmitic acid it is it is CH 3, CH 2 whole 5, CH double bond CH C H 2 whole 7 C O O H, then Oleic acid it is CH 3, CH 2 whole 7 CH double bond CH C H 2 whole 7 COOH here you see that number of double carbon atom where double bond is 1 8 9 again here also between 9 and 10, here also between 9 and 10 right, but this side the numbers are different here it was CH C H 2 whole 3, here it is CH 2 whole 5, here it is CH 2, whole 7 right.

But this side all of them have the same configuration right. Then from oleic acid if we go it is Linoleic acid where it is CH 3, CH 2whole 4 CH double bond CH C H 2 CH double bond CH C H 2 whole 7 COOH again 8 9 between 9 and 10 position 1 and then 11 12 between 12 and 13 position another. So, 2 double bonds in Linoleic acid right; in Linoleic acid 2 double bonds are there, so the more the double bonds are there in unsaturated fatty acids better it is because it acts if the external if oxidation is there, then oxygen can easily combine in this double bond.

So, this can be taken by one oxygen or another oxygen or may not be oxygen, but some other substituted product that can come up right. So, there we can see that between C 9 and C 10 1 double bond and between 11 12 between 12 and 13 1 double bond in Linoleic acid right.

Similarly in Linolenic acid, Linolenic acid it is CH 3, CH 2 CH double bond CH whole 3, then CH 2 whole 7 COOH So 1 methyl group outside and then CH 2 CH double bond CH whole 3. So, there are 3 such groups CH 2 CH double bond CH 3 unsaturation is there in Linolenic acid right.

So, 3 unsaturation in Linolenic acid and there it is CH 2 CH double bond CH whole 3 is associated with 1 side with methyl group and the other side with rest of the rest of the earlier that 8 C 8 or 9. COOH then CH 2 whole 7 and then CH double bond right. So, that 1 7 8 and 1 9; So 9 position those things are same like this right, like this 1 right, here it is COOH CH 2 whole 7 and then it is the double one which is coming here at right, and this like this is that the 3. So, this is 3 double bonds here we have 2 double bonds and in all other cases this is single double bond.

Then a typical another one call Arachidonic acid Arachidonic acid is CH there CH 2 whole 3 CH 2 CH double bond CH whole 4 and CH 2 whole 3 COOH right. This is quick call a where we have 4 double bond. So we have given we said between between 1 to 6 double bonds are there naturally occurring unsaturated carboxylic acid. So we have given example upto 4 if you have given 5 and 6 it would have been much much more complex.

So, but it shows that the higher the number of carbon atoms there is a possibility of unsaturation more in that lower number of carbon atoms like C 4, C 6, C 8, C 12, C 10, their this unsaturation possibilities are less because you have to have stereo Chemically stable the compound also has to be stereo Chemically stable stereo means in the special arrangement that that compound has to be stable right.

So, in this another information I would like to share in this class that Oleic acid where which is available Oleic acid is this right Oleic acid which is available in olive oil in olive oil around 75 percent it is Oleic acid, around 60 to 80 percent Linolenic acid is in safflower seed oil safflower seed oil contains around 60 to 80 percent Linolenic acid,

Which is also having a single double bond and around around 75 percent is the Oleic acid present in olive oil, and in you will see nowadays people have also started using olive oil as one of the one of the oil cooking oil for themselves. Many people who can afford of course, olive oil is a costlier much much costlier than normal available oil or vegetable oils.

But vegetable also are nowadays the prices are going up and we see here that Linoleic acid is around 60 to 70 or 80 percent available in some of the vegetable oil like safflower seed oil right.

So, like this we need to know some of the chemistry otherwise it is not possible to follow why and how and when etcetera all this w's are to be answered right. We will continue this fat in the next class also.

Thank you.