Food Oils and Fats: Chemistry & Technology
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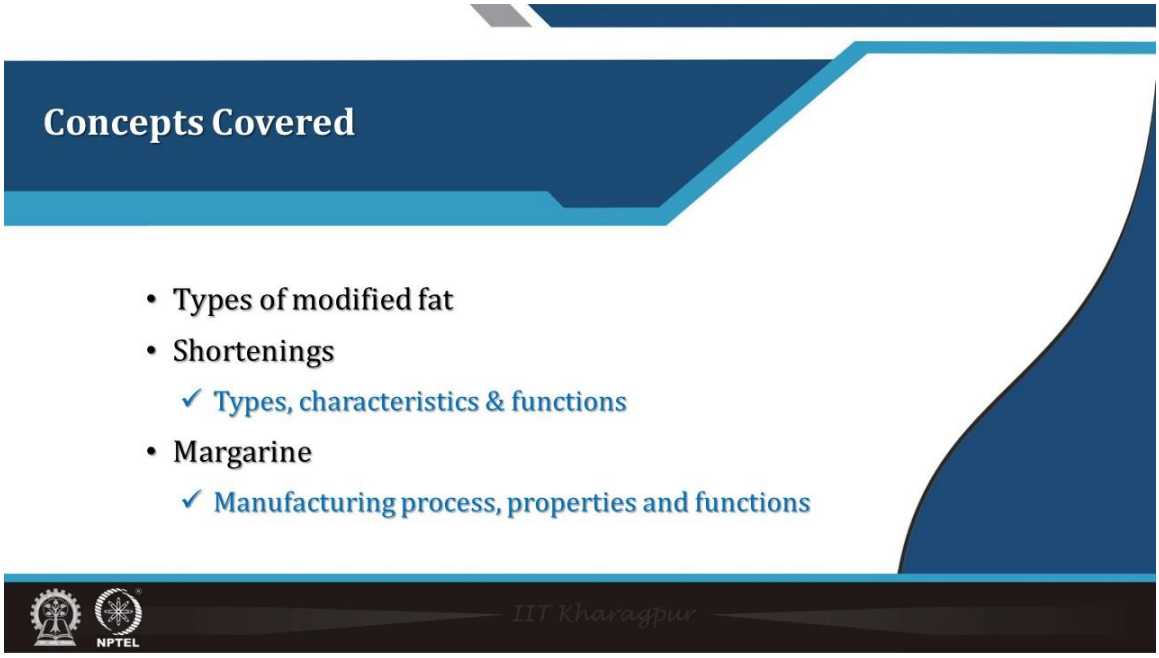
Module 7 : Modifications of Oils and Fats
Lecture 34 : Margarine & Shortenings



Hello everybody, good morning. Now, I am in lecture 34 of this course and in this lecture, we will talk about margarine and shortening which is a very important type of

modified fat that has a wide-ranging application in the bakery and confectionery industry. In this lecture, we will discuss what the various types of modified fat are, and why we need to modify fat we have already discussed earlier. Different modified fats will be taken up in this and two important fats, like shortenings, their types, characteristics, and functions, and the margarine, the manufacturing process for margarine, their properties, and functional applications will be discussed.

The different types of modified fat include butter, oil, shortening, and margarine. And here the bread is taken that if you use butter in the preparation of bread, if use oil in the preparation of bread, shortening and margarine all these types of fats used in the making of the bread are shown. They have an important effect on the final product characteristics as you can see here. If the butter is used, it will give less height to, a compact, fine-textured product, but the crumb structure will be small. Oil gives a moist product tall and light slightly coarse, but open crumb. Shortening will give a tall and light, but coarse and dry, and crumbly structure. Margarine gives moist, but not light coarse, air pockets and salty bread. So, it has all these types of fat influence their final product characteristics. That is why these modified fats particularly margarine, shortening etcetera their characteristics are modified to suit the particular functional application in the food processing industries. More specifically we will take up here the bakery and confectionery industry. So, the major functions of these products are to tenderize the product and soften the texture of the product, add moistness and richness, to assist in the leavening of the product when used as a creaming agent or when used to give flakiness to puff pastry, pie doughs, or other similar products. It is used to increase keeping quality and to add flavor.

- Many different fats are available to the baker. These fats have different properties that make them suitable for different purposes.
- Among the properties, fat must be selected based on its melting point, softness or hardness at different temperatures, flavour and ability to form emulsions.

❑ Fats emulsions

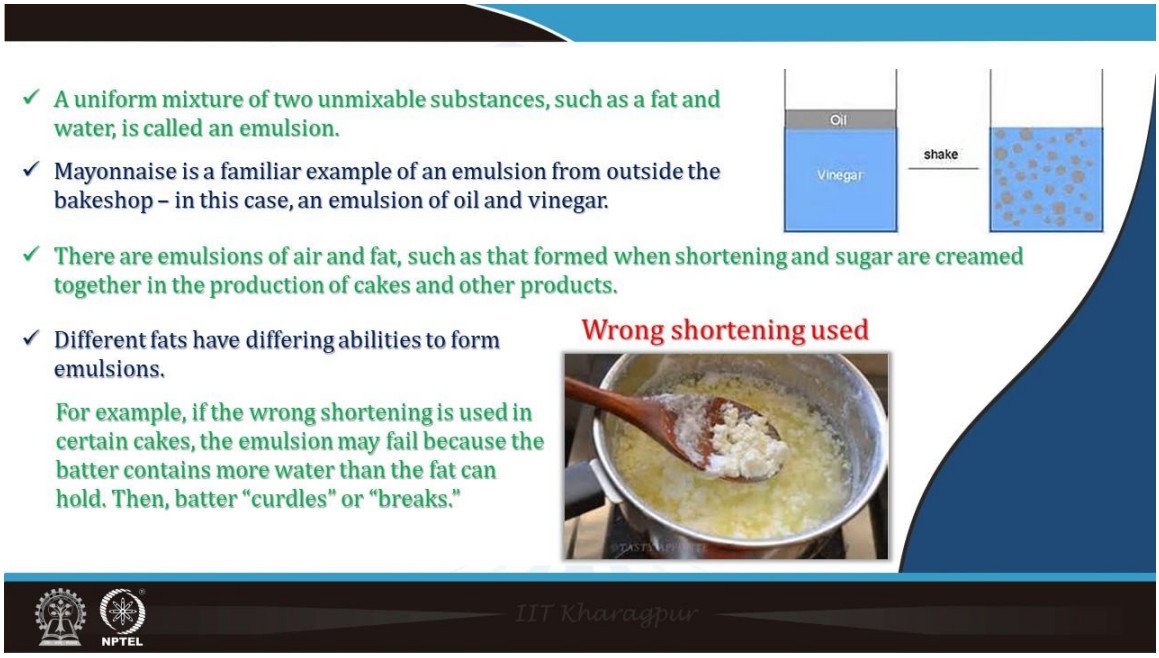
✓ Most bakery ingredients mix easily with water and other liquids and actually undergo a change in form.

For example, salt and sugar dissolve in water; flour and starch absorb water and the water becomes bound up with the starch and protein molecules.

Many different fats are available to the baker. These fats have different properties that make them suitable for different purposes. Among the properties, fat must be selected based on its melting point, softness or hardness at different temperatures, flavour, and ability to form emulsions. Most bakery ingredients mix easily with water and other liquids and actually undergo a change in form. For example, salt and sugar dissolve in water; flour and starch absorb water and the water becomes bound up with the starch and protein molecules, this gives a particular desirable characteristic in the products that is when there are proper interactions between these components.

- Fat, on the other hand, does not change form when it is mixed with liquids or other bakery ingredients.
- Instead, the fat is merely broken down into smaller and smaller particles during mixing.
- These small fat particles then become more or less evenly distributed in the mix.

Fat, on the other hand, does not change form when it is mixed with liquids or other bakery ingredients. Instead, the fat is merely broken down into smaller and smaller particles during mixing. These small fat particles then become more or less evenly distributed in the mix and you can see here that it is a successful emulsion that the fat is kept properly in a small aliquot in a proper stable emulsion form whereas, the failed emulsion here you can see in the picture. It depends on what are the conditions, types of fat, how it is mixed with and other proper conditions.

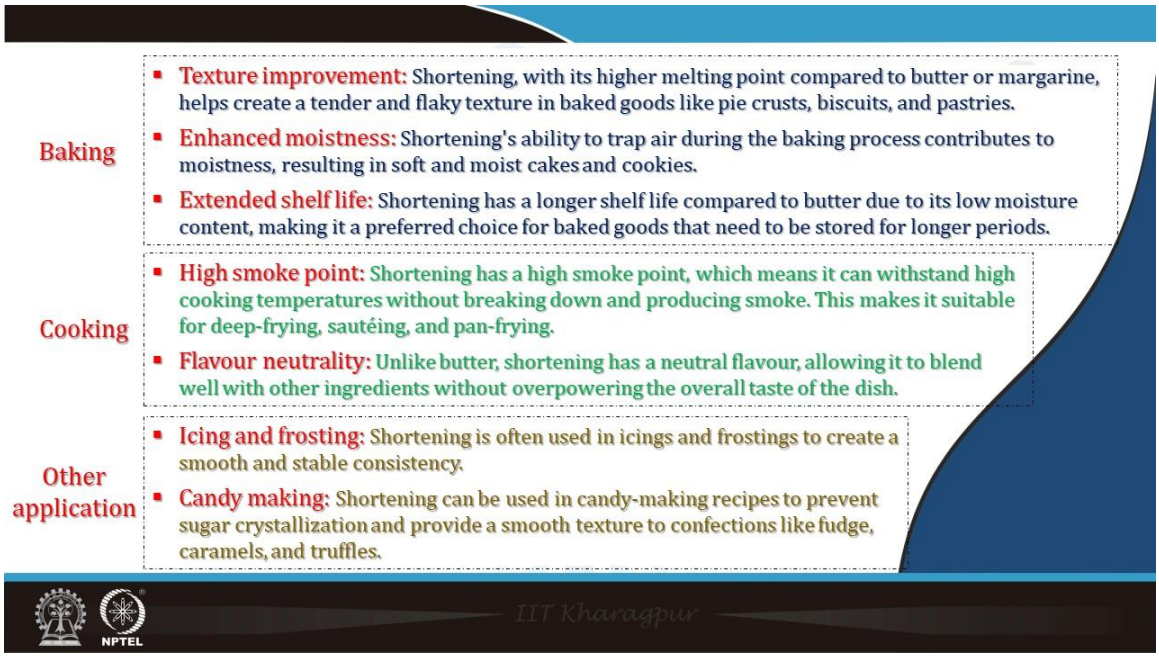


A uniform mixture of two un-mixable substances, such as fat and water, is called an emulsion as you can see in the figure shown. Mayonnaise is a familiar example of an emulsion from outside the bakeshop – in this case, an emulsion of oil and vinegar. There are emulsions of air and fat, such as that formed when shortening and sugar are creamed together in the production of cakes and other products. Different fats have differing abilities to form emulsions. For example, if the wrong shortening is used in certain cases, the emulsion may fail because the batter contains more water than the fat can hold. Then, batter "curdles" or "breaks." When the wrong shortening is used you can see in the picture here. So, proper quality and quantity of these components is very essential for proper mixing.

Shortening

- Shortening has historically been referred to a solid fat added to dough to prevent development of long strands of gluten in baked product. This results in crumbly, dense doughs that are required in the production of various confections.
- Today, the term "shortening" typically describes a vegetable oil-based ingredient.
- Shortenings generally consist of nearly 100% fat.
- It may be made from vegetable oils, animal fats, or both.
- During manufacturing, fats are hydrogenated and it converted liquid oils into solid fats.
- The shortening is important for many baked goods, such as pie crusts, because gluten creates a gummy or chewy end product.
- When fat is worked into dry flour, the fat creates a barrier between gluten molecules, thus preventing them from cross-linking once a liquid is added.

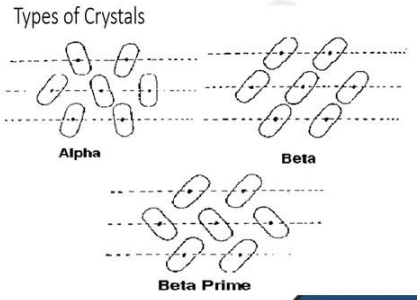
Now let us talk about shortening. Shortening has historically been referred to as a solid fat added to dough to prevent the development of long strands of gluten in baked products. This results in crumbly, dense doughs that are required in the production of various confections. Today, the term "shortening" typically describes a vegetable oil-based ingredient. Shortenings generally consist of nearly 100% fat. It may be made from vegetable oils, animal fats, or both. During manufacturing, fats are hydrogenated and it converted liquid oils into solid fats. The shortening is important for many baked goods, such as pie crusts, because gluten creates a gummy or chewy end product. When fat is worked into dry flour, the fat creates a barrier between gluten molecules, thus preventing them from cross-linking once a liquid is added, and that influences the final product texture.



The application of these shortening in baking is, that it gives texture improvement. Shortening, with its higher melting point compared to butter or margarine, helps create a tender and flaky texture in baked goods like pie crusts, biscuits, and pastries. Gives enhanced moistness by its ability to trap air during the baking process, it contributes to moistness, resulting in soft and moist cakes and cookies. It extends the shelf life. Shortening has a longer shelf life compared to butter due to its low moisture content, making it a preferred choice for baked goods that need to be stored for longer periods. In cooking, Shortening has a high smoke point, which means it can withstand high cooking temperatures without breaking down and producing smoke. This makes it suitable for deep-frying, sautéing, and pan-frying. Unlike butter, shortening has a neutral flavor, allowing it to blend well with other ingredients without overpowering the overall taste of the dish. Other applications are icing frosting, and candy making. Shortening is often used in icings and frostings to create a smooth and stable consistency. Shortening can be used in candy-making recipes to prevent sugar crystallization and provide a smooth texture to confections like fudge, caramels, and truffles.

Shortenings

- Incorporation of air, plasticity, consistency and solid-liquid ratio are important characteristics of shortenings that depend, in part, on polymorphism.
- β' Crystals - large amounts of small air cells- Yields whiter, creamier product that is tender and has a smooth texture
- β Crystals - small amounts of large air cells - Yields large clustered crystals with a waxy or grainy texture



The shortenings help in the incorporation of air, plasticity, consistency, and solid-liquid ratio are important characteristics of the shortening that depend in part on the polymorphism. Beta prime crystal gives a large amount of small air cell incorporation. So, it yields a whiter, creamier product that is tender and has a smooth texture whereas, the beta crystals help incorporation of a small amount of large air cells. So, it yields large clustered crystals with a waxy or grainy texture. So, polymorphs in the shortening are very important functionalities to incorporate proper characteristics.

❑ Regular shortening

- These shortenings have a fairly tough, waxy texture, and small particles of the fat tend to hold their shape in a dough or batter.
- They can be manufactured to be of varying degrees of hardness.
- Regular shortenings have a good creaming ability.
- This means that good quantity of air can be mixed into them to give a batter lightness & leavening power.
- Also, this type of shortening melts only at a high temperature.
- Because of their texture, these shortenings are used for flaky products such as pie crusts and biscuits.
- They are also used in many other pastries, breads, and products mixed by creaming, such as certain pound cakes, cookies, and quick breads. Unless another shortening is specified in a formula, regular shortening is generally used.

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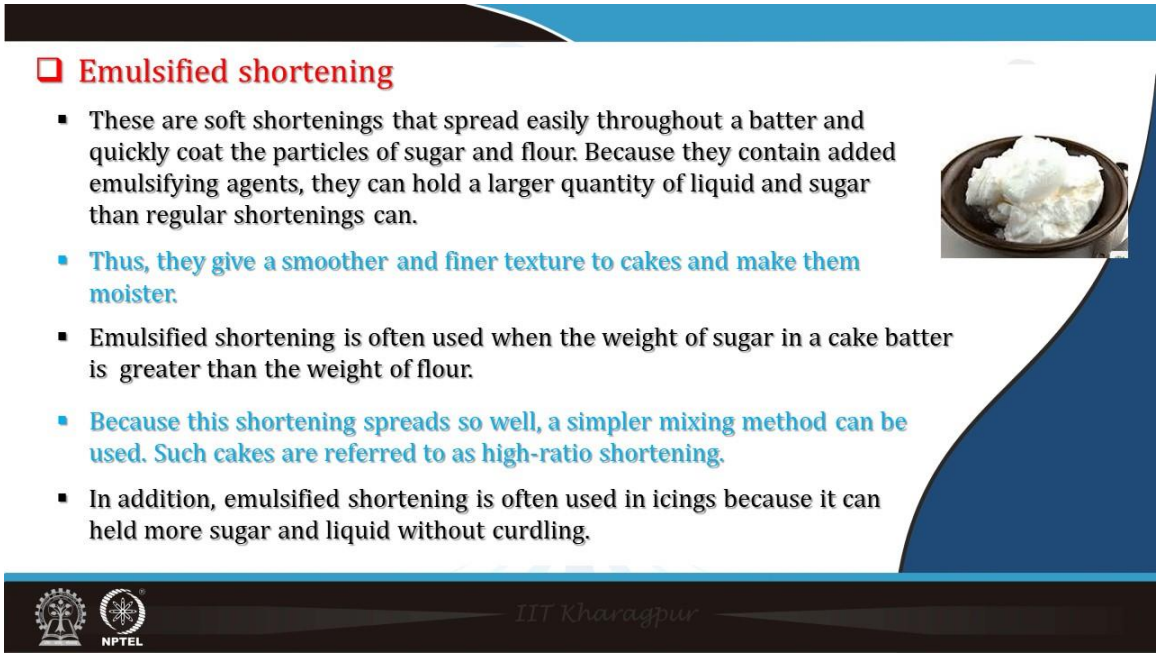
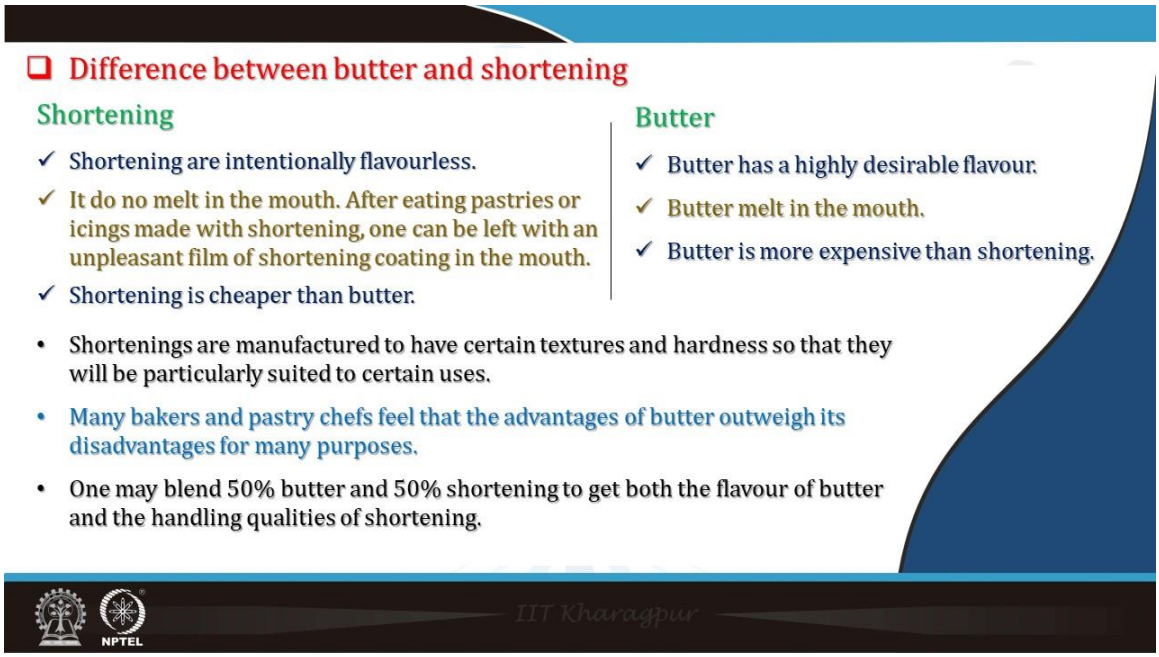


Then emulsified shortening. These are soft shortenings that spread easily throughout a batter and quickly coat the particles of sugar and flour. Because they contain added emulsifying agents, they can hold a larger quantity of liquid and sugar than regular shortenings can. Thus, they give a smoother and finer texture to cakes and make them moister. Emulsified shortening is often used when the weight of sugar in a cake batter is greater than the weight of flour. Because this shortening spreads so well, a simpler mixing method can be used. Such cakes are referred to as high-ratio shortening. In addition, emulsified shortening is often used in icings because it can hold more sugar and liquid without curdling.



The difference between butter and shortening is, that butter has a highly desirable flavor butter melts in the mouth butter and is more expensive than shortening. But the shortening is intentionally flavorless, it does not melt in the mouth. After eating pastries or icings made with shortening, one can be left with an unpleasant film of shortening coating in the mouth. Shortening is cheaper than the butter. Shortenings are manufactured to have certain textures and hardness so that they will be particularly suited to certain uses. Many bakers and pastry chefs feel that the advantages of butter outweigh its disadvantages for many purposes. One may blend 50% butter and 50% shortening to get both the flavor of butter and the handling qualities of shortening.

Margarine

- Margarine is manufactured from various hydrogenated animal and vegetable fats, plus flavouring ingredients, emulsifiers, colouring agents, and other ingredients.
- It contains 80 to 85% fat, 10 to 15% moisture, and about 5% salt, milk solids, and other components.
- Thus, it may be considered a sort of imitation butter consisting of shortening, water, and flavoring.

❑ Major categories of margarine

✓ Cake margarines or Baker's margarines

✓ Pastry margarines

So, now after having discussed shortening let us talk about margarine. Margarine in other words is also many a times known as vegetable butter. Margarine is manufactured from various hydrogenated animal and vegetable fats, plus flavoring ingredients, emulsifiers, coloring agents, and other ingredients. It contains 80 to 85% fat, 10 to 15% moisture, and about 5% salt, milk solids, and other components. Thus, it may be considered a sort of imitation butter consisting of shortening, water, and flavoring. Major categories of margarine are cake margarine or baker's margarine and pastry margarine.

❑ Cake margarines or Baker's margarines

- Cake margarine or baker's margarine is a type of fat used in baking, particularly for making cakes, pastries, and other baked goods. It is a solid fat that is specifically formulated to have certain characteristics that make it suitable for baking applications.
- Cake margarine is typically made from vegetable oils, such as soybean oil or palm oil, which are partially hydrogenated to solidify them.
- This process creates a semi-solid fat with a higher melting point than regular butter, allowing it to maintain its shape and structure at room temperature.
- Cake margarine has several advantages in baking. It provides a tender and moist texture to baked goods, enhances their flavor, and helps to create a desirable crumb structure. It is also easier to cream with sugar compared to butter, making it a convenient option for cake batters.

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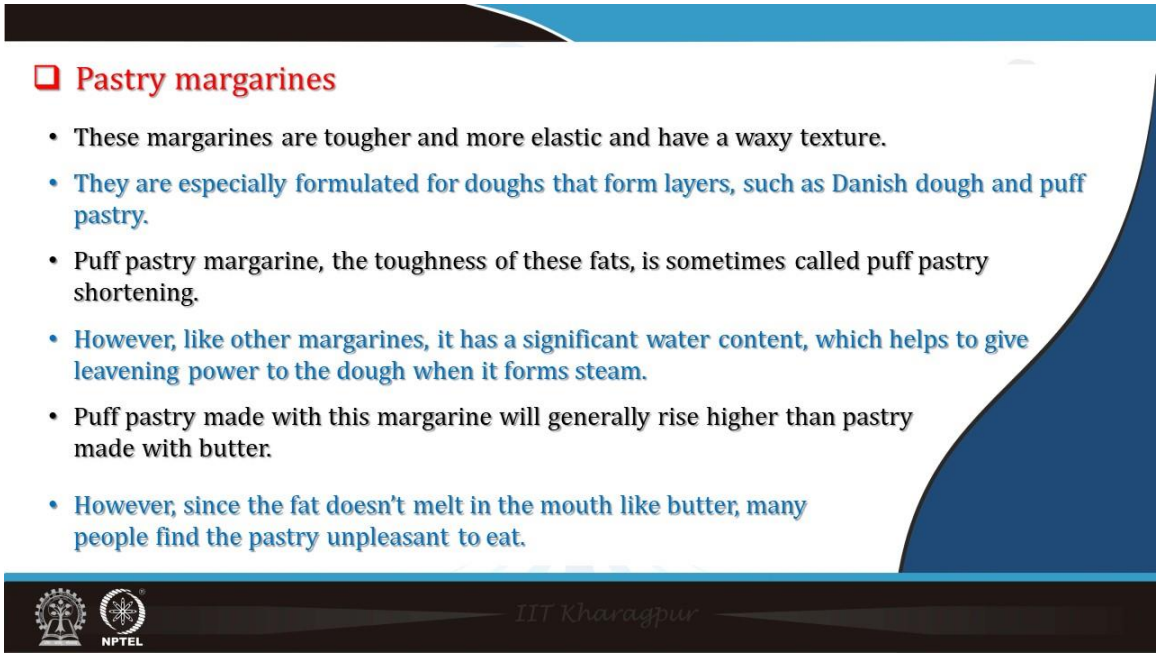
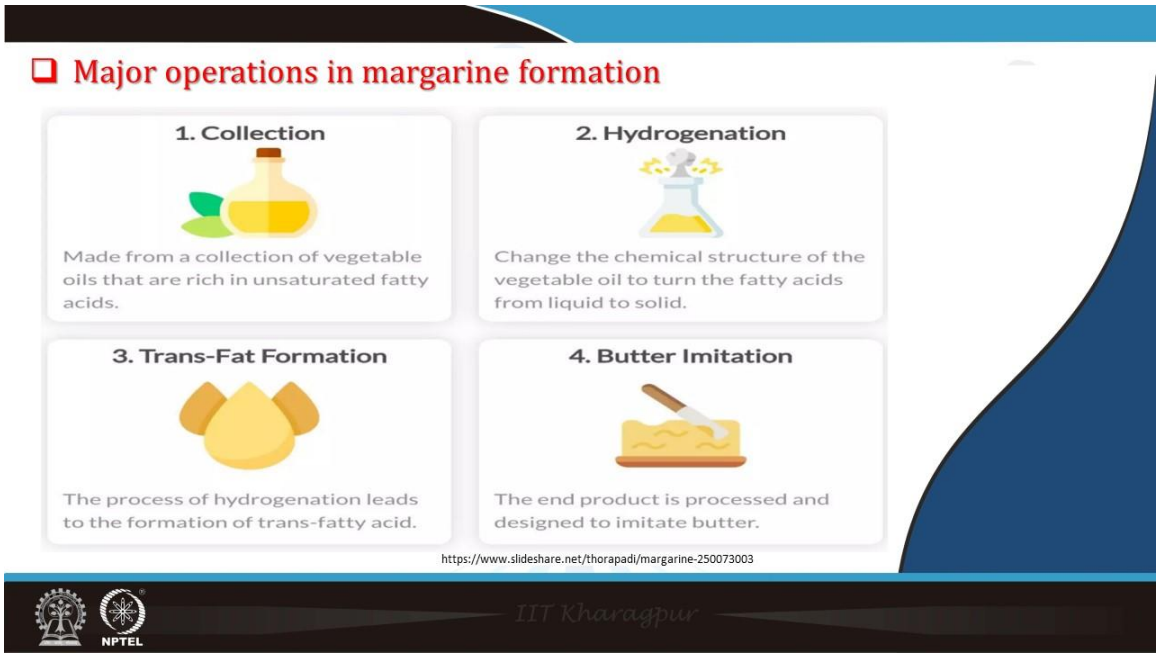
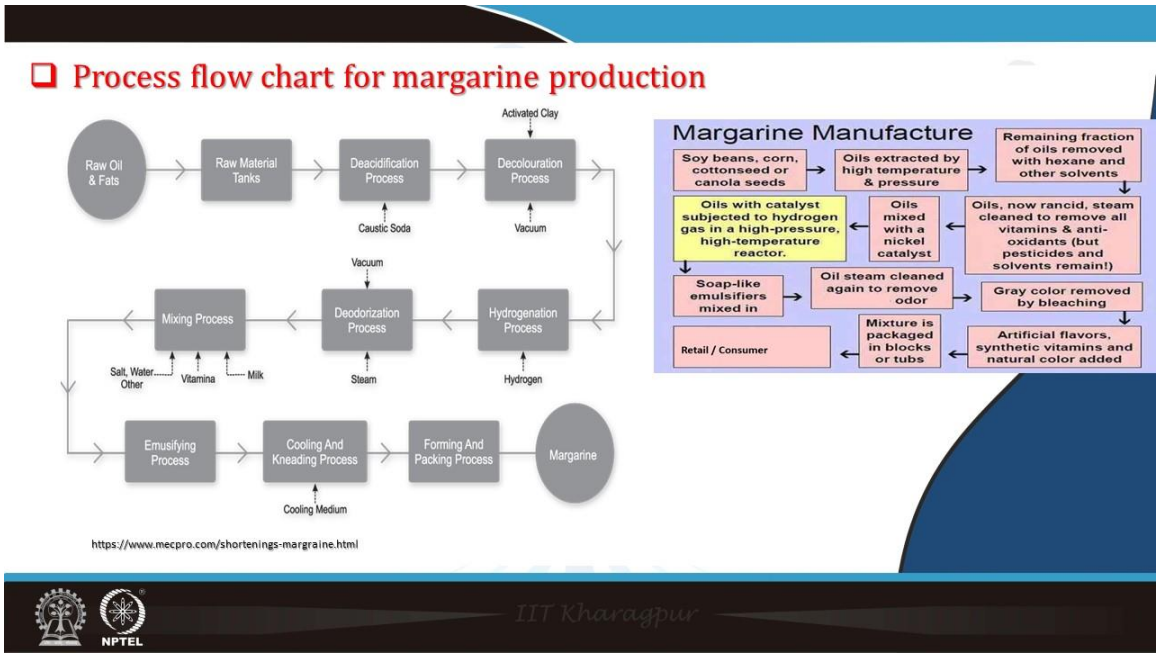


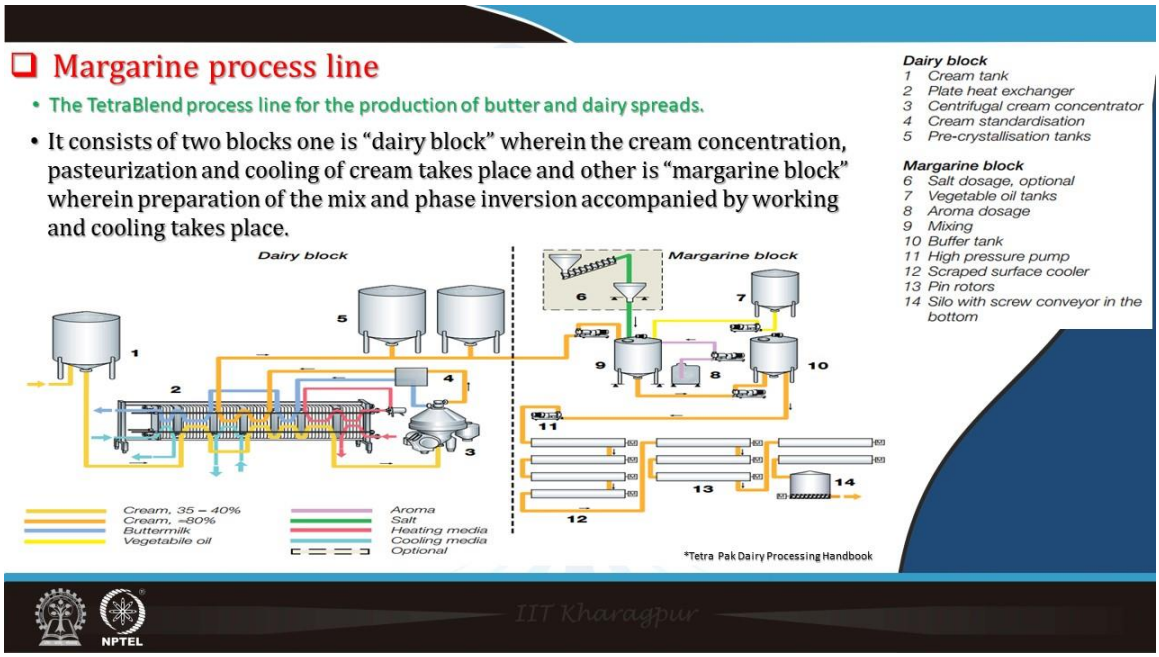
Then pastry margarines, these margarine are tougher and more elastic and have a waxy texture. They are specially formulated for doughs that form layers, such as Danish dough and puff pastry. Puff pastry margarine, the toughness of these fats, is sometimes called puff pastry shortening. However, like other margarine, it has a significant water content, which helps to give leavening power to the dough when it forms steam. Puff pastry made with this margarine will generally rise higher than pastry made with butter. However, since the fat doesn’t melt in the mouth like butter, many people find the pastry unpleasant to eat.



So, the major operations in the preparation of the margarine formation are the collection that is it is made from a collection of vegetable oils that are rich in unsaturated fatty acids or polyunsaturated fatty acids. More percent of polyunsaturated fatty acids gives an option to incorporate health options in the margarine. The second step is hydrogenation which changes the chemical structure of the vegetable oil to turn the fatty acids from liquid to solid. Then this trans-fat formation, the process of hydrogenation leads to the formation of trans fatty acid, but here the proper conditions are selected so that less trans-fat is formed, and then butter imitations that is for the impressions of butter. The end product is processed and designed to imitate butter where emulsifiers, moisture, and other ingredients are added and it is worked out in a similar manner like which is done in traditional butter and you get a butter substitute or imitation butter or vegetable butter.



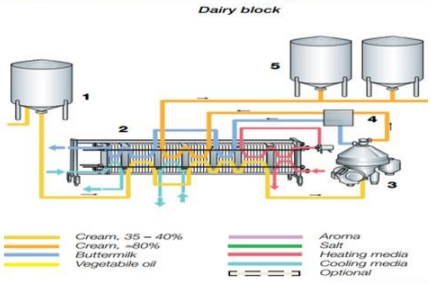
This process flow chart is the same which is discussed earlier fats, oils enter the raw material tank, then the deacidification process, decolorization, and hydrogenation process, that is, the decolorized, bleached, and deodorized oil is hydrogenated and even sometime after hydrogenation it is deodorized. Then it is mixed with salt, water, other ingredients, vitamin A, milk or milk solids, and so on and it is worked out then it is properly mixed to have proper emulsifying action. Then it is cooled and kneaded firmly it gives in shape forming process and you get margarine. So, this is the step used. As just in brief as I told you earlier that is taking the oil, solidifying it partially, solidifying it to bring it to proper consistency then adding to other ingredients, working out, and giving the shape of the normal butter. So, this is the process flow chart for the preparation.



Here you see that is the margarine process line, the tetra blend process line for the production of butter and dairy spreads. This is a very popular process and equipment machinery is available. As you can see here it consists of two blocks that is one is the dairy block where in the cream concentration pasteurization cooling of the cream takes place and the other block is the margarine block where in preparation of the mix and the phase inversion accompanied by working and cooling takes place. So, here you can see the yellow line is the one which is the fat oil cream with the 35 to 40 percent fat going. Then the orange line is the concentrated cream that is it is flow and then this blue line is the flow of buttermilk and this completely yellow line here shows the flow of vegetable oil. The other colors like aroma, salt, heating media, cooling media, and the optional ingredients are given by these other colors, that is green, red, and light orange. In the dairy block, you can see the first cream from the cream tank it passes through the heat exchanger and then it goes to the concentrator. So, it is a centrifugal cream concentrator and cream standardization. From there it is sent to the pre-crystallization tanks and then it moves to the margarine block where it has an arrangement for the salt dosage, which is optional (6). Then vegetable oil tanks are there in the margarine block, aroma dosages tank, a system for mixing, then a butter tank is there, a high-pressure pump, a scraped surface cooler and pin rotors, and a silo with a screw conveyor to the bottom. So, all the arrangements are there in both the blocks.

❖ Dairy block

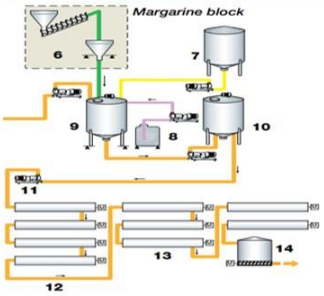
- The process starts with pasteurized cream of 35 to 40% fat content.
- As the cream may come from another creamery or a local cream storage tank, its temperature must be adjusted to 60 – 70°C before it enters the cream concentrator, a hermetic centrifugal machine.
- The degree of concentration, i.e. the cream fat content, is automatically controlled by the continuous standardization device.
- Fat contents of up to 82% is attained and then the cream is cooled to 18 – 20°C before being routed to a holding / pre-crystallization tank.



So, in the dairy block as you can see in the figure here the process starts with pasteurized cream of 35 to 40% fat content. As the cream may come from another creamery or a local cream storage tank, its temperature must be adjusted to 60 – 70°C before it enters the cream concentrator, a hermetic centrifugal machine. The degree of concentration, i.e. the cream fat content, is automatically controlled by the continuous standardization device. Fat contents of up to 82% are attained and then the cream is cooled to 18 – 20°C before being routed to a holding / pre-crystallization tank.

❖ Margarine block

- This part of the process line starts with a batching station where the product mix is prepared. Various ingredients are mixed together according to the recipe for the product in question. Thus concentrated cream is mixed with appropriate volumes of vegetable oil, salt and water phase, in that order. After thorough mixing the mixture is pumped into a buffer tank (10).
- A new batch can then be prepared. The process is continuous from the tank, from which the product mix is taken to the high pressure pump (11).



- It is then fed into the scraped-surface coolers (12), where phase inversion takes place.
- Before final cooling the spread is held and worked by pin rotors (13).
- Leaving the final cooling stage, the product enters the storage silo (14) from where it is pumped into the filling machine, often a tub filling machine.
- The whole process is controlled from a process computer and a recipe computer.

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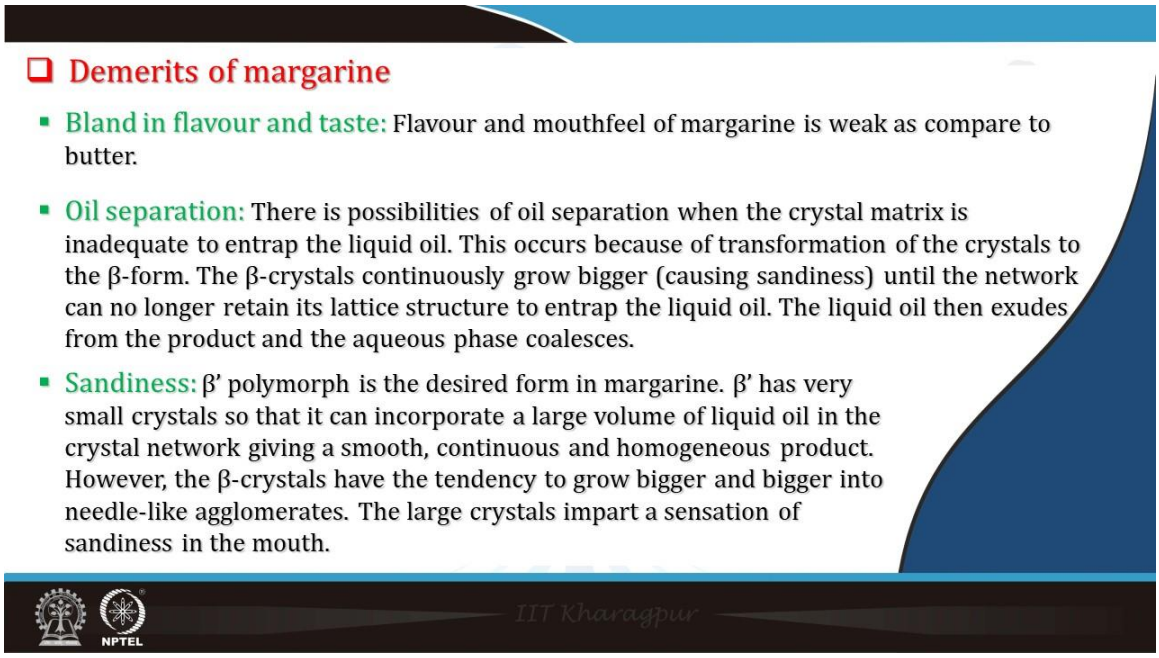
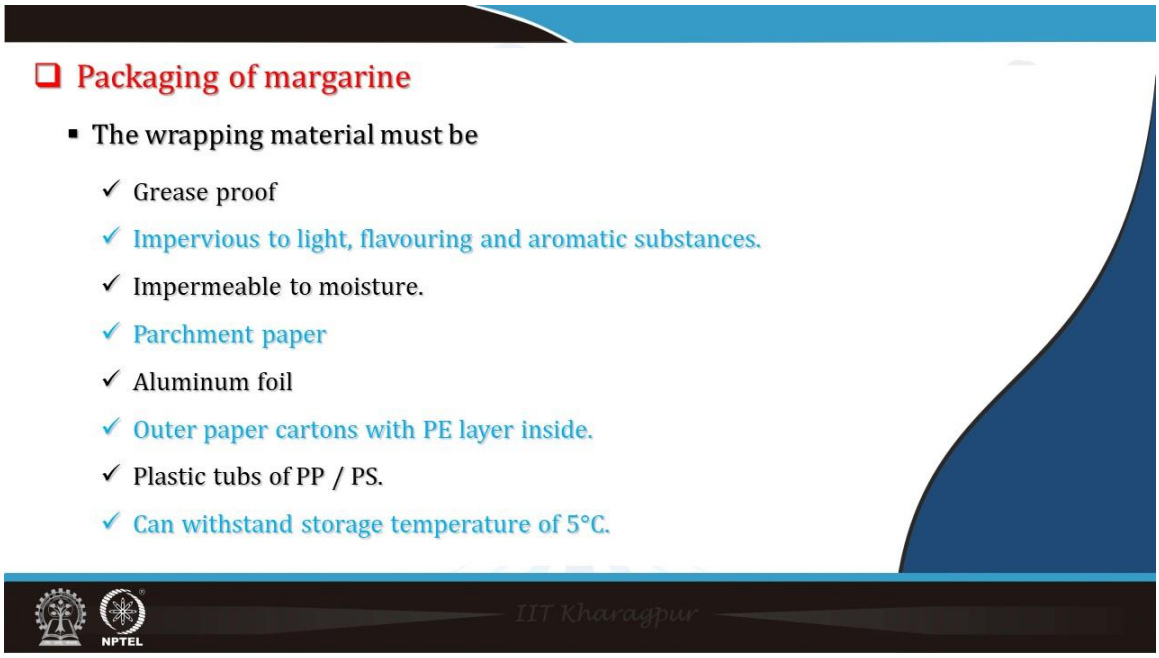
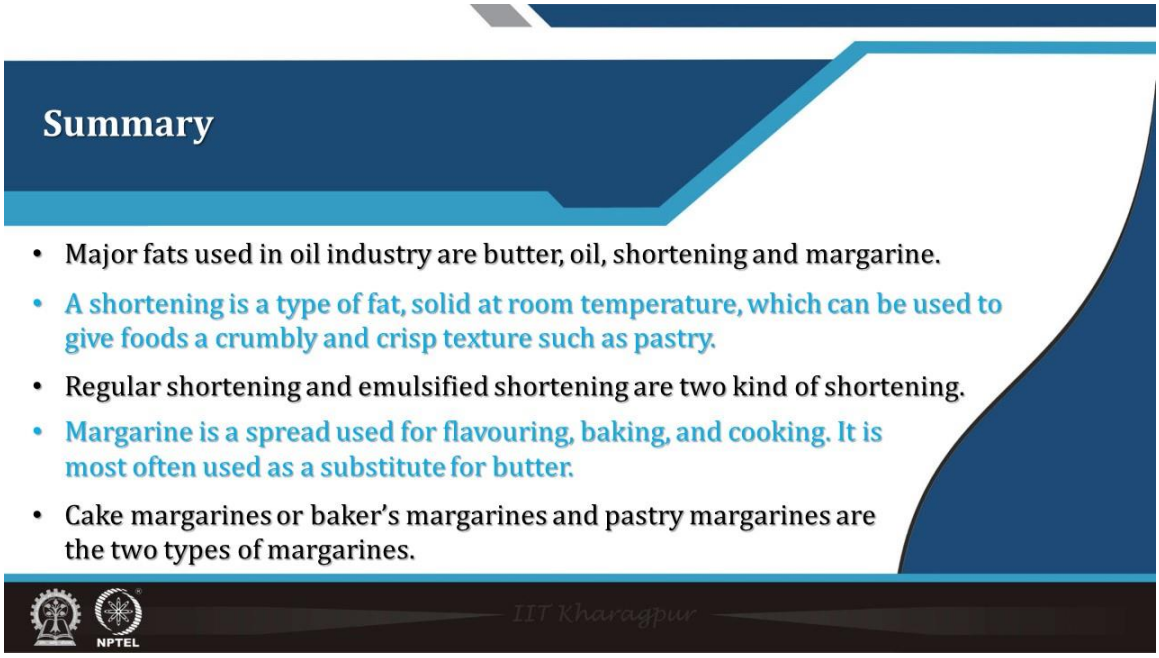
Then let us talk briefly about the merits and demerits of margarine. The merits include its spreadability. It is one of the most highly regarded attributes and margarine shows good spreadability at refrigeration temperature as compared to butter. Products with a solid fat index (SFI) of 10–20 at serving temperature are optimal on a consumer panel. Then its consistency and texture. Consistency is the measure of smoothness, evenness, and plastic state in margarine. Texture is a measure of the structure. This attribute can be altered to the desired level by using different vegetable oils in the formulation as butter has less scope to alter consistency and texture. Margarine contains minimum or no cholesterol in the product. Margarine is cheaper than butter.



The demerits of margarine include, bland in flavour and taste. The flavor and mouthfeel of margarine are weak as compared to butter. There is possibility of oil separation when the crystal matrix is inadequate to entrap the liquid oil. This occurs because of the transformation of the crystals to the β-form. The β-crystals continuously grow bigger (causing sandiness) until the network can no longer retain its lattice structure to entrap the liquid oil. The liquid oil then exudes from the product and the aqueous phase coalesces. β' polymorph is the desired form in margarine. β' has very small crystals so that it can incorporate a large volume of liquid oil in the crystal network giving a smooth, continuous and homogeneous product. However, the β-crystals have the tendency to grow bigger and bigger into needle-like agglomerates. The large crystals impart a sensation of sandiness in the mouth.

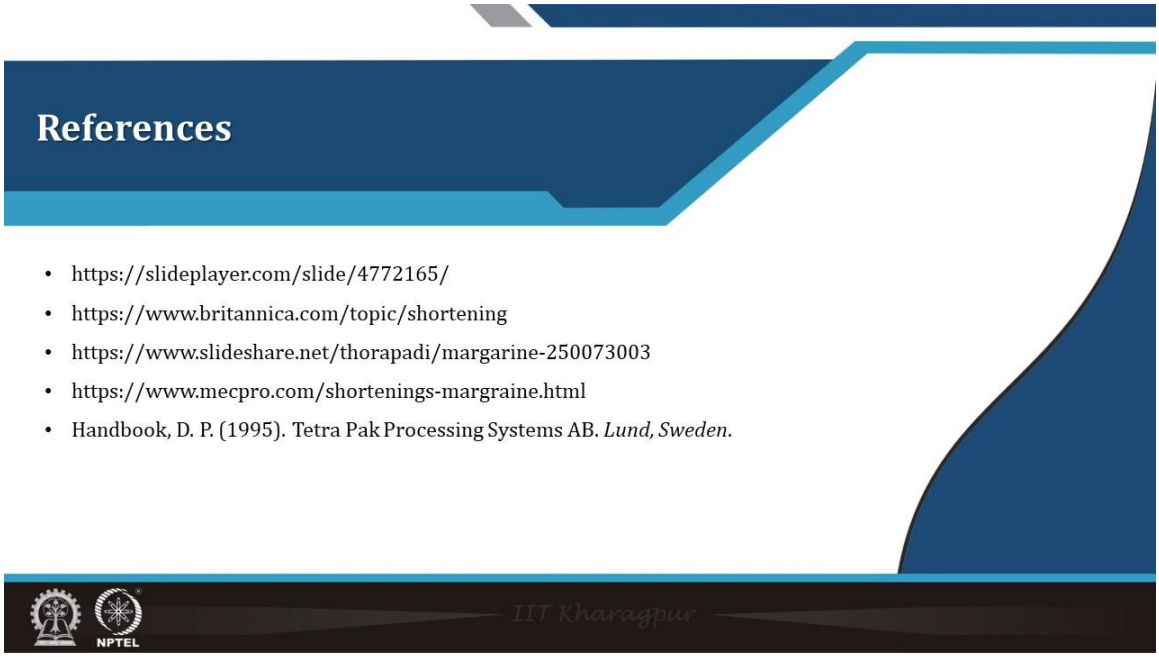


In packaging material that is generally recommended for margarines are like the material should be grease-proof, it should be impervious to light flavoring and aromatic substances, it should be impermeable to moisture. Normally parchment paper is used for packing butter, but it can be used for the packing of margarine as well as aluminum foil, outer paper cotton with a PE layer inside, and plastic tubs of PP or PS. It should withstand a storage temperature of around 5 degrees Celsius.



Finally, I will summarize this lecture by saying that the major fats used in the oil industry are butter, oil, shortening, and margarine. A shortening is a type of fat, solid at room

temperature, which can be used to give foods a crumbly and crisp texture such as pastry. Regular shortening and emulsified shortening are two kinds of shortening. Margarine is a spread used for flavouring, baking, and cooking. It is most often used as a substitute for butter. Cake margarine or baker's margarine and pastry margarine are the two types of margarines.



These are the references that are used in the preparation of this lecture. Thank you very much for your patience here. Thank you.