Food Oils and Fats: Chemistry & Technology
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Module 8 : Animal & Dairy Fats
Lecture 36: Animal Fats

Hello everybody, Namaste. Now we are in the 8th module of this course. In this module, the five lectures will be devoted on Animal and Dairy Fats. In the lecture today, we will talk about Animal Fats.

Concepts Covered

- Types of animal fats
- Lard – Characteristics and types
- Lard treatment
- Rendering and their processes types
- Byproduct adipose tissues
- Edible greases and tallows

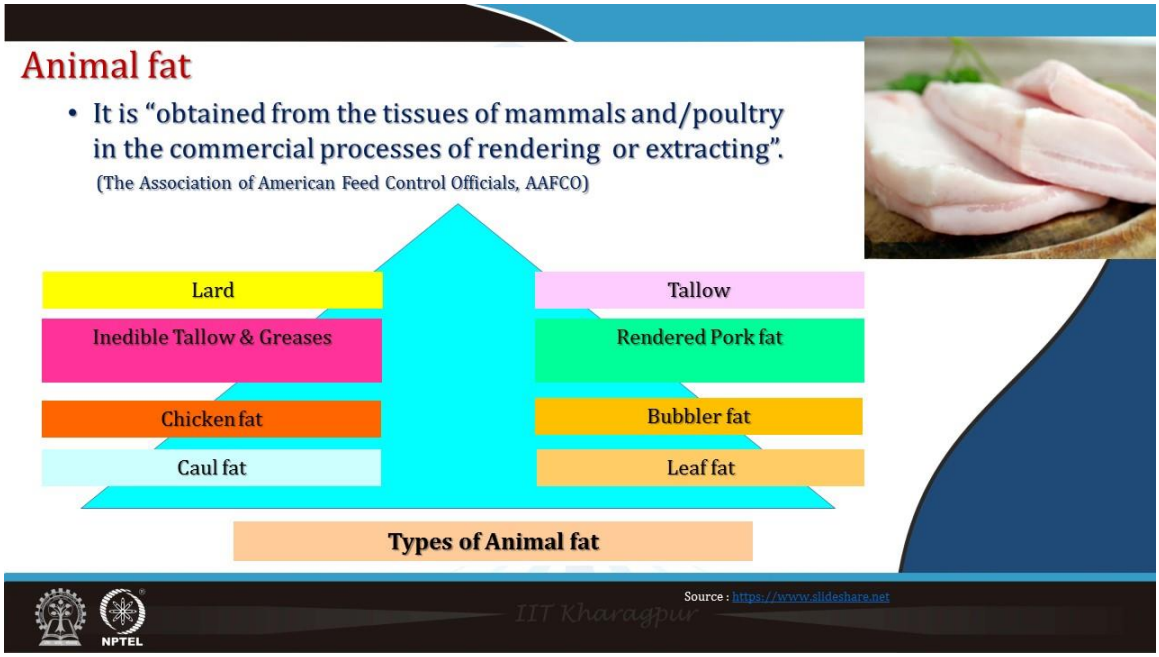
We will discuss what are the different types of animal fats, lard, its types and characteristics, lard treatment, rendering and their process types, by-product adipose tissues and edible greases and tallows.

Slaughtering and trimming of fatty tissues

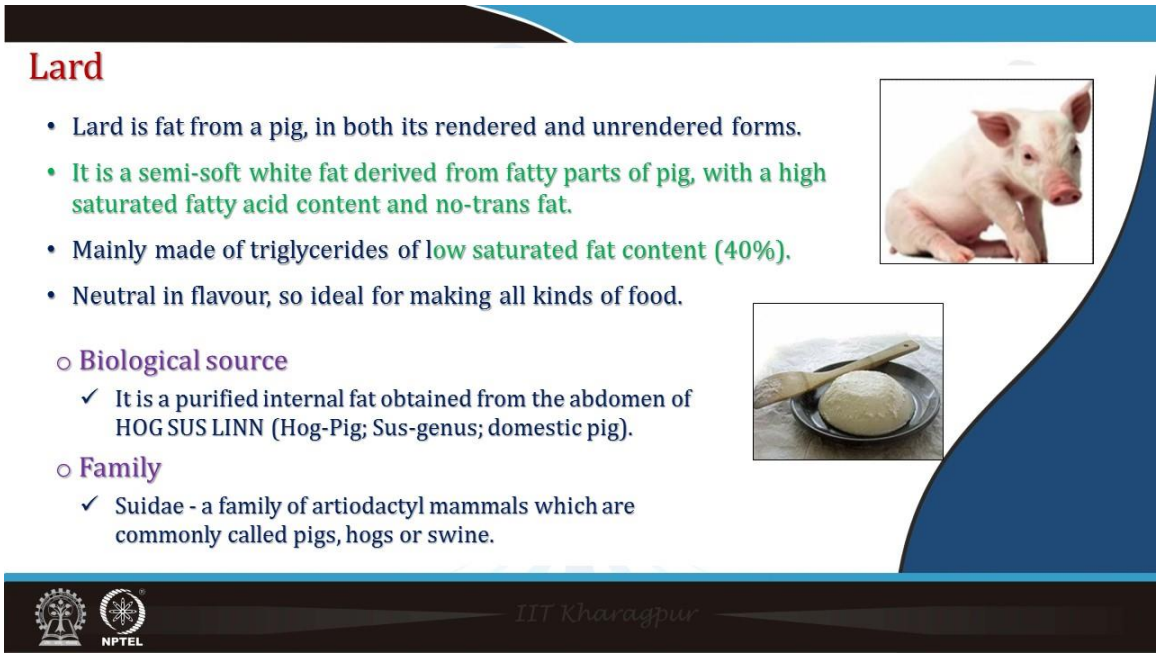
- The animals are slaughtered using standard techniques and fatty tissues are trimmed from the carcasses.
- The trimmed fatty tissues are used for extraction of fat using suitable technique viz. rendering.
- Different types and quality of animal fats are produced using different techniques.

You know that first before extracting the fat from animals that they are required to be slaughtered obviously using standard techniques. After slaughtering the carcasses which is obtained from that the fatty tissues, adipose tissues etc. are trimmed. And then

these trimmed fatty tissues are used for extraction of fat using suitable technologies more popularly the rendering technology which is a heating process type of heating process. Different types and qualities of animal fats are produced using different rendering techniques or different extraction techniques.



Let us first understand what is the animal fat. When we talk about animal fat, what does it include? As per the Association of American Feed Control Officials that is popularly known as AAFCO, animal fat is the fat which is obtained from the tissues of mammals and or poultry in the commercial process of rendering or extracting. There are different types of animal fat like cow fat, leaf fat, chicken fat, bubbler fat, inedible tallows and greases, rendered pork fat, lard and tallows. So, these are different types of animal fats. So, let us talk about lard.



Lard is fat which is obtained from pig in both its rendered and unrendered form. We can talk about lard as a pig fat. It is a semi-soft white fat derived from fatty parts of the pig with a high saturated fatty acid content and it does not include any type of trans fats. This lard is mainly made of triglycerides of low saturated fat content. It has more saturated fat content and less low saturated or unsaturated fat content.

It has around 40 percent of the saturated fat content. It is a neutral in flavor. So, it is ideal for making all kinds of foods. If you look at the biological structure of the lard, it is a purified internal fat obtained from the abdomen of hog sauce line that is Hog-Pig, Sus-genus or domestic pigs. These are the animals which are used for obtaining lard.

Lard characteristics

- **Physical properties**
  - ✓ Colorless or yellowish
- **Melting point**
  - ✓ Leaf fat : 43-48 °C
  - ✓ Back fat : 30-40 °C
- **Chemical constituents**
  - ✓ 40% solid triglyceride, 50% liquid triglyceride
  - ✓ Solid triglyceride- Stearin, Palmitin
  - ✓ Liquid triglyceride-Olein
  - ✓ These two solid and liquid triglycerides are separated by using pressure at 0 °C and sold as Stearin and Lard oil, respectively.
- **Chemical properties**
  - ✓ Stable and preferred fat for frying
  - ✓ Acid value : 3.4

Oil or Fat	Unsat./Sat. ratio	Saturated					Mono unsaturated	Poly unsaturated	
		Capric Acid C10:0	Lauric Acid C12:0	Myristic Acid C14:0	Palmitic Acid C16:0	Stearic Acid C18:0	Oleic Acid C18:1	Linoleic Acid (ω6) C18:2	Alpha Linolenic Acid (ω3) C18:3
Lard (Pork fat)	1.2	-	-	2	26	14	44	10	-

https://www.slideshare.net/zuriatiz/animal-fats-and-oil

The characteristics of the lard are physical properties, colorless or aloe fat, the melting point of leaf fat is around 43 to 48 degree Celsius, melting point of back fat is 30 to 40 degree Celsius. It consists of 40 percent solid triglycerides, 50 percent liquid triglycerides. Solid triglycerides include mainly styrene and palmitine whereas, liquid triglycerides are olein. These two solid and liquid triglycerides are separated by using pressure at 0 degree Celsius and sold as stearin and lard oil respectively. The lard is stable and it is a preferred fat for frying. Its acid value is around 3.4. If you look at the saturated and unsaturated ratio in the lard fat, it is around 1.2. The saturated acids mainly which are present that is it is a palmitic acid around 26 percent, stearic acid 14 percent and myristic acid is less amount 2 percent. Monounsaturated fatty acids that is oleic acid C18:1, they are about 44 percent and polyunsaturated fatty acids mainly the linoleic acid is 10 percent approximately.

Lard Composition and Physical Properties

Characteristics	Typical	Range
Specific gravity, 50°C	—	0.896 to 0.904
Refractive index, 50°C	—	1.448 to 1.460
Iodine value	57	45 to 70
Saponification number	—	192 to 203
Unsaponifiable matter, %	—	<1.0
Titer, °C	—	32 to 45
Mettler dropping point, °C	32.5	31.5 to 33.0
Solidification point, °C	—	4 to –2
AOM stability, hours	54	53 to 60
Oxidative stability index (110°C), hours	16.9	16.6 to 19.0
Tocopherol content, ppm		
α-tocopherol	172	129 to 215
β-tocopherol	30	22 to 37
γ-tocopherol	26	19 to 32
δ-tocopherol	13	10 to 16
Fatty acid composition, %		
C-10:0 Capric	0.1	—
C-12:0 Lauric	0.1	—
C-14:0 Myristic	1.5	0.5 to 2.5
C-14:1 Myristoleic	—	<0.2
C-15:0 Pentadecanoic	0.1	<0.1
C-16:0 Palmitic	26.0	20.0 to 32.0
C-16:1 Palmitoleic	3.3	1.7 to 5.0
C-17:0 Margaric	0.4	<0.5
C-17:1 Margaroleic	0.2	<0.5
C-18:0 Stearic	13.5	5.0 to 24.0
C-18:1 Oleic	43.9	36.0 to 62.0
C-18:2 Linoleic	9.5	3.0 to 16.0

Source : O'brien 2008) & https://www.splendidtable.org

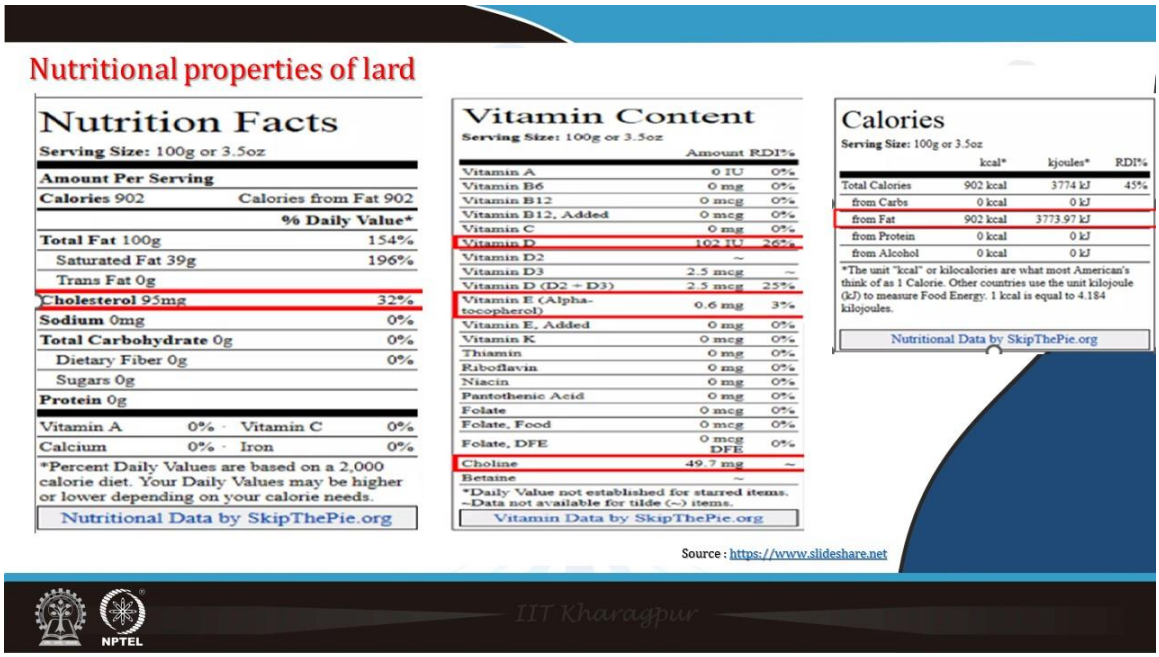
In this table, I have tried to give you the lard composition and the physical properties, major physical properties also I give in the last slide but here in little detail. This is you can see its iodine value is around 57. It is sedimentation point is that its AOM stability is around 54 hours. That Metller dropping point is 32.5 degree Celsius and its oxidative stability index at 110 degree Celsius is around 16 hours. Its tocopherol content if you see it has around 172 ppm alpha tocopherol, beta tocopherol, gamma tocopherol and delta tocopherols are about 30, 26 and 13 ppm. Similarly, it has a good amount of palmitic acid as you saw in the earlier slide also and about oleic acid 43 percent.

Lard Composition and Physical Properties (Continued)

Characteristics	Typical	Range
C-18:3 Linolenic	0.4	<0.5
C-20:0 Arachidic	0.2	<1.0
C-20:1 Gadoleic	0.7	<1.0
C-20:2 Eicosadienoic	0.1	<1.0
C-20:4 Eicosatetraenoic	—	<1.0
C-22:0 Behenic	—	<1.0
Triglyceride composition, %		
SSS Trisaturated	—	2 to 5
SUS Disaturated	—	25 to 35
SUU Monosaturated	—	50 to 60
UUU Triunsaturated	—	10 to 30
Crystal habit	β	
Solids fat index at:		
10.0°C/50°F	29.0	26.5 to 31.5
21.1°C/70°F	21.6	19.5 to 23.5
26.7°C/80°F	15.3	13.0 to 17.5
33.3°C/92°F	4.5	2.5 to 6.5
37.8°C/100°F	2.8	2.0 to 4.0
40.0°C/104°F	2.2	1.5 to 3.0

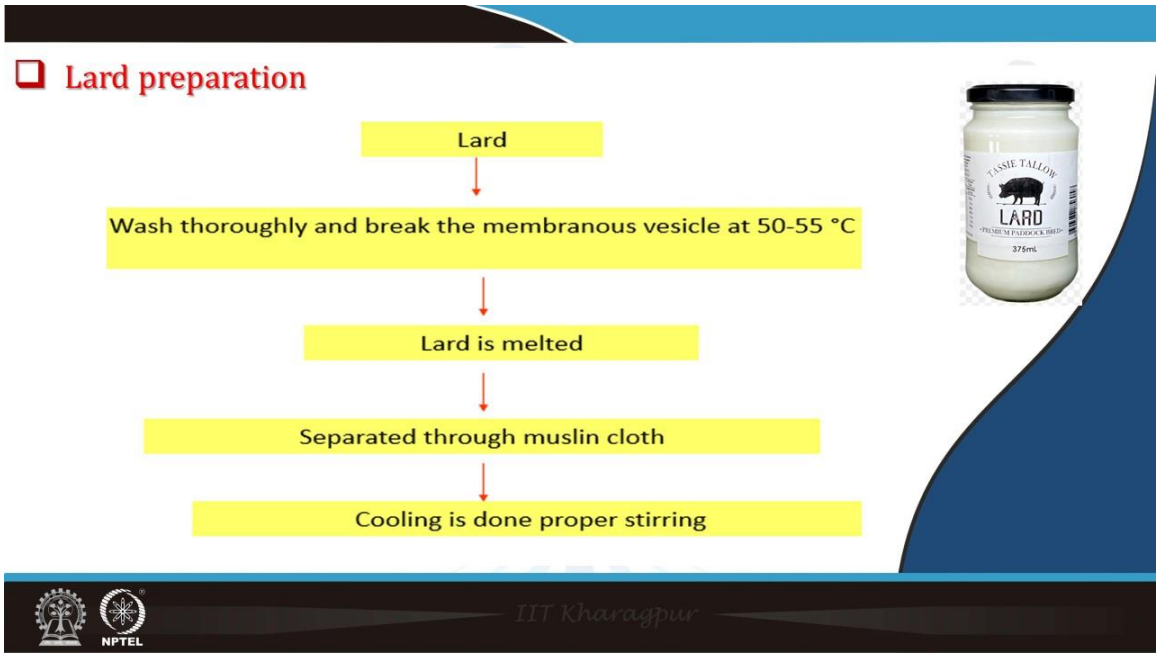
Notes: S = saturated, U = unsaturated, AOM = active oxygen method.

The other linolenic and arachidonic and all these are present in very small quantity. Its triglyceride composition if you look at that is SSS that is the trisaturated acids are may be around 2 to 5 percent whereas, the SUS disaturated are more that is about 25 to 35. Then SUU monounsaturated 50 to 60 and UUU that is the triunsaturated acids are in the range of 10 to 30. Its crystal habit is beta. Beta type crystals are more formed and solid fat index at 10 degree Celsius is 29 and at 40 degree Celsius is 2.2 that is obviously, increase the temperature solid fat index lowers down reduces.



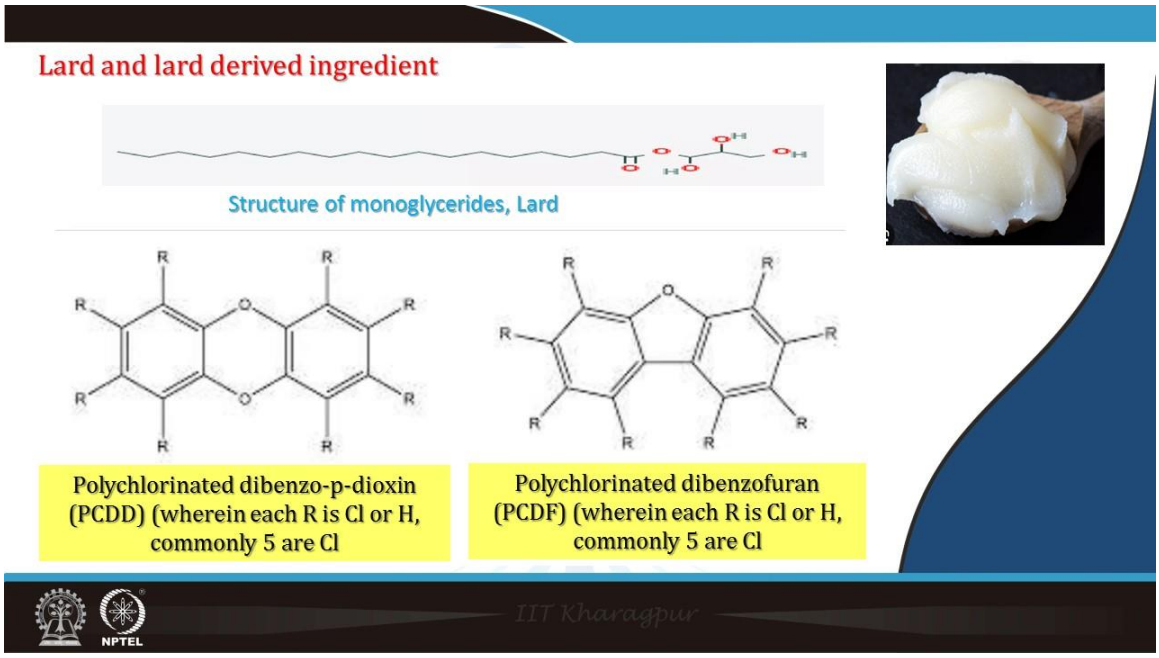
As far as the nutritional properties of a lard is concerned that is a nutrition fat per serving size of 100 gram it gives around 902 calories. Total fat that is around if you take 100 gram that is it becomes around 154 percent of per daily value. Its cholesterol content is around 32 percent it gives a 32 percent of the daily value cholesterol. And vitamin D around 102 international unit that is the 26 percent of the recommended daily intake. Vitamin E is around 0.6 milligram that is 3 percent of the recommended daily intake.

Choline is has around 49.7 milligram. Its boom fat gives around 902 kilo calorie. So, these are some of the nutritional fat, vitamin C content and calories provided by the lard.



Now, let us see the preparation of the lard.

Obviously, as I told you first the after the slaughtering the carcasses are washed thoroughly and break into the that is the fatty tissues etcetera. They are trimmed and these are break into a membranous vessel at around 50 to 55 degree Celsius. And then these broken and macerated or crushed fatty tissues are melted, heated and lard is after it is separated through muslin cloth or using other centrifugal methods etcetera. And normally cooling is done prior to with proper stirring.



These are the lard and lard derived ingredient if you can see structure of monoglycerides in the lard it is shown here.

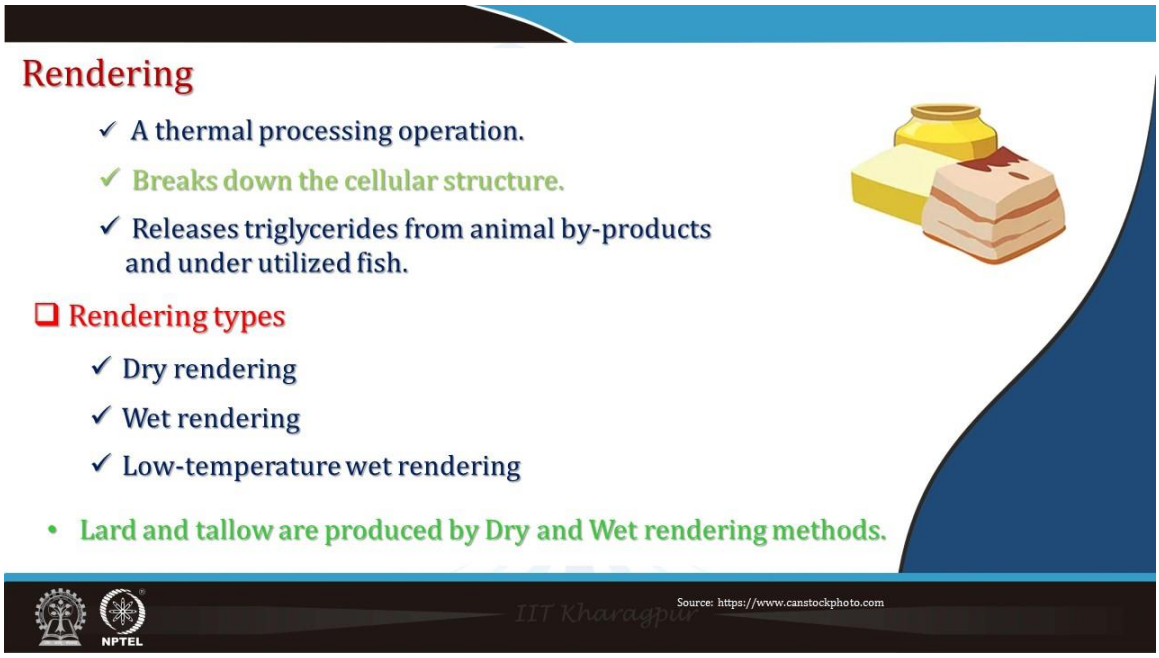
And it has polychlorinated dibenzo-p-dioxin which is popularly known as PCDD wherein that is structure you can see these are the these are the R groups. And these R groups will be either chlorine or hydrogen commonly there are in this compound there are five of these R's are chlorine whereas, in the polychlorinated dibenzofuran PCDF, ok. The structure you see that here you have a built in rings five member rings connecting two hexane and this has R connected in the side chains and this R is a chlorine or hydrogen commonly in this compound PCDF that is five of the R will be chlorine group. So, these are the some of the lard ingredients which are present type of the ok.

So, let us see what role does lard play in our food or in our daily life ok.

It is one of the few edible oils with a relatively high smoke point and therefore, it is good for shallow frying and deep frying. It is a you can say cheaper substitute of the cooking oils or other oils. It is used also as a coating fat for as a shortening or as a spread that is just similar to butter because of its characteristic melting properties and spread ability etcetera. And it has as I told you earlier also it has no trans fat and around 40 percent of the saturated fats are there. So, it can be used in lard cake or in pie making and also lard that is used for rice preparations, it has used as a bread spread.

Also it is sometime used as a lubricant in some of the machine parts particularly food machines etcetera or for making soap lard is also used for soap making.

Lard treatment and medicinal usage if you talk about in the medicinal usage, Lard had been widely used around the world in folk medicines applied as a politics that is a poultice to burns, cuts and inflamed areas it is applied ok. It is also used as a balm that is as a moisturizing and protective hand cream to prevent against chapping and cracking this is another reason to include in the survival kit that is Lard is commonly included in the survival kit. Then mixed with weaves wax Lard can be used to refurbish and maintain wood and leather. It is its natural qualities of preservation make it applicable for almost any tool or weapon.

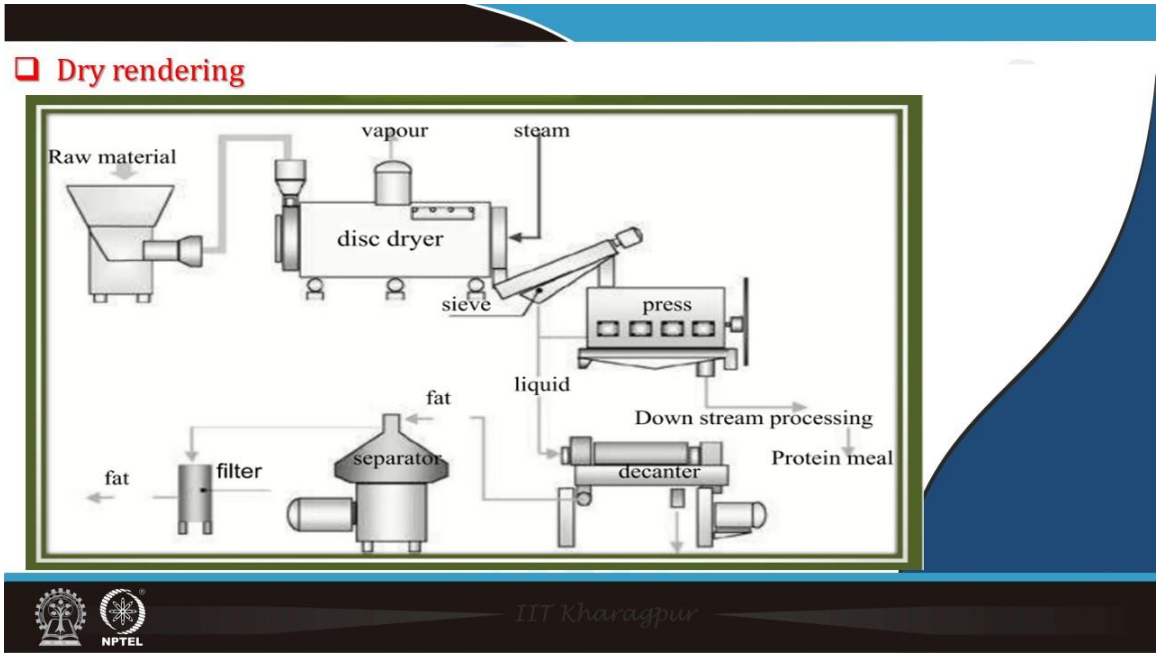


Now, let us discuss about the technology for obtaining the Lard or extracting the Lard that is it is a rendering process that is a simple heating process ok. It is a thermal operation that is the trimmed fatty tissues they are masqueraded or they are chopped and then they are heated using a suitable heating arrangement. So, hence this heated as you could see that in the earlier classes here the lipids fat is confined in the adipose tissues or membrane cell membrane. So, when you apply the heat the cell structure or membrane breaks down and it releases the triglycerides. Whereas, the membrane which is a proteinous material it coagulates.

So, you get that is the oil from animal byproducts and underutilized species etcetera can also be used rendering method is used. And then this denatured protein material is separated by centrifugation process, decantation process or by other methods. So, once we get oil and we get that is the this separated denatured tallows etcetera and edible regions etcetera which are used separately for making various products.

So, rendering process may be of three types commonly it is used dry rendering, wet rendering and low temperature wet rendering ok. And obviously, the conditions although all these are the basically heating process as heating, but obviously, the conditions of the rendering heating will influence or will give you that proper conditions of the or proper quality it will help maintaining proper quality in the lard ok.

And normally lard and tallows are produced by dry and wet rendering method dry and wet rendering method, but prime steam lard and recently obtained by low temperature wet rendering which gives a better quality lard ok.



So, in this slide it is shown a dry rendering process you can say that carcasses which are obtained. Obviously, they are send here where this steam is supplied for heating it is a disk dryer. So, direct steam is applied to the crust carcasses etcetera ok. The this is obtained that is well to the press where liquid is separated and it is the protein meal is obtained ok.

Protein meal that is the tallows and it is send for the for the process. Whereas, the oil which is obtained here it is send to the decanter and then finally, it is separated and some of the residues etcetera of the solid residue and other things which are there they are by centrifugal separator etcetera and filtered you get the lard here this is the process of dry rendering.

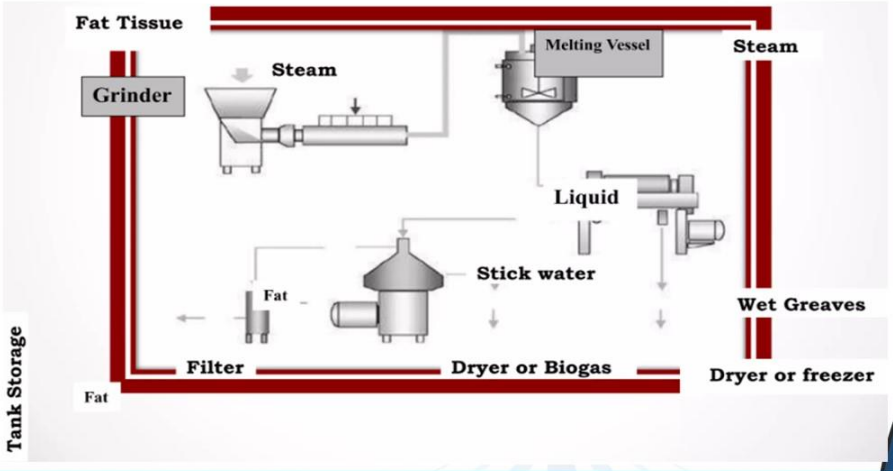
Advantages and disadvantages of dry rendering

- Advantages
  - ✓ Can produce a good quality of tallow.
  - ✓ Recovery of fat is better.
- Disadvantages
  - ✓ Time consuming.
  - ✓ Labor intensive.
  - ✓ Up to 25% of meat is lost in the gravy.
  - ✓ For good tallow, viscera is cut and washed.

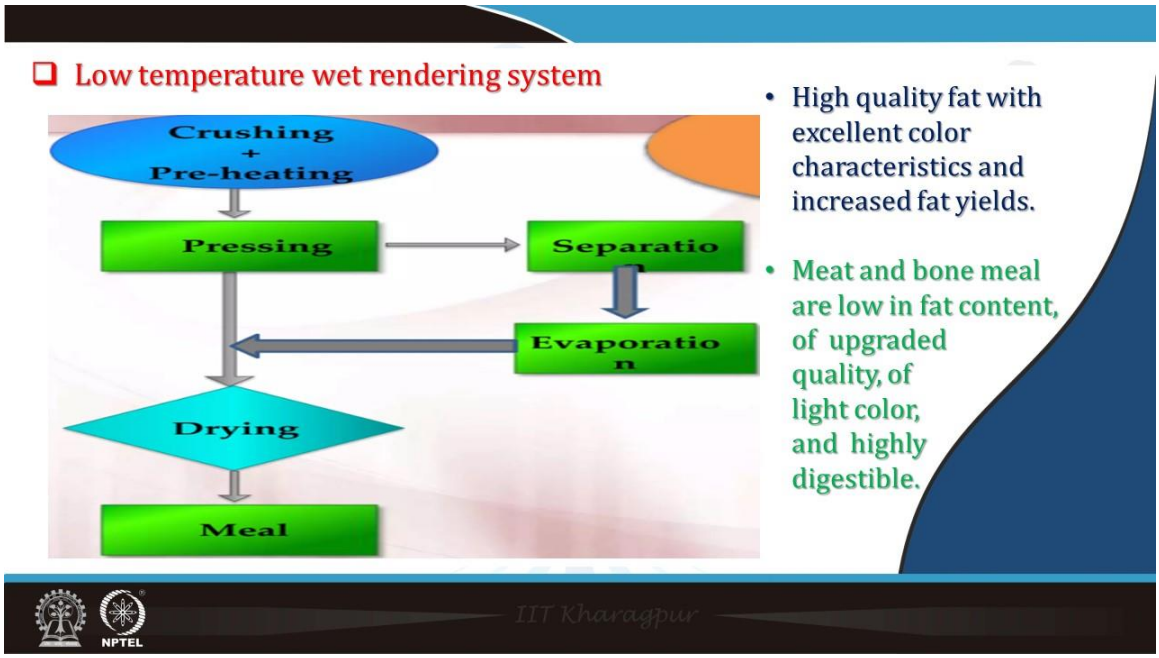
Source: https://www.caloriesecrets.net

So, advantage of dry rendering include that is it can produce a good quality of tallows because not much that is the particularly tallows it is which is obtained after the extraction of the fat it is quality is maintained in the dry rendering process. And also recovery of the fat is better in this case. However, it has the disadvantages like around it is a time consuming process labour intensive up to 25 percent of the meat is lost in the gravy and for good tallows even viscera is a cut and washed making good tallows ok.

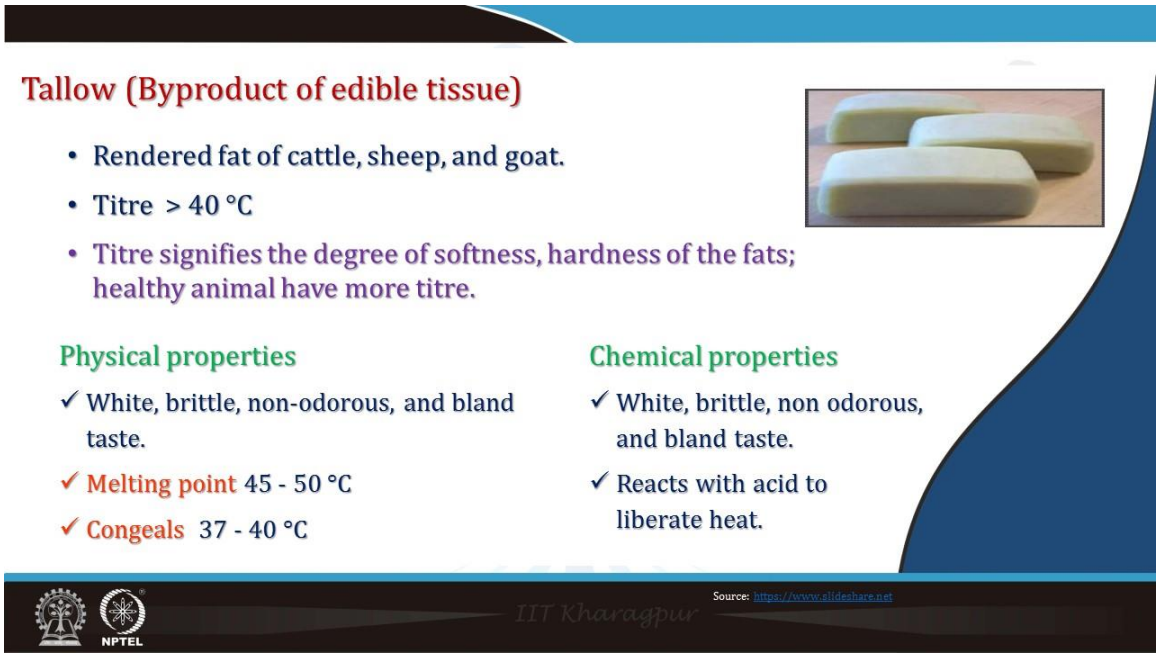
Wet rendering



In the wet rendering process that is the here the fat it is used they are ground and then it is subjected to it is steam and then into melting basis vessel. The liquid is obtained liquid is a water to the dryer freezer and the water and fat is obtained. So, this is a simple there is a dry rendering and wet rendering in the wet rendering there is a wet steam or sometime it is boiling water or the gentle heat is wet heat is applied ok.



So, and in the low temperature wet rendering process that is the crushing and preheating then tracing separating evaporation finally, drying and will these are the steps in low temperature wet rendering process. So, it gives a high quality fat with excellent colour characteristics and increased fat yields meats and bone meals are low in fat content of upgraded quality and they are of high light colour and they are highly digestible. So, low temperature wet rendering process gives a better recovery ok.



Now, the tallow that is byproduct of edible tissue it is rendered fat of cattle, sheep and goat it is tighter is more than 40 degree Celsius that tighter signifies the degree of softness hardness of the fats healthy animal have more tighter ok. Physical properties of the tallow it is white, brittle, non-odorous and bland taste it is melting point is around 45 to 50 degree Celsius and congeals has melting that is congeals are 37 to 40 degree Celsius. It is a white, brittle, non -odorous and bland tasting material it reacts with acid to liberate heat ok.

Tallow Composition and Physical Properties

Characteristics	Typical	Range
Specific gravity, 40°C/water at 20°C	—	0.893 to 0.904
Refractive index, 40°C	—	1.448 to 1.460
Iodine value	45	40 to 49
Saponification number	—	190 to 202
Unsaponifiable matter, %	—	<0.8
Titer, °C	—	40 to 49
Mettler dropping point, °C	46.5	45 to 48
Solidification point, °C	—	
AOM stability, hours	16	—
Oxidative stability index, hours	3.6	—
Fatty acid composition, %		
C-12:0 Lauric	0.2	<0.2
C-14:0 Myristic	4.0	1.4 to 7.8
C-14:1 Myristoleic	0.5	0.5 to 1.5
C-15:0 Pentadecanoic	1.0	0.5 to 1.0
C-16:0 Palmitic	24.3	17.0 to 37.0
C-16:1 Palmitoleic	2.5	0.7 to 8.8
C-16:2 Hexadecadienoic	—	<1.0
C-17:0 Margaric	2.1	0.5 to 2.0
C-17:1 Margaroleic	1.3	<1.0
C-18:0 Stearic	21.4	6.0 to 40.0
C-18:1 Oleic	33.6	26.0 to 50.0
C-18:1 Vaccenic (geometeric *trans*)	4.9	3.4 to 6.2
C-18:2 Linoleic	1.6	0.5 to 5.0
C-18:2 (positional *trans*)	1.1	0.6 to 1.7

Source: O'brien, R. D. (2008).

The tallow composition and physical property if you look here that is a it has around iodine value of 45, it is a metal dropping point is around 46 degree Celsius, it is AOM stability is 16 hours and it is oxidative stability index is around 3.6 hours ok. It has myristic acid around 4 percent, 24.3 percent is around palmitic acid and oleic is 33.6, stearic is 21.2 and margaric acid is 2.1. So, these are the some of the and almost positional transfer at a c-8 into positional transfer at a c-8 around 1.1. This it is a in rumenic that is conjugated trans 0.9 ranges may be around 0.6 to 1.7 and here linolenic is 0.6 and other fatty acids also may be 0.4.

Tallow Composition and Physical Properties (Continued)

Characteristics	Typical	Range
C-18:2 Rumenic (conjugated *trans*)	0.9	0.6 to 1.7
C-18:3 Linolenic	0.6	<2.5
C-20:0 Arachidic	0.2	<0.5
C-20:1 Gadoleic	0.1	<0.5
C-20:4 Eicosatetraenoic	—	<0.5
Other fatty acids	0.4	0.3 to 0.6
Triglyceride composition, %		
SSS Trisaturated	21.5	15 to 28
SUS Disaturated	49.0	46 to 52
SUU Monosaturated	32.5	0 to 64
UUU Triunsaturated	1.0	0 to 2
Crystal habit	β′	
Solids fat index at:		
10.0°C/50°F	36.0	28.5 to 36.5
21.1°C/70°F	23.5	18.0 to 26.0
26.7°C/80°F	21.0	16.5 to 29.0
33.3°C/92°F	15.0	11.5 to 16.0
37.8°C/100°F	9.5	7.0 to 10.5
40.0°C/104°F	7.0	4.5 to 8.0

Notes: S = saturated, U = unsaturated, AOM = active oxygen method.

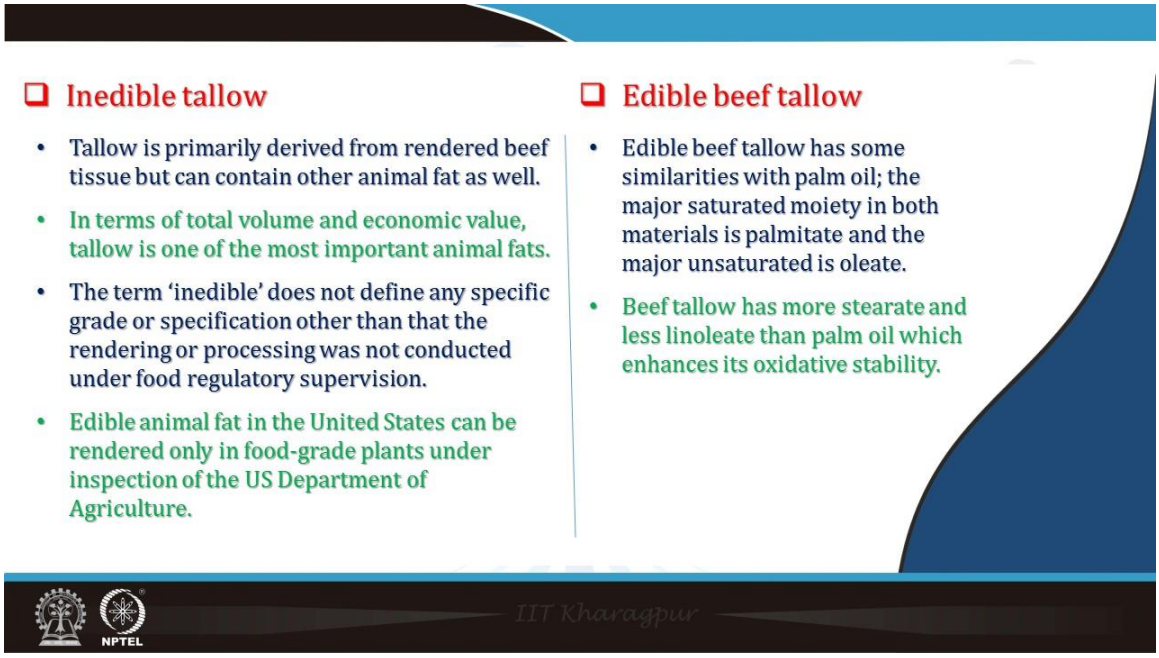
Source: O'brien, R. D. (2008).

The triglyceride composition like SS, S tri saturated fatty acids are 21.5, SUS di saturated 49, SUU monomer saturated 32.5 and UUU tri saturated fatty acids are 1 and here its crystal habit is normally it gives beta dash crystal, beta prime crystal it gives ok and solid two fat index in this case also at 10 degree Celsius its SFI solid fat index is 36 and at 40 degree Celsius its SFI becomes 7. So, as you at higher temperature SFI decreases ok.

Mutton tallow

- Mutton tallow is produced mainly in countries with large stocks of sheep and high consumption of mutton.
- Around 450 million sheep and lambs are slaughtered yearly, yielding >6 MMT of meat.
- Assuming ~3% of fat (living weight), this corresponds to ~0.5 MMT of total fat or ~0.2 MMT of rendered fat.
- The fatty acid spectrum of mutton tallow resembles that of beef tallow with the predominant fatty acids being palmitic, stearic and oleic acid.
- The proportion of trans fatty acids is very high (~10%).

Now, the mutton tallow, mutton tallow is produced mainly in countries with large stock of sheep and high consumption of mutton those areas around 450 million sheeps of and lambs are slaughtered yearly yielding more than 6 MMT of meat ok and assuming 3 percent of fat that is living weight this correspond to approximately 0.5 MMT fat total fat or 0.2 MMT of rendered fat. The fatty acid spectrum of mutton tallow resembles that of beef tallow with the predominant fatty acids being palmitic, stearic and oleic acids. The portion of fat trans fatty acids here of course, is comparatively high and it is around approximately 10 percent.



Then inedible tallow or beef tallow if you make a comparison that is inedible tallow it is primarily derived from rendered beef tissue, but can contain other animal fats as well. In terms of total volumes and economic value, tallow is one of the most important animal fats. The term inedible does not define any specific grade or specification other than that the rendering or processing was not conducted under food regulatory supervision.

Edible animal fat in the United States can be rendered only in food grade plants under inspection of US Department of Agriculture. Edible beef tallow has some similarities with the palm oil, the major saturated moiety in both the materials is

palmitate and the major unsaturated is oleate. Beef tallow has more stearate and less linoleate than palm oil which enhances its oxidative stability.

Usage of tallow can be used in making candles, it can also in making food that is for frying purposes etcetera, in making lubricants and it is also used in mainly medicinal purposes and soups manufacture. Then edible greases, this food grade greases is a lubricant that is formulated using synthetics and delivers high performance without compromising safety and health.

Edible greases

- Food grade grease is a lubricant that is formulated using synthetics and delivers high performance without compromising safety or health.
- Food grade grease is used on
  - ✓ High and slow speed chains
  - ✓ Caster races and bearings
  - ✓ Conveyor bearings
  - ✓ All types of ovens

Food grade greases is used on high and slow speed chains, caster races and bearings, even in making conveyor bearings and all types of ovens, etcetera made using food grade.

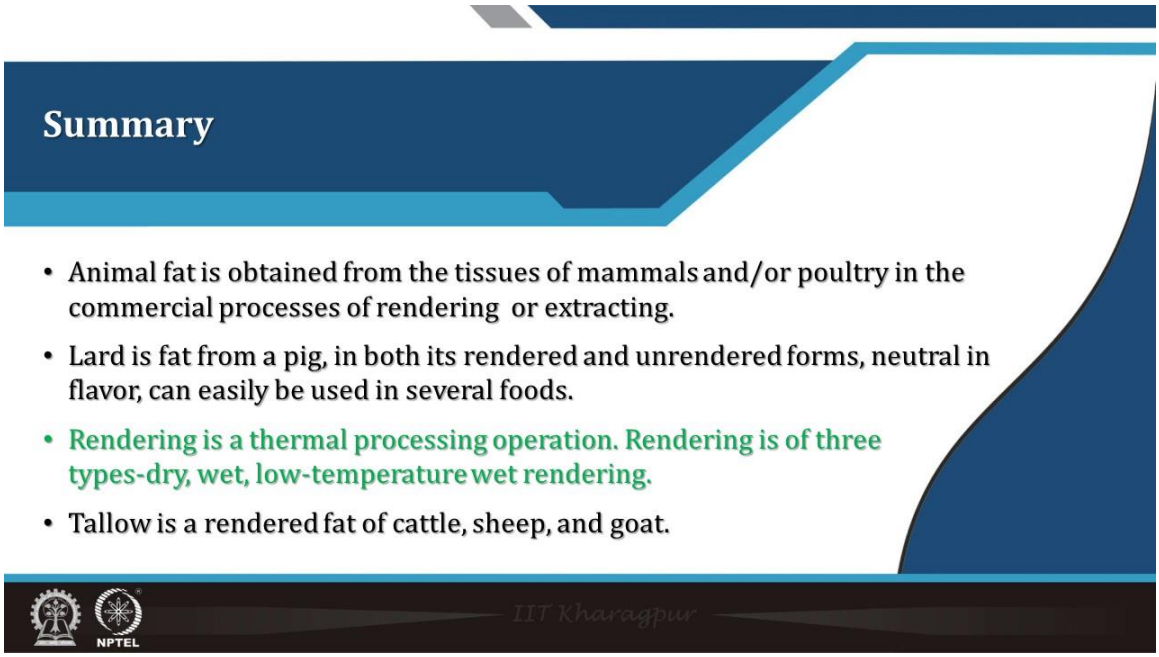
Why is food grade grease used?

- According to the FDA, approximately 48 million people in the U.S. (1 in 6) get sick, 128,000 are hospitalized, and 3,000 die each year from food borne diseases.
- The FDA believes this is preventable, which is why they have instituted the Food Safety and Modernization Act (FSMA).
- The FSMA main concern is focusing on food-borne illness and not only responding to it but preventing it.
- One way to do this is to take note of lubricants used to manufacture and maintain machinery, which up until recently, contained very toxic chemicals like Barium, Lithium and Black Graphite.

Then why is food grade greases used? The FDA has approximately 48 million people in the US, that is 1 in every 6 persons get sick and 128,000 are hospitalized and 3000 die each year from the food world diseases. The FDA believes this is preventable

which is why they have instituted the Food Safety and Modernization Act, it is popularly known as FSMA. The FSMA main concern is focusing on food borne illnesses and not only responding to it, but preventing it. One way to do this is to take note of lubricants used to manufacture and maintain the machinery which up until recently contained very toxic chemicals like barium, lithium, black graphite etcetera.

Food grade greases are used in various food processing equipment and other industrial equipment applications. These include plane and rolling element bearings, joints, linkages and solids centralized lubrication system and enclosed gearboxes. Food grade greases must not only perform the same technical functions as any other lubricant, but they have other demanding requirements including like restricting degradation from food products, chemicals, water and steam etcetera, exhibiting a neutral behavior when in contact with elastomers and plastics and being physiologically inert, odorless, tasteless, non-toxic and harmful. That is harmless, they should not react with the food components and they should not interfere with the odors, tastes and other components of the food material.



Finally, I will summarize this lecture by saying that animal fat is obtained from the tissues of mammals and/or poultry in the commercial process of rendering or extracting. Lard is a fat from pig in both its rendered and un-rendered form. It is neutral in flavor and can easily be used in several foods. Rendering is a thermal processing operation of three types dry rendering, wet rendering and low temperature wet rendering. Tallow is a rendered fat of cattle, sheep and goat.

These are the references used in this lecture.

Thank you very much for your attention. Thank you.