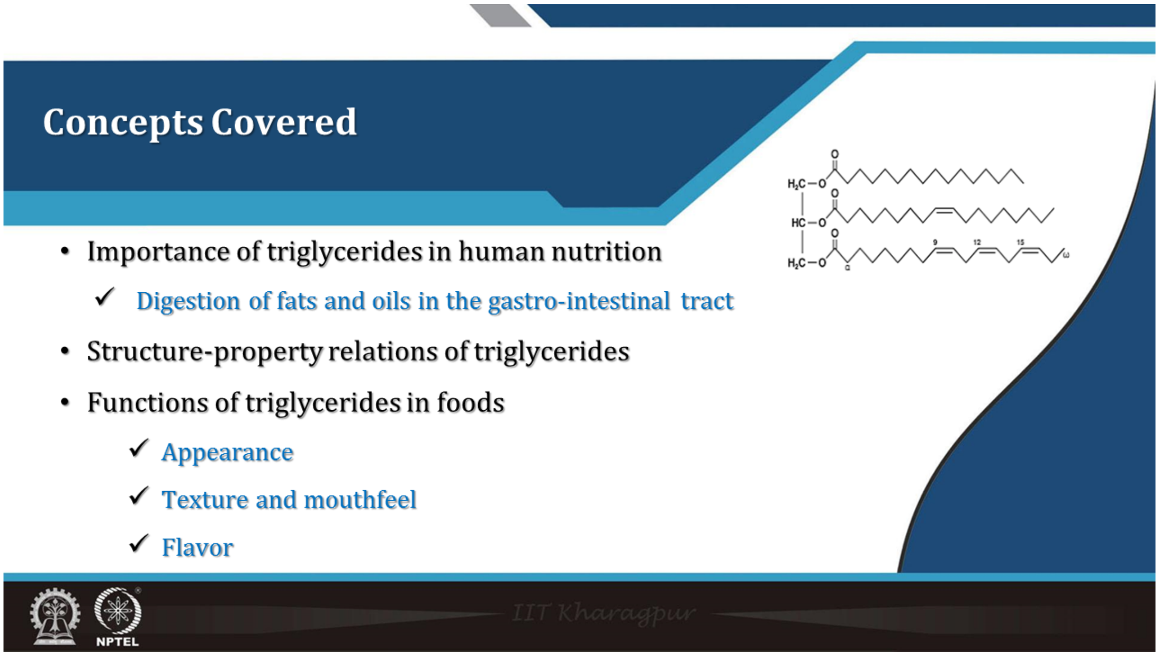
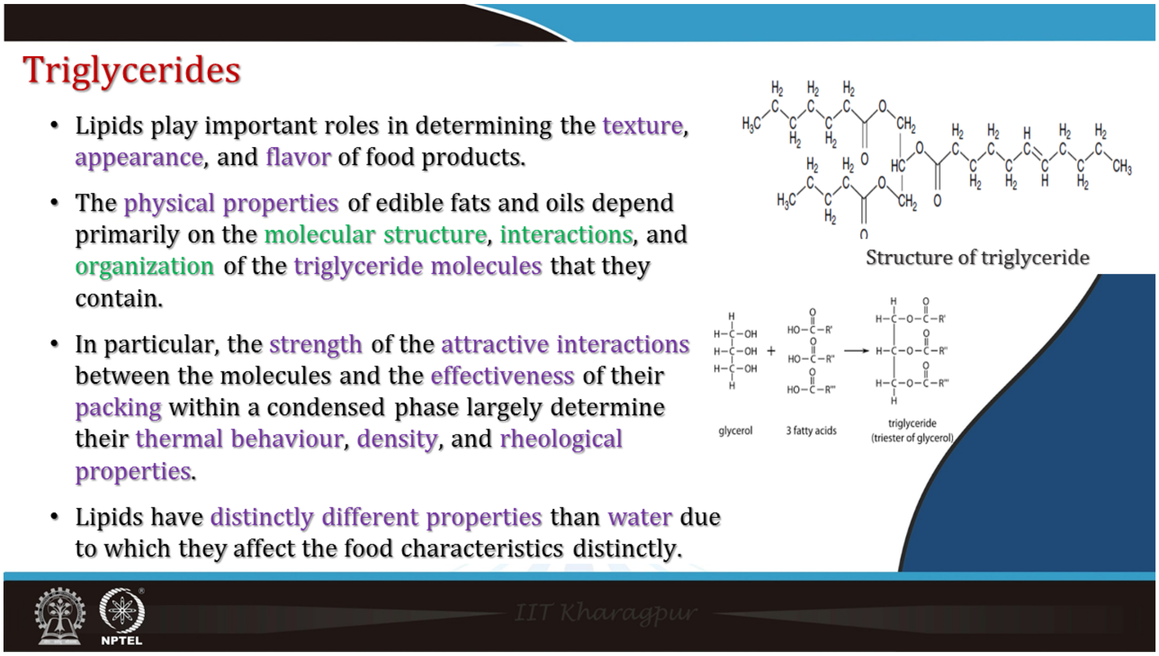
Food Oils and Fats: Chemistry & Technology
Professor H N Mishra
Agricultural and Food Engineering Department
Indian Institute of Technology Kharagpur
Week 1: Course Overview and Introduction
Lecture 09: Triglycerides – Function in Nutrition & Food Processing

Hi everyone, Namaste. Now, we are today in the 9th lecture of this course. In the earlier class, we discussed about triglycerides and their chemistry and some important functions particularly the important properties.

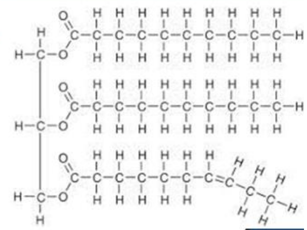


In today's class, in the next half an hour or so, we will discuss about functions of triglycerides in nutrition and food processing. We will discuss what is the importance of triglycerides in human nutrition particularly how it is digested in the gastrointestinal tract. Then we will also discuss briefly the structure property relationship of triglycerides and functions of triglycerides in food products. How different triglycerides influence the appearance of texture, mouthfeel and flavor of food products. Here also we discuss that yes triglycerides are that 3 molecules attached with 3 molecules of fatty acids attached with glycerol molecule and these are in general lipids.



So, lipids play important role in determining the texture, appearance and flavor of food products. Let us take a very simple example like in our home even we prepare chapati. So, you see the chapati, puri that is which is deep fat deep fat fried chapati and then paratha that is smeared fat and you see the difference in all their texture, their flavor and their color you feel. So, this is the simplest example which we can say that how these lipids or fats influence the properties of food products. Physical properties of edible fats and oils depend primarily on the molecular structure, interactions and organization of the triglyceride molecules that they contain. In particular, the strength of the attractive interactions between the molecules and the effectiveness of their packing within a condensed phase largely determine their thermal behavior, their density and rheological properties. Lipids have distinctly different properties than water due to which they affect the characteristics of food distinctly.

Comparison of Some Bulk Physicochemical Properties of a Liquid Oil (Triolein) and Water at 20°C



	Oil	Water
Molecular weight	885	18
Melting point (°C)	5	0
Density (kg m^{-3})	910	998
Compressibility (m s^2 kg^{-1})	5.03×10^{-10}	4.55×10^{-10}
Viscosity (mPa s)	≈50	1.002
Thermal conductivity (W m^{-1} K^{-1})	0.170	0.598
Specific heat capacity (J kg^{-1} K^{-1})	1980	4182
Thermal expansion coefficient (°C^{-1})	7.1×10^{-4}	2.1×10^{-4}
Dielectric constant	3	80.2
Surface tension (mN m^{-1})	≈35	72.8
Refractive index	1.46	1.333

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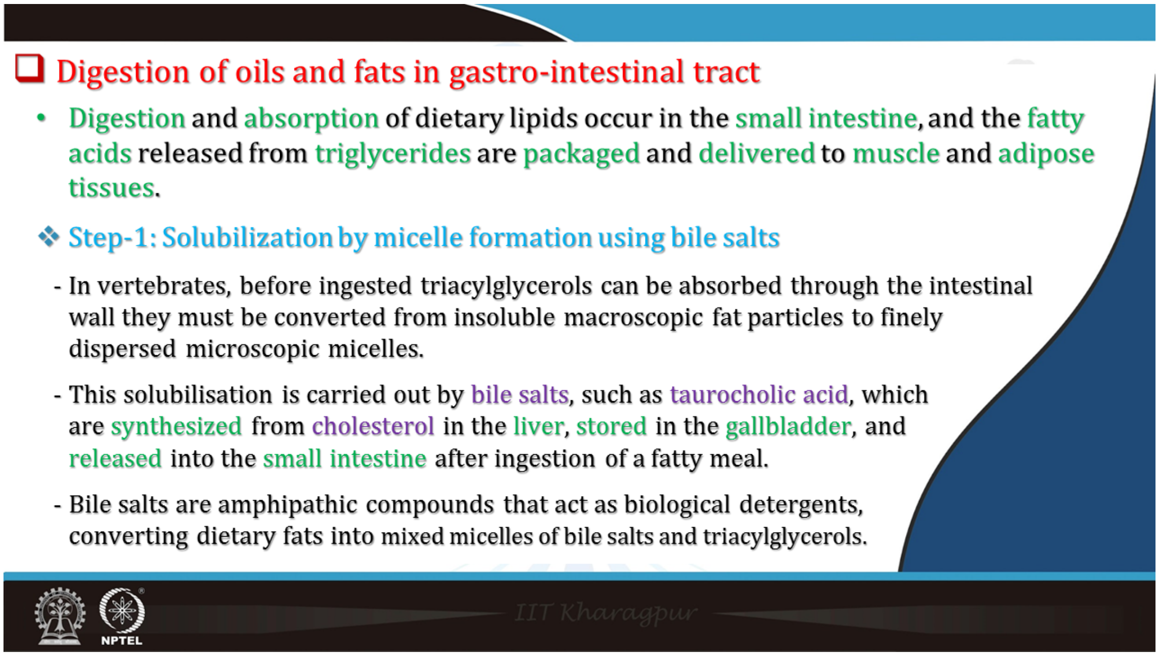
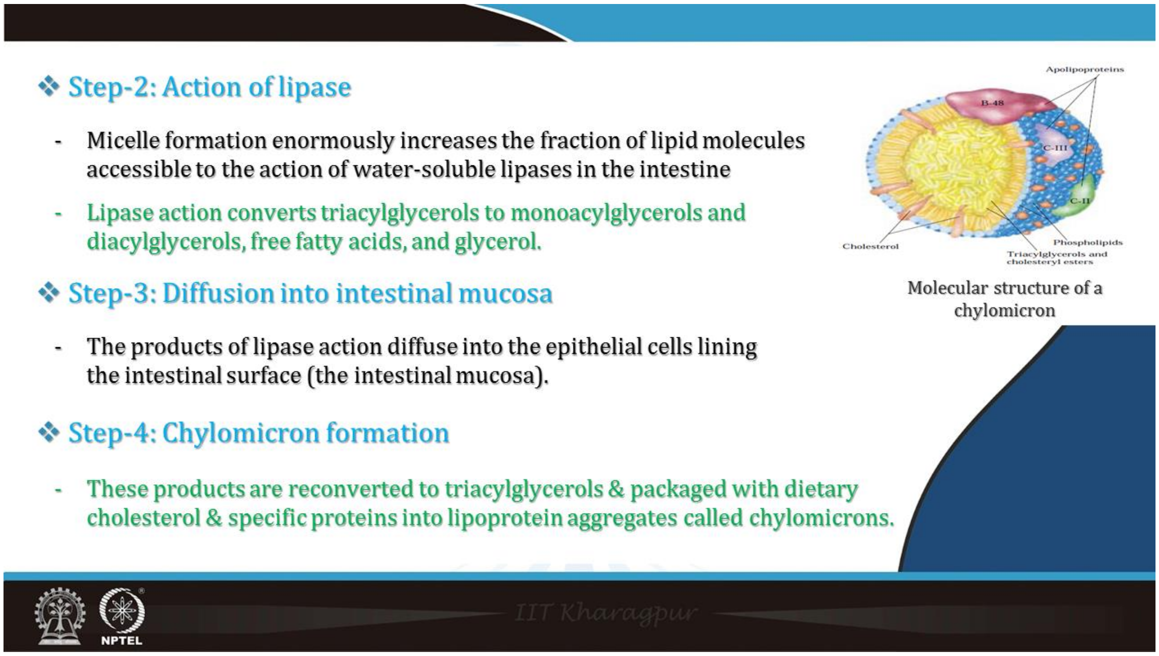
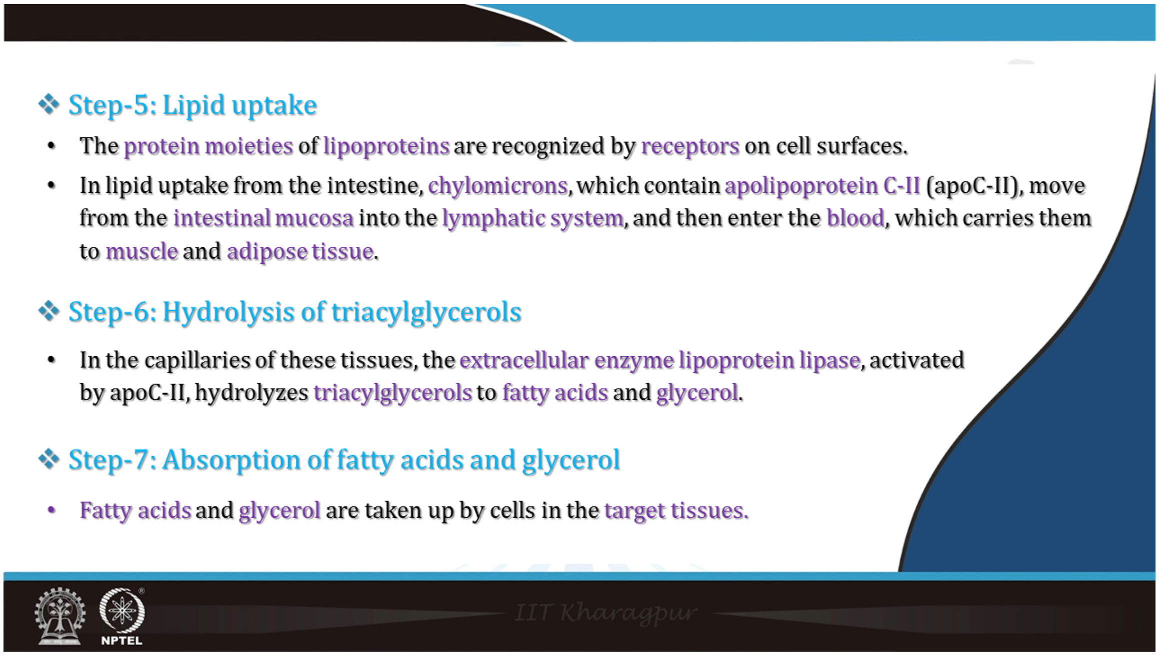
In this slide, I have just tried to give you that a comparison of some major physical chemical properties of a liquid oil with water at 20 degree Celsius. A liquid oil is basically triolein that is it is a triglyceride containing olein simple triglyceride, oleic acid in all the three glycerol OH groups. So, the molecular weight you see here there is a how much difference water has a molecular weight of 18 whereas, this oil triolein it has a molecular weight of 885. Melting point triolein of course, it is already an oil. So, it is 5 degree Celsius is the melting point. If you freeze it before 5 degree Celsius, it may be little further otherwise above 5 degree Celsius, it will be that liquid. Its density that is oil has 910 kg per cubic meter whereas, water has density of 998. You see that that is the water is more dense than the oil. Similarly compressibility that is a oil is more compressible than water as the data indicate here. That is viscosity is that is 50 in case of oil and 1.002 that is a milli Pascal second that is in the case of for water. Similarly the data for thermal conductivity, thermal expansion coefficient all are different you see the thermal expansion coefficient is much more for oil than that of the water. Similarly dielectric constant however, water has a more dielectric constant than oil ok. Surface tension there is a again there are difference water has more this tension and refractive index of oil is more than that of the oil we are talking about triolein it is more than that of the water ok.



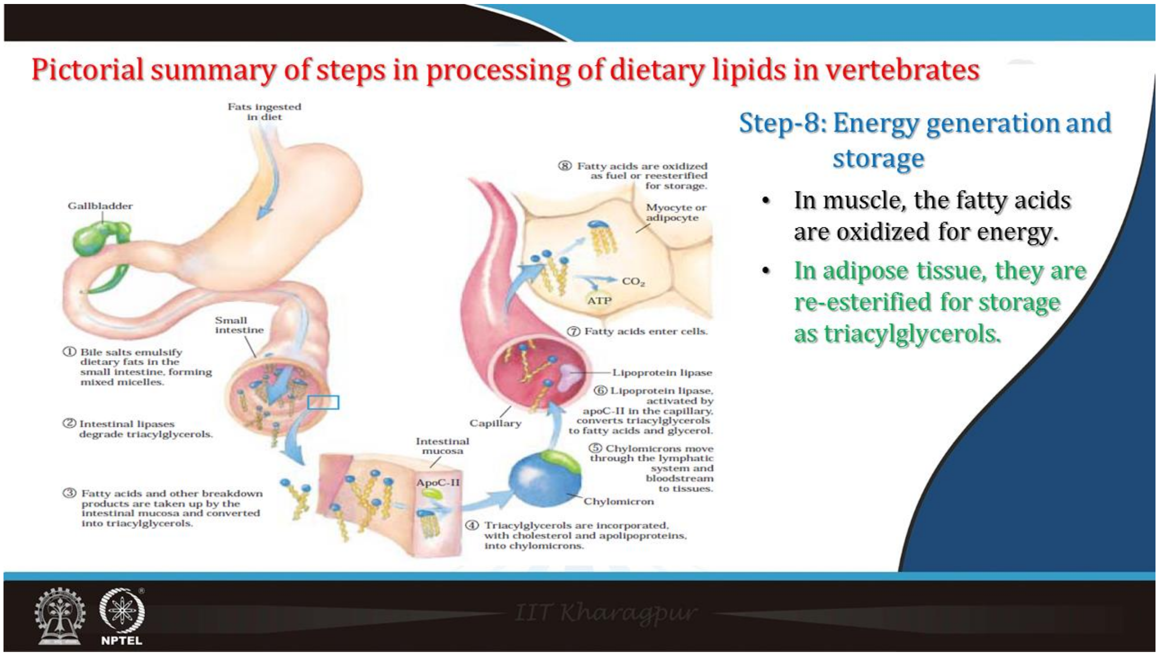
So, let us see what happens how the oils triglycerides are digested in the intestinal tract and digestion and absorption of dietary lipids occur in the small intestine and the fatty acids are released from the triglycerides and they are packed and delivered to the muscle and adipose tissues. So, it whole process may be after one or two slides I will show you a pictorial view then the things will become more clear, but tell that it occurs in several steps. That the first step after you have ingested the fat or triglycerides the first stage is the solubilization by micellar formation using bile salts that is in vertebrates before ingested triglycerols or triacylglycerols can be absorbed through the intestinal wall. They must be converted from insoluble macroscopic fat particles to finally, dispersed microscopic micelles and this solubilization is carried out by the bile salts ok. Such as taurocholic acid which are synthesized from cholesterol in the liver and is stored in the gall bladder and they are released into the small intestine after the ingestion of a fatty meal. So, these bile salts they are amphiphatic compounds that act as a biological detergents converting dietary fats into mixed micelles of bile salts and triacylglycerols ok.



Then comes the second step that is where that is the action of lipase starts. So, that is the micelle formation enormously increases the fraction of oil molecules it assemble to the action of water soluble lipase in the intestine and the lipase action converts the triacylglycerols into monoacylglycerols and diacylglycerols and free fatty acid or even glycerol. So, in the mixture now you are having all glycerol plus free fatty acid plus monoacylglycerol dryacylglycerol and so on. Then finally, it goes to the third step that is diffusion into intestinal mucosa. The products of lipase action diffuse into the epithelial cell lining the intestinal surface that is the which is normally known as intestinal mucosa. Then it is followed by chylomicron formation that is these products which are diffused into the intestinal mucosa then they are converted reconverted rather to triacylglycerol and and packed with the dietary cholesterol and specific proteins into lipoproteins aggregates and which are called chylomicrons.



Then the next step is the lipid uptake where the protein moieties of lipoproteins are recognized by the receptors of the cell surface. And in lipid uptake from the intestine chylomicrons which contain lipoproteins C-II that is the apoprotein C2 shortly it is called apo C2. They move from the intestinal mucosa into the lymphatic system and then enter the blood which carries them to the muscle and adipose tissues. In the next step there is the where triacylglycerols are hydrolyzed and in the capillaries of these tissues the extracellular enzyme lipoprotein lipase is activated by apo C-II hydrolyzes triacylglycerols so fatty acids and glycerol. In the step 7 there is absorption of fatty acids by glycerol that is fatty acids and glycerols are taken up by the cell in the target tissues ok.



So, here I have shown you that is you can see that it is a complete intestinal setup that is fatty fats are ingested in the diet, it come through the stomach there is a gall bladder then the for gall bladder bile is secreted then bile salt emulsify fatty fats in the small intestine forming mixed micelles and then it comes to the next step that is intestinal lipases degrade triacylglycerols. In the third step fatty acids and other breakdown products are taken up by the intestinal mucosa and converted into triacylglycerols ok. Then finally, this triacylglycerols are incorporated with cholesterol and apolipoproteins and

❑ Structure-property relations of triglycerides

❖ Density

- It influences properties of food systems and helps in food process design.
  - ✓Density difference b/w oil & aqueous phases affects creaming rate of oil droplets in (O/W) emulsions.
  - ✓Density determines amount of lipid that can be stored in tanks or flow through pipes of given volume.

Type of fat	Density (kg/m^3)	Comments
Liquid oils	~ 910–930 (Room temperature)	- Density decreases with increasing temperature
Completely solidified fats	~ 1000–1060 (Room temperature)	- Density decreases with increasing temperature
Partially crystalline fat	Depends on solid fat content (SFC) - The fraction of the total fat phase that is solidified.	- Density increases as the SFC increases e.g. after cooling below crystallization temperature. - Density of partially crystalline fat can be used to determine its SFC.

❑ Effect of TG structure on density

Structural factor	Effect on density
✓ Efficiency of packing of TG	- More efficient the packing → higher the density
✓ Type of fatty acids in TG molecule	- Linear saturated fatty acids pack more efficiently than branched or unsaturated fatty acids - Thereby they have higher densities
✓ Physical state of fat	- Solid fats have higher densities due to more efficient packing than liquid oils - Exception Lipids with high concentrations of pure triacylglycerols → Such lipids crystallize over a narrow temperature range → Density of such lipids actually decreases on crystallization due to void formation.

Thermal properties

- Thermal characteristics determine

→ Total amount of heat that must be supplied (or removed) from a lipid system to change its temperature.

→ Rate at which temperature change can be achieved.

Thermal property	Value	Comments
Specific heat capacity (CP)	~2 J/g (Most liquid oils & solid fats)	- Increases with increasing temperature
Thermal conductivity (κ)	~0.165 W/(m·K)	- Poor conductors of heat than water (~0.595 W/(m·K))
Melting point (Tm)	Depend on packing of triacylglycerol molecules within fat crystals	
Enthalpy of fusion (Hf)		

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And this specific heat capacity increases with the increasing temperature ok. The again the oils or triglycerides they normally have the thermal conductivity to the tune of 0.165 watt per meter Kelvin ok. And they are poor conductors of heat than water that is the water has more thermal conductivity. Melting point as well as enthalpy of fusion that is Tm and Hf they depend on packing of triglycerides, acylglycerol molecule within the fat crystals.

Effect of TG structure on thermal properties

Structural Factor	Effect on Melting Point and Enthalpy of Fusion
✓ Packing of TG in fat crystals	✓ More effective packing results in higher Tm & Hf
✓ Chain length of fatty acids in TG	✓ Increasing chain length of pure TG results in higher Tm and Hf
✓ Degree of saturation of fatty acids in TG	✓ Tm and Hf are higher for saturated fatty acids than for unsaturated fatty acids
✓ Branching of fatty acids	✓ Tm and Hf are higher for straight-chained fatty acids than for branched fatty acids
✓ Symmetry of distribution of fatty acids on glycerol	✓ Tm and Hf are higher for TG's with more symmetrical distribution of fatty acids on glycerol
✓ Configuration of double bond	✓ Tm and Hf are higher for trans than for cis double bonds
✓ Stability of polymorphs	✓ Tm and Hf are higher for more stable polymorphic forms

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Effect of triglyceride structure on thermal properties like if you see that the packing of triacylglycerol in fat crystals how it influences the thermal property. So, more effective packing results in high values for Tm and Hf both that is the melting point as well as enthalpy of fusion. Then the increasing the chain length of your triglycerides results in higher Tm and Hf. Tm and Hf are higher for saturated fatty acids than for unsaturated fatty acids. So, if triglyceride has more unsaturated fatty acids so, it is Tm and Hf will be less. Tm and Hf are higher for straight chain fatty acids than that of the branched chain fatty acids. Then effect of symmetry of distribution of fatty acids on glycerol that is Tf and Hf are higher triglycerides with more symmetrical distribution of the fatty acids on the glycerol backbone. And then Tm and Hf both are higher for the trans fat than that for the cis fats cis bonds ok. And these two values Tm and Hf melting point and enthalpy of fusion are higher for more stable polymorphic forms ok. That is the stability of the polymorphic part if the polymorphic part are more stable ok. Then their Tm and Hf both will be high ok.

Melting Points and Heats of Fusion of the Most Stable Polymorphic Forms of Selected Triacylglycerol Molecules

Triacylglycerol	Melting Point (°C)	ΔH_f (J g^{-1})
LLL	46	186
MMM	58	197
PPP	66	205
SSS	73	212
OOO	5	113
LiLiLi	−13	85
LnLnLn	−24	—
SOS	43	194
SOO	23	—

L = lauric acid (C12:0), M = myristic acid (C14:0), P = palmitic acid (C16:0), S = stearic acid (C16:0), O = oleic acid (C18:1), Li = linoleic (C18:2), Ln = linolenic (C18:3).

Source: Adapted from Walstra, P. (2003). *Physical Chemistry of Foods*, Marcel Dekker, Inc., New York, NY.

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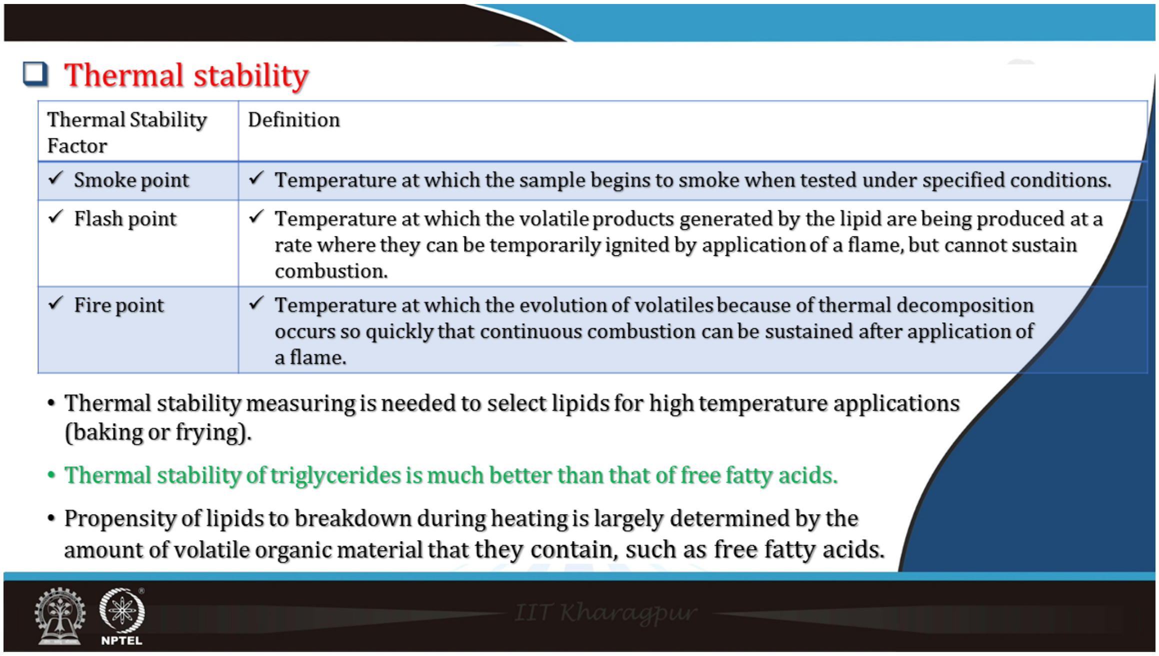
Here in this table there are melting points and heat of fusions of some stable most stable poly forms of selected triglyceride molecule are given that is the triacylglycerides are LLM, MMM, PPP, SSS, OOO, LI, LI, LI and LN, LN, NN, SOS, SOO that is these are the simple glyceride as well as mixed glyceride. L is lauric acid, M is myristic acid that is MMM means there is a triglyceride where all the three fatty acids are myristic acid. LLL is the triglyceride where all the three fatty acids are lauric acid. So, you can see the melting point of the LLL is 46 degree Celsius whereas, MMM it is 58 degree Celsius. So, PPP that is a fatty acid which comes contains all the three palmitic acid all the three fatty acids are palmitic acid is a melting point is furthermore ok. SSS 73 degree Celsius, but so, it is among the saturated part increasing the number of carbon alright that it results into the saturation that is melting point increases. But if you go that is the when the unsaturation is there then again the melting point is decreases that is oleic acid which is oleic acid is 1 double bond. So, here you see that is melting point is 5 degree Celsius, linolenic acid is more double bonds minus 23 degree Celsius, linolenic acid minus 24 degree Celsius etcetera ok. And similarly heat of fusion also these values are given you can see ok. Then the thermal stability is very important characteristics like most of the when the oils and fats are heated during heat processing, during frying operation, cooking operations they may oxidize. So, thermal stability thermal properties if you talk about smoke point, flash point, fire point. So, thermal stability measuring is needed to select the lipids of high temperature application particularly for baking and frying that is a oil which has higher smoke point means it can be exposed to higher temperature ok. And this specific heat capacity increases with the increasing temperature ok. The again the oils or triglycerides they normally have the thermal conductivity to the tune of 0.165 watt per meter Kelvin ok. And they are poor conductors of heat than water that is the water has more thermal conductivity. Packing point as well as enthalpy of fusion that is Tm and Hf they depend on packing of triglycerides, acylglycerol molecule within the fat crystals. Effect of triglyceride structure on thermal properties like if you see that the packing of triacylglycerol in fat crystals how it influences the thermal property. So, more effective packing results in high values for Tm and Hf both that is the melting point as well as enthalpy of fusion. Then the increasing the chain length of your triglycerides results in higher Tm and Hf. Tm and Hf are higher for saturated fatty acids than for unsaturated fatty acids. So, if triglyceride has more unsaturated fatty acids so, it is Tm and Hf will be less. Tm and Hf are higher for straight chain fatty acids than that of the branched chain fatty acids. Then effect of symmetry of distribution of fatty acids on glycerol that is Tm and Hf are higher triglycerides with more symmetrical distribution of the fatty acids on the glycerol backbone. And then Tm and Hf both are higher for the trans fat than that for the cis fats cis bonds ok. And these two values Tm and Hf melting point and enthalpy of fusion are higher for more stable polymorphic forms ok. That is the stability of the polymorphic part if the polymorphic part are more stable ok. Then their Tm and Hf both will be high ok. Here in this table there are melting points and heat of fusions of some stable most stable poly forms of selected triglyceride molecule are given that is the triacylglycerides are LLM, MMM, PPP, SSS, OOO, LI, LI, LI and LN, LN, NN, SOS, SOO that is these are the simple glyceride as well as mixed glyceride. L is lauric acid, M is myristic acid that is MMM means there is a triglyceride where all the three fatty acids are myristic acid. LLL is the triglyceride where all the three fatty acids are lauric acid. So, you can see the melting point of the LLL is 46 degree Celsius whereas, MMM it is 58 degree Celsius. So, PPP that is a fatty acid which comes contains all the three palmitic acid all the three fatty acids are palmitic acid is a melting point is furthermore ok. SSS 73 degree Celsius, but so, it is among the saturated part increasing the number of carbon alright that it results into the saturation that is melting point increases. But if you go that is the when the unsaturation is there then again the melting point is decreases that is oleic acid which is oleic acid is 1 double bond. So, here you see that is melting point is 5 degree Celsius, linolenic acid is more double bonds minus 23 degree Celsius, linolenic acid minus 24 degree Celsius etcetera ok. And similarly heat of fusion also these values are given you can see ok.



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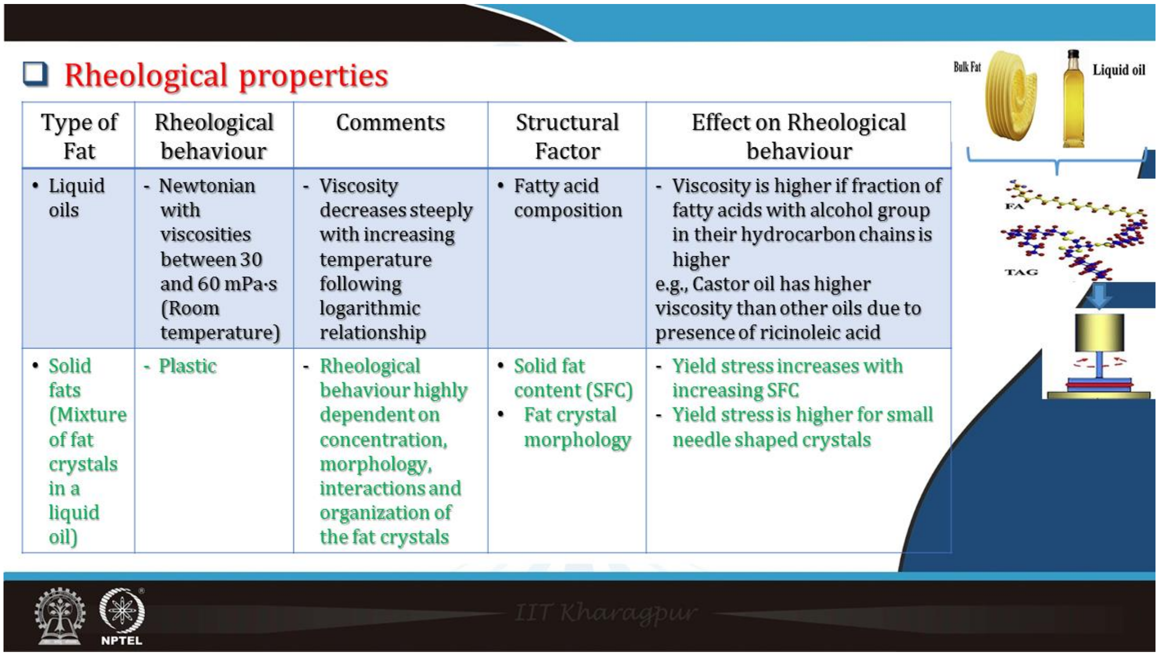
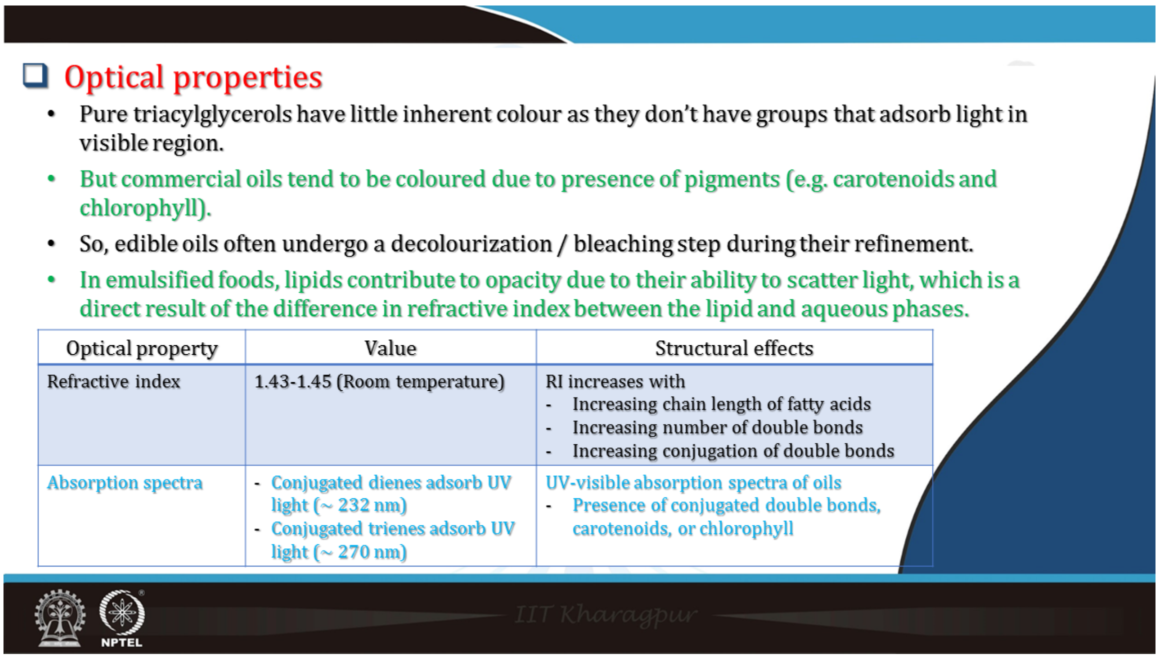
So, the smoke point is the temperature at which the sample begins to smoke when tested under specified conditions that is if you go on heating that is the air temperature will come at which the oil will catch fire means that oil cannot be that oil cannot be further heated. So, that is that decides the yes up to. So, you want that a frying operation to conduct at 200 degree Celsius. So, obviously, you cannot use an oil which has a smoke point of 150 degree Celsius. You have to have a oil which has a smoke point more than 200 degree Celsius. So, similarly flash point is defined as the temperature at which the volatile products generated by the lipids are being produced at a rate where they can be temporarily ignited by application of a flame, but cannot sustain combustion. Fire point is the temperature at which the evolution of volatiles because of the thermal decomposition occur so quickly that continuous combustion can be sustained after application of a flame.



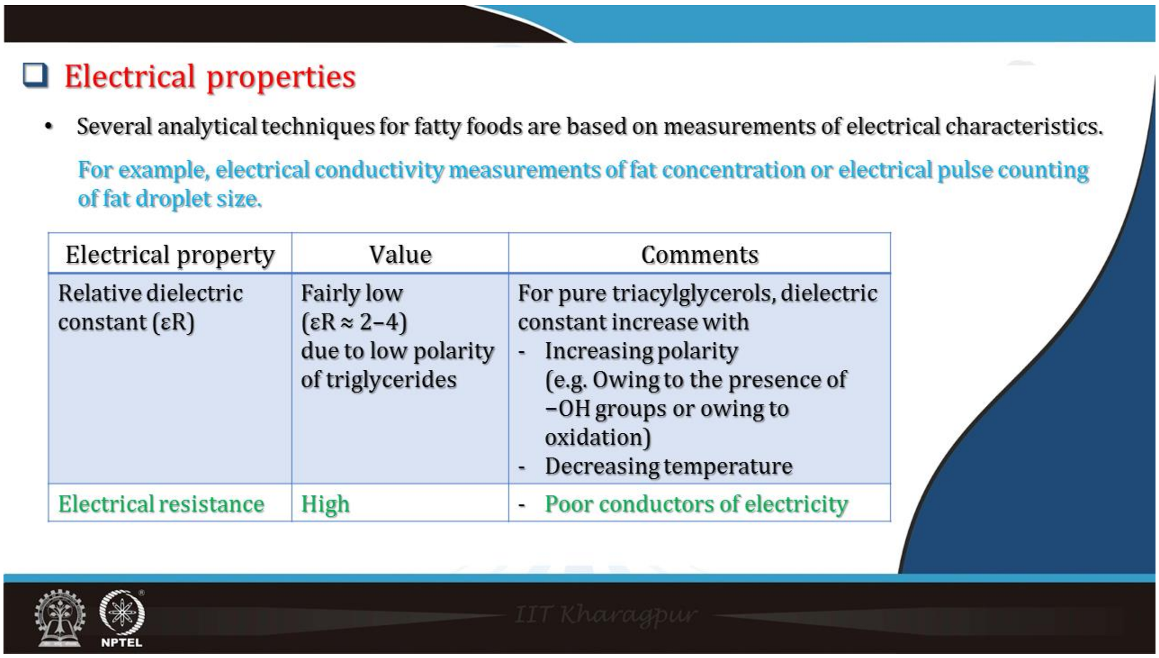
Rheological properties

Type of Fat	Rheological behaviour	Comments	Structural Factor	Effect on Rheological behaviour
• Liquid oils	- Newtonian with viscosities between 30 and 60 mPa·s (Room temperature)	- Viscosity decreases steeply with increasing temperature following logarithmic relationship	• Fatty acid composition	- Viscosity is higher if fraction of fatty acids with alcohol group in their hydrocarbon chains is higher e.g., Castor oil has higher viscosity than other oils due to presence of ricinoleic acid
• Solid fats (Mixture of fat crystals in a liquid oil)	- Plastic	- Rheological behaviour highly dependent on concentration, morphology, interactions and organization of the fat crystals	• Solid fat content (SFC) • Fat crystal morphology	- Yield stress increases with increasing SFC - Yield stress is higher for small needle shaped crystals

Then, let us discuss rheological properties where the type of fat, their rheological behavior, what are the structural factors and then their structural factor, their effect on the rheological behavior. So, for liquid oil, there a Newtonian with viscosities between 30 and 60 milli Pascal second at room temperature whereas, the viscosity decreases steeply with increasing temperature following logarithmic relationship. The solid fats that is a mixture of fat crystals in a liquid oil that is they have both solid and liquid fat, they are normally plastic in nature and their rheological behavior highly depends on concentration, morphology, interactions and organization of the fat crystal that is again what is the solid fat ratio, how they are packed, how their crystals are packed at sub-cellular level etcetera. If you look at the structural factor that is in the liquid oils, structural factors may be solid fatty acid composition. So, the viscosity is higher if the fraction of fatty acid with alcohol group in their hydrocarbon chain is higher. Like for example, castor oil has higher viscosity than other oils due to presence of ricinoleic acid. Similarly, the solid fat content in the fat or fat crystal morphology, the this if you look at the structural factor and their effect on rheological behavior, so they yield stress increases with increasing the solid fat content and also that is yield stress is higher for a small needle shaped crystals.



Optical properties that pure triglyceride have little inherent color as they do not have groups that absorb light in visible region, but commercial oils tend to be colored due to the presence of pigments that is the carotenoids, chlorophyll etcetera which are extracted along with the triglyceride from their material oil bearing material. So, this pigment add color to the oil. So that is why these edible oils commercial edible oils they often undergo a decolorization or bleaching step during the refining process and where these pigments are removed. In emulsified foods, lipid contribute to opacity due to their ability to scatter light which is a direct result of the difference in refractive index between the lipid and aqueous phases. So, optical properties if you see refractive index its value it room temperature is around 1.43 to 1.45 and refractive index increases with increasing the chain length of the fatty acid, increasing the number of double bonds as well as increasing conjugation of double bond, ok. All these increases will result into the increase in the refractive index value. So, if you have more unsaturated fatty acid, obviously they will be having more refractive index, ok. Longer chain length, polyunsaturated fatty acid there will be more refractive index. Then absorption spectra that is conjugated diene absorb ultraviolet light at around 232 nanometer range whereas, conjugated triene absorb ultraviolet light as 270 nanometer and UV visible absorption spectra of oils that is presence of conjugated double bond like carotenoids or chlorophylls etcetera they influence the absorption spectra.



So, as far as the electrical properties is concerned there are several analytical techniques for fatty acids. They are based on measurement of electrical characteristics. For example, electrical conductivity measurement of fats concentration or electrical pulse counting of the fat droplet size. So, relative dielectric constant it is a fairly low for the fats and oils due to their low polarity of triglycerides or for pure triglyceride dielectric constant increases with increasing polarity and that is mainly owing to the presence of OH group or owing to the oxidation process and also this dielectric constant increases with the decreasing the temperature. The electrical resistance is normally high for oils. However, there is a they are poor conductors of electricity because of this high electric resistance.

❑ Effect of triglycerides on appearance of food products

- The characteristic appearance (colour, opacity, etc.) of many food products is strongly influenced by the presence of lipids.

Food System	Appearance	Important Factors
Liquid oils	Colourful and optically clear	Presence of light-absorbing pigments such as chlorophyll & carotenoids
Solid fats	Usually optically opaque (Due to scattering of light by fat crystals)	Concentration, size, and shape of fat crystals
Emulsions	Opaque (due to scattering of light by oil droplets which are immiscible with water)	Concentration, size, and refractive index of oil droplets. e.g. whole milk (~4% fat) has whiter appearance that skim milk (<0.1% fat) since milk fat globules that scatter light strongly, but skim milk only contains casein micelles that scatter light more weakly

Left: Skim milk
Right: Whole milk

Common effect of triglycerides on appearance of the food products the characteristic appearance color, opacity of many food product is strongly influenced by the presence of lipids. For example, liquid oil they are colorful and optically clear that is the presence of light absorbing pigments such as chlorophyll and carotenoid etcetera in the liquid oil they influence the appearance of the they absorb the light and accordingly the appearance of the food products in which they are present is a influenced. Solid fats usually optically opaque they are usually optically opaque and due to scattering of the light fat crystals and then concentration size and shape of the fat crystals will influence the appearance of the food product in which they are present. Then the at perhaps the effect of emulsion is the food system is emulsion that is they are normally opaque due to the scattering of light by oil droplets which are immiscible with water and here the concentration size and refractive index of oil droplet alright. For example, you see that whole milk it has 4 percent fat is generally whiter as you can see here in this picture it is whiter than that of the skim milk which has less than 0.1 percent food and this skim milk is they can scatter light strongly ok. And skim milk only contains casein micelles that is scattered light more weakly that is whole milk is scattered light that is the strongly whereas, the skim milk it scatters light more weakly and because of that skim milk is slightly light blue in color and whereas, the whole milk is pure whole white in color. So, the fat content obviously, it influences the appearance of the food.

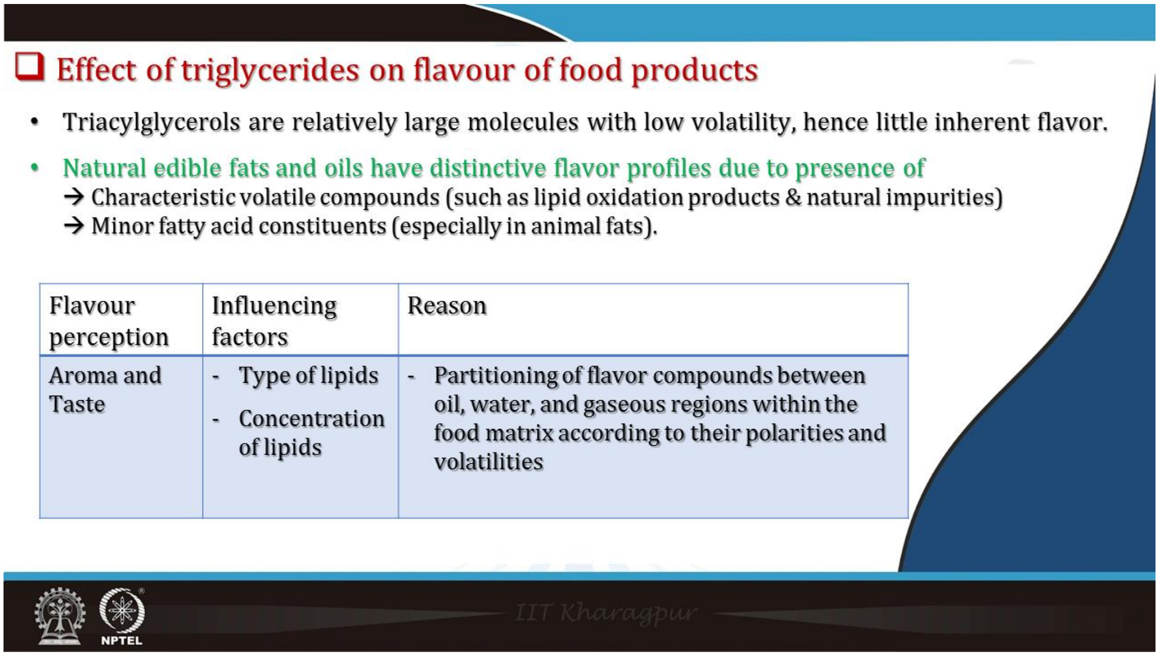
Effect on appearance (Contd...)

- An interesting example of importance of fat crystallization on appearance of food products is "bloom."
- It occurs due to stability problem associated with fat crystallization (e.g., poor tempering, incompatibility of fat blends, fat migration, and fat recrystallization).

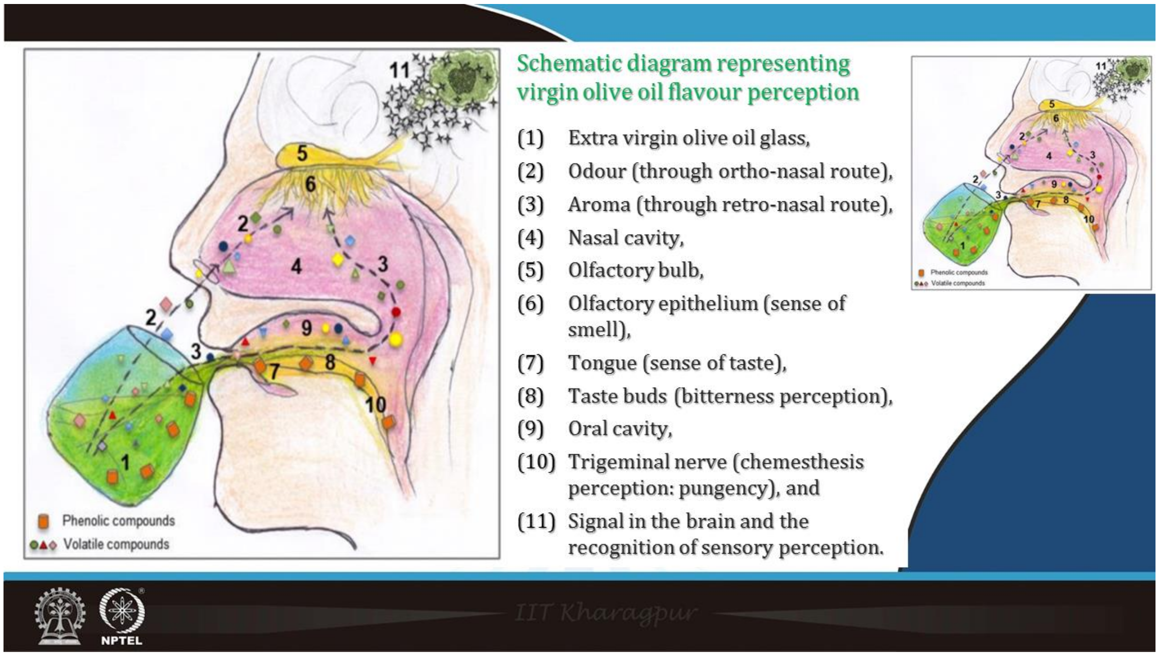
Chocolate Blooms (A quality defect)

Appearance	Cause	Macroscopic mechanism	Microscopic mechanism	Control
Large white spots or a dull-whitish gray appearance on surface of the product	Fluctua-ting temper-ature during storage	Melting and recrystallization of fat phase	Change in morphology of fat crystals at the surface - From flat smooth crystals that specularly reflect light giving smooth appearance. - To spiky crystals that diffusely reflect light giving a cloudy appearance.	- Using surfactants that limit crystal transition - Careful control of storage temperature

Similar in interesting example of the importance of fat crystallization and appearance of the food product is bloom it occurs due to stability problem associated with fat crystallization. For example, poor temperature, incompatibility of the fat blends, fat migration and fat recrystallization etcetera it influence the bloom. So, large white spots are a dull whiteish grey appearance on the surface of the product if it is there its major main cause might be fluctuating temperature during storage ok. And here the macroscopic mechanism for that is the melting fat and recrystallization of the fat phase. However, minor changes which affecting the appearance is that it changes in the morphology of the fat crystals on the surface from flat smooth crystals that specularly reflect light giving a smooth appearance to silky crystal or spiky crystals that diffusely reflect light giving a cloudy appearance ok. So, using surfactant that limit crystal transition the careful control of the storage temperature one can control the bloom in the food products ok.



Then effect of triglyceride on the flavor of food product triglycerides are relatively large molecules with low volatility. Hence little influence in a these triglycerides they have little inherent flavor. In fact, purely refined and deodorized oils they do not have any flavor they are supposed to be blend in taste and flavor. However, natural edible fats and oils have distinctive flavor profile due to the presence of characteristic volatile compounds such as lipid oxidation products or natural impurities etcetera which might be present there or some flavoring materials might get extracted from the food in which they are extracted or oil seed etcetera. And also the minor fatty acid constituent which are especially in particularly in animal fats. So, the flavor perception like aroma and taste it will depend upon the type of the lipid as well as concentration of the lipid because partitioning of flavor compounds between oil, water and gaseous regions within the food matrix according to their particles and volatiles that causes the influence or flavor taste in aroma and flavor.



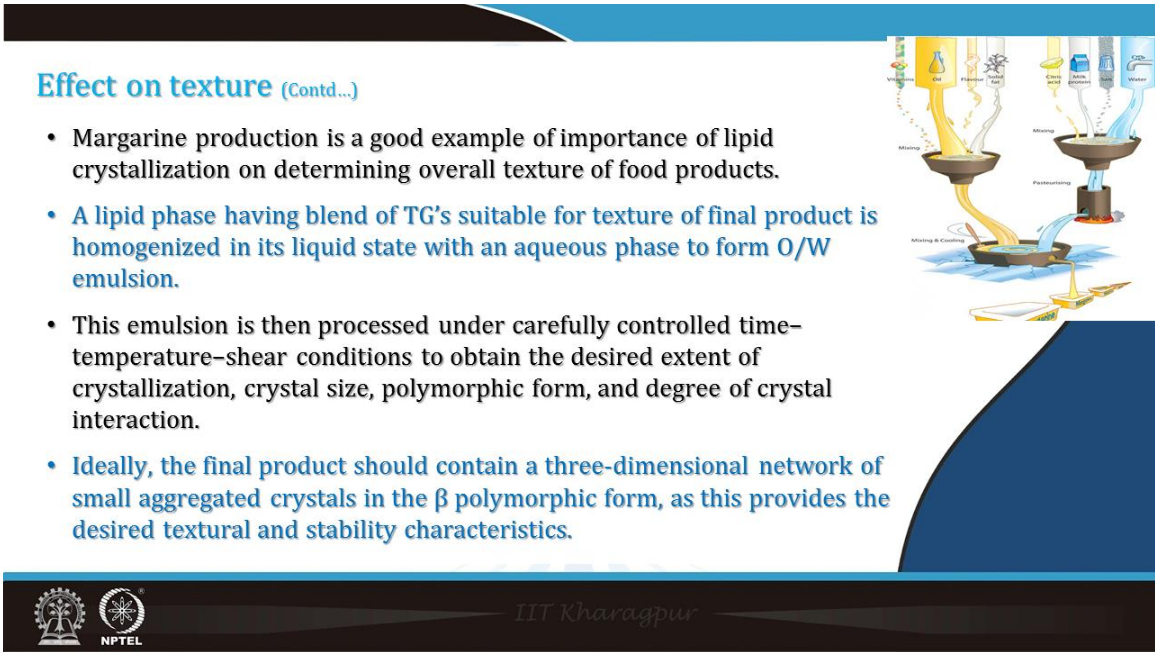
Here just in this picture if you shown you that is schematic diagram representing virgin olive oil flavor perception that is virgin olive oil in it comes that is you see first is that here extra virgin olive oil glass it comes it is containing in the glass and then when there are two senses one is the mouth because the flavor means that is the joint appreciation of both tongue like taste as well as nose smell ok. So, one is that one route that it will come to the this aroma through nestle nasal route and also order through the orthonasal route that is 2 and 3. So, this two routes aroma will come and then four is the nasal cavity it goes to the nasal cavity and finally, fifth is the olfactory bulb olfactory and it comes that is olfactory epithelial where they sense of a smell. So, these routes these cells comes and olfactory epithelial cells that is sense of a smell they sense the smell and then it is and there is the tongue with the sense of taste the taste buds that is they give the bitterness perception etcetera then it comes to the oral cavity and finally, the trigeminal nerve chemesthesis perception and pungency etcetera that is the point of this. So, all these they send the signal into the brain here and the brain record this signal very promptly and it is in the few fraction of second vary right. So, all these signals different send signals that is in the brain and brain records its and appreciates it and finally, decides that yes what is the it is a recognition of the sensory perception it recognizes that yes it is only valid it is this particular sense of flavor or taste ok.

Effect of triglycerides on texture of food products

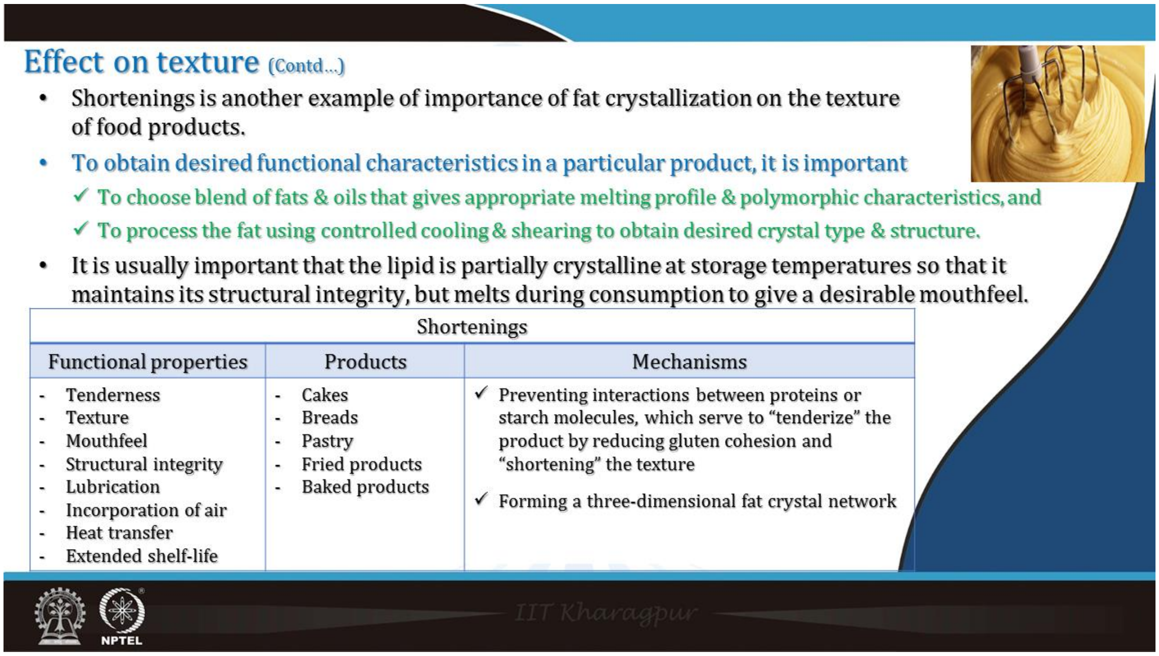
- The influence of lipids on the texture of foods is largely determined by the physical state of the lipid and the nature of the food matrix (e.g., bulk fat, emulsified fat, or structural fat).

Fat type	Examples	Factors influencing texture
Bulk liquids	Cooking or salad oils	- Viscosity of oil (over the temperature range of interest)
Partially crystalline fats	Chocolate, baked products, shortenings, butter, and margarine	- Concentration, morphology, and interactions of the fat crystals - Melting profile of fat crystals (affects spreadability)
O/W emulsions	Creams, desserts, dressings, and mayonnaise	- Presence of fat droplets (gives creamy texture)
W/O emulsions	Margarine, butter, and spreads	- SFC; morphology and interactions of the fat crystals

Then effect of triglyceride and the texture of the food products the influence of lipid and the texture of food is largely determined by the physical state of the lipid and the nature of the food matrix that is like bulk fat, emulsified fat, structural fat etcetera. Bulk liquids like cooking and salad oils here viscosity of the oil over the temperature range of is of the interest and this influences the texture ok. Similarly that is the partially crystalline fats they are present in chocolate, baked products, shortening, butter and margarine and here concentration, morphology and interaction of fat crystals melting profile of the fat crystals all these affect the melting profile affect the spreadability and these factors will influence the texture. Then oil in water emulsion like cream, dessert, dressings and mayonnaise here presents of fat droplets gives creamy texture. Water in oil emulsion like in margarine, butter and spreads solid fat content morphology and interaction of the fat crystal will influence the texture of the product ok.



Margarine production is a good example of importance of lipid crystallization and determining overall texture of the food products. A lipid phase having a blend of triglyceride suitable for texture of final product is homogenized in its liquid state with an aqueous phase to form oil in water emulsion. This emulsion is then proceeded under carefully controlled time temperature shear conditions to obtain the desired extent of crystallization, crystal size, polymorphic form and degree of crystal interaction. Ideally the final product should contain a three-dimensional network of small aggregated crystals in the beta polymorphic forms as this provides the desired textural and stability characteristics.



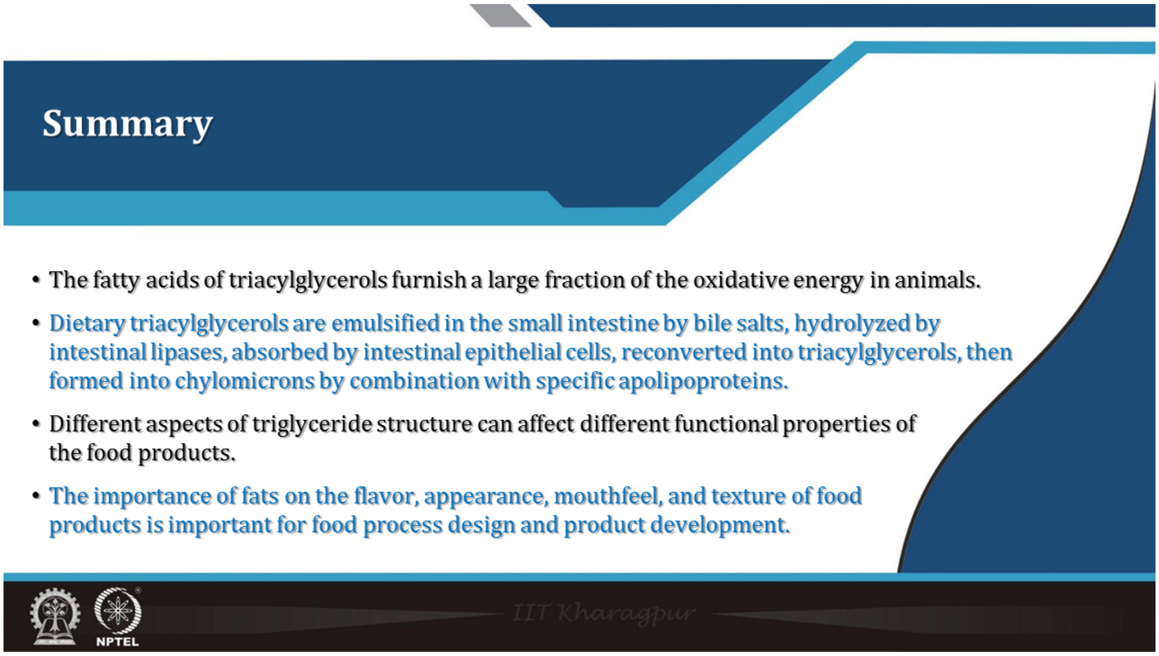
Shortening is another example of importance of fat crystallization on the texture of food products to obtain desired functionality or desired functional characteristics of a particular product. It is important to choose blend of fat and oil that gives appropriate melting profile and polymorphic characteristics and to process the fat using controlled cooling and shearing to obtain desired crystal type and structure. Because this desired crystal type and structure will influence its properties particularly whipping and other properties entrapment of air and all those things in baking this is very important. So, it is usually important that the lipid is partially crystalline at storage temperature. So, that it maintains its structural integrity, but melts during consumption to give a desirable mouth feel. So, functional properties may be tenderness, texture, mouth feel, structural integrity, lubrication, incorporation of air, heat transfer, extended shelf life etcetera in the product like cake, bread, pastry, fried products, baked products etcetera. So, in all these products these functional properties that is they influence the texture, they prevent the interaction between the protein or starch molecule which serve to tenderize the product by reducing gluten cohesion and shortening the texture and forming a three dimensional fat crystal network.

Effect of triglycerides on mouthfeel of food products

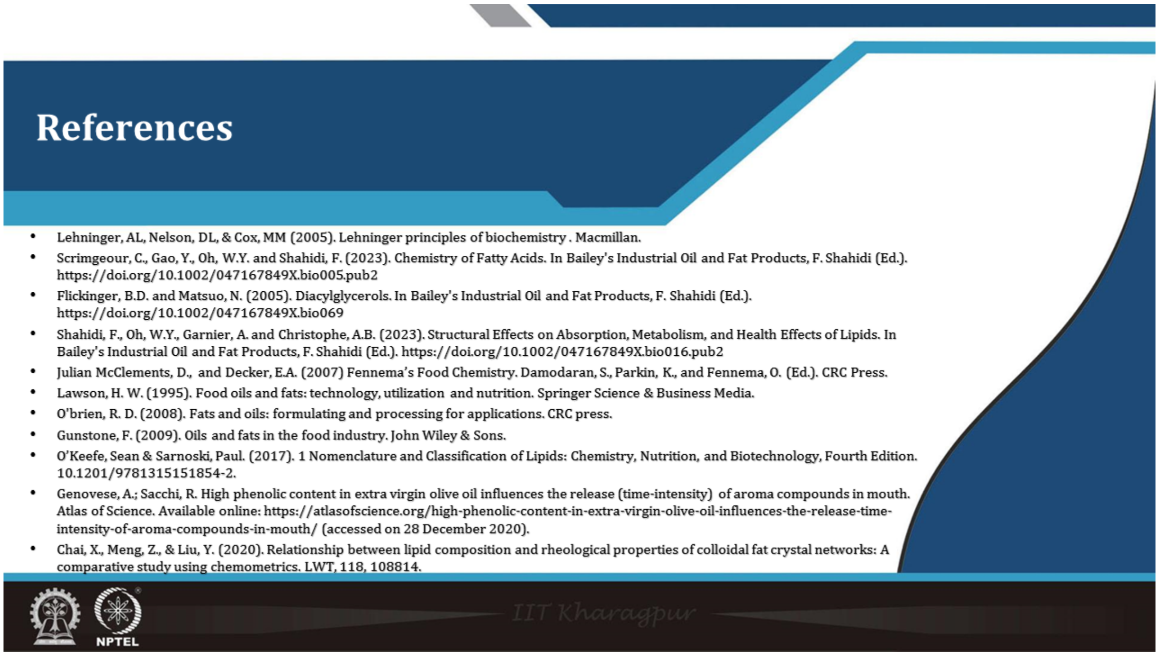
- The triglycerides can also affect the mouthfeel of food systems that they are present in.
- Various factors such as physical state and the properties of fats crystals can lead to different mouthfeel perceptions.

Mouthfeel	Influencing factors	Reason
✓ Oily	✓ Physical state of lipids	✓ Coating of tongue by liquid oils during mastication
✓ "Grainy" or "Gritty"	✓ Size of fat crystals	✓ If fat crystals are large in size
✓ "Smooth textured"	✓ Size of fat crystals	✓ If fat crystals are small in size
✓ Cooling sensation	✓ Properties of fat crystals	✓ Melting of fat crystals

Then effect of triglyceride and the mouth feel of the product you can see the triglyceride can also affect the mouth feel of food system that they are present in various factors such as physical state and properties of the fat crystals can lead to different mouth feel perception like if it is the physical state of the lipids can give oily mouth feel because coating of tongue by liquid oil during mastication. Solid fat crystals they may give grainy or gritty texture. If fat crystals are particularly large in size, then size of fat crystals also it influences that is they give them smooth or texture particularly if the fat crystals are small in size ok. So, properties of the fat crystals its melting characteristics etcetera it gives a cooling sensation. So, melting characteristics and that is why even cocoa butter you see cocoa fat because of its unique melting characteristics it is used in a variety of confectionery products and it gives a very good mouth feel.



So, now I will summarize this lecture by saying that the fatty acid or that the triglyceride functions in a large way they furnish large fraction of oxidative energy in animals. Dietary triglycerides are emulsified in the small intestine by bile salts, hydrolyzed by intestinal lipase, absorbed by intestinal epithelial cells, reconverted into triacyl glycerols and then formed into chylomicrons by combination with specific lipoproteins. Dietary aspects of triglyceride structure and affect the functional properties of the food product and the importance of fats on flavor, appearance, mouth feel, texture of the food product is important ok. And this is very very important in design deciding the usefulness of a particular fat and oil in a for a particular food processing operations or its use in a particular food giving the desired characteristics, structural characteristics, appearance, flavor and so on.



So, these are the references which are used in this lecture.

Thank you for your patience hearing.