Lipids





Plan

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Lipids

They have common physical and chemical property. Lipids are not soluble in water and soluble in non-polar organic solvents. "Lipos" is Greek and means fat.

fats, waxes, complex lipids, isoprenoids, steroid, carotenoids, prostaglandins, chlorophyll

Physical chemical classification

Function of the second state of the second

non-hydrolysable lipids (isoprenoids, steroid, carotenoids, prostaglandins, chlorophyll etc.).

Lipids (fixed oils, fats, complex lipids and waxes) are esters of long-chain fatty acids and alcohols, or of closely related derivatives. The chief difference between these substances is the type of alcohol; in fixed oils and fats, glycerol combines with the fatty acids; in waxes, the alcohol has a higher molecular weight, e.g., cetyl alcohol $[CH_3(CH_2)_{15}OH]$.

Biosynthesis of lipids

 The biosynthesis of saturated and unsaturated fatty acids is from combinations of acetate units (acetate pathway).

Fats and oils are made from two kinds of molecules: <u>glycerol</u> (a type of alcohol with a hydroxyl group on each of its three carbons) and three fatty acids joined by dehydration synthesis. Since there are three fatty acids attached, these are known as triglycerides.



Triglyceride





where R, R', and R" are long <u>alkyl</u> chains;

- The linkage between a fatty acid and glycerol is called an acylglyceride linkage. Thus, a fat is a triacylglyceride.
- If R, R', and R" are palmitic acids (the same fatty acid radical), the compound is called tripalmitin .
 - If R, R', and R" are different fatty acids (1- stearic, 2- oleic,), the compound is called stearindiolein₈. © CNC Department, NUPh, 02.09.2015

Classification of fatty acids

Fatty acid	Structure	Short name	
Saturated fatty acids			
Palmitic	CH ₃ (CH ₂) ₁₄ COOH	16:0	
Stearic	CH3(CH2)16COOH	18:0	
Unsaturated fatty acids			
Oleic	$CH_3(CH_2)_7CH = CH(CH_2)_7COOH$	18:1 (9cys)	
Linoleic	$CH_3(CH_2)_4(CH=CHCH_2)_2(CH_2)_6COOH$	18:2 (9cys,12 cys)	
Linolenic	CH ₃ CH ₂ (CH=CHCH ₂) ₃ (CH ₂) ₆ COOH	18:3 (9 cys12 cys,15 cys)	
Ricinoleic ⁽	CH ₃ (CH ₂) ₅ CHOHCH ₂ CH=CH(CH ₂) ₇ COOH	18:1(9 cys,12OH)	

The terms <u>saturated</u>, <u>mono-</u> <u>unsaturated</u>, and <u>poly-unsaturated</u> refer to the number of hydrogens attached to the hydrocarbon tails of the fatty acids as compared to the number of double bonds between carbon atoms in the tail.

<u>Fats</u>, which are mostly from <u>animal sources</u>, have all single bonds between the carbons in their fatty acid tails, thus all the carbons are also bonded to the maximum number of hydrogens possible.

I. Lipids: essential fatty acids



(CH₂)₆COOH

Physical and chemical

properties The "tail" of a fatty acid is a long hydrocarbon chain, making it hydrophobic. The "head" of the molecule is a carboxyl group which is hydrophilic. Fatty acids are the main component of *soap*, where their tails are soluble in oily dirt and their heads are soluble in water to emulsify and wash away the oily dirt. However, when the head end is attached to glycerol to form a fat, that whole molecule is hydrophobic.

 H_2

Since the fatty acids in these triglycerides contain the maximum possible amount of hydrogens, these would be called *saturated fats*.

- The hydrocarbon chains in these fatty acids are, thus, fairly straight and can pack closely together, making these *fats solid at room* temperature.
 - Oils, mostly from plant sources, have some double bonds between some of the carbons in the hydrocarbon tail, causing bends or "kinks" in the shape of the molecules.
- Because some of the carbons share double bonds, they're not bonded to as many hydrogen as they could if they weren't double bonded to each other. Therefore these oils are called *unsaturated* fats.
 - Because of the kinks in the hydrocarbon tails, unsaturated fats (or oils) can't pack as closely together, making them *liquid at room* temperature. © CNC Department, NUPh, 02.09.2015 13

Although most vegetable oils are liquid at ordinary temperatures and most animal fats are solid, <u>there</u> <u>are notable exceptions</u>, such as cocoa butter, which is <u>a solid vegetable oil</u>, and cod liver oil, which is <u>a</u> <u>liquid animal fat</u>.

Fixed oils (Plants)	Fats (Animals)
1) <i>Liquid oil</i> Fixed oil, consist of unsaturated fatty acids	1) Liquid oil
Olive oil	Fish oil
2) Solid oils Cacao butter	1) <i>Fats (solid)</i> , consist of saturated fatty acids
	Swine fat (Lard).

In unsaturated fatty acids, there are two ways the pieces of the hydrocarbon tail can be arranged around a C=C double bond (*cis* and *trans*).

- In <u>cis bonds</u>, the two pieces of the carbon chain on either side of the double bond are either both "up" or both "down," such that both are on the same side of the molecule.
 - In <u>trans bonds</u>, the two pieces of the molecule are on opposite sides of the double bond, that is, one "up" and one "down" across from each other.

Naturally-occurring unsaturated
 vegetable oils have almost all cis
 bonds, but using oil for frying causes
 some of the *cis* bonds to convert to
 trans bonds.

If oil is used only once like when you fry an egg, only a few of the bonds do this so it's not too bad. However, if oil is constantly reused, like in fast food French fry machines, more and more of the cis bonds are changed to trans until significant numbers of fatty acids with trans bonds build up. The reason for this concern, is that fatty acids with trans bonds are carcinogenic, or cancer-causing.

Production of fixed oils and fats

Fixed oils and fats of vegetable origin are obtained by:

1. Expression

Fixed oils are obtained by expression in hydraulic presses. If the expression is carried out in the cold, the oil is known as a "<u>virgin oil</u>" or a "cold-pressed oil." In contrast, if the expression is carried out in heat, the oil is known as a "hot-pressed oil."

2. Extraction by solvents

Sometimes organic solvents are used for the extraction of oils.

Animal fats are separated from other tissues by rendering with steam, with or without pressure. The heat melts the fat, which rises to the top and may be separated by decantation.

Oils may be further clarified by filtration and bleached with ozone. Stearins are often removed by chilling and filtration.

Applications of fixed oils and fats

- 1. Soap manufacture
- 2. Suppositories, tablet coating
- 3. Dietary supplements
- 4. Emulsifying agents
- 5. Manufacture of paints, varnishes and lubricants
- 6. Therapeutic uses (castor oil).

Fixed oils are also classified into :

- 1. drying oils (Linseed oil)
- 2. semidrying oils (Sunflower oil)
- 3. nondrying oils (Olive oil)

By the process of hydrogenation liquid oils converts to solid or semisolid fats.

Physical chemical properties

- Fats and fatty oils are greasy to the touch, on a paper left a spot,
- The colour of oils depends on a way of their obtaining. The majority of oils have white or light yellow colour. The oils are yellowish due to presence of carotenoids, greenish, if contain chlorophyl.
- An odor and taste are specific.
- All fats are lighter than water, the gravity of fats and oils arrange in limits 0,910 — 0,975 g / см3.
- The majority of fats is melted in an interval from 22 up to 55 0C.
 - A boiling temperature for fats are not determine, as they are destroyed at 250 0C with formation of aldehyde acrolein:

Physical indexes Refractive index Density Solubility

Chemical indexes

Acid value
Saponification value
Ether number
Iodine number

To determine the identity, quality, purity of fixed oils we use:-

- acid value:- the number of milligrams of KOH required to neutralized the free fatty acids in 1 g of the substance.
 - 5,61 . n
- IA = ----- =

m

IS = ----- =

m

 saponification value:- the number of milligrams of KOH required to neutralized the free fatty acids and saponify the esters contained in 1g of the substance.

 $C_3H_5(COOR)_3 + 3 \text{ NaOH} \longrightarrow C_3H_5(OH)_3 + 3 \text{ R} \cdot \text{COONa}$ $28,05 \cdot (n2 - n1)$

An ether number (IE) is calculated on a formula:

IE = IS - IA

where: IS is a saponification value; IA is an acidvalue.

Iodine number :- the number of grams of I₂ absorbed by 100 g of the substance.

Indicates the degree of unsaturation.

Fixed oils and fats are employed in pharmaceutical industries as:

- emollient;
- vehicle for other medicaments;
- r soap manufacture;
- Iubricants;
- r food industries.

Olive oil – Oleum Olivarum Fructus Oleae European olive - Olea europaea L. Fam.- Oleaceae

★Act.const.
>Oil (50-70%);
>Cyanidin.

May be obtained by:Cool pressing
Hot pressing

***Usage :-**Cholagouge , Emollient , Laxative. Solvent for injections. Anti-allergy soaps. Liniments . Food industry .

Almond oil – Oleum Amygdalarum Almond – Amygdalus communis L. Fam. - Rosaceae

Act.const.
Oil (20-60%):Trioleine
Enzymes , Emulcin
Amygdalin

May be obtained by:Cool pressing
Hot pressing

Solvent for injections.
Emollient. Ingredient in cosmetics.
Anti-allergy soaps. Liniments

Peach oil – Oleum Persicorum Apricot kernel oil, Peach kernel oil, Plum kernel oil,-Persica vulgaris Mull. Fam. – Rosaceae * Act.const. ≻Oil (till 60%): Trioleine >Enzymes Emulcin; Amygdalin May be obtained by:-

Cool pressing from kernels of Peach, Apricot, Plum. *Usage :-Solvent for injections. Emollient, Ingredient in cosmetics, Liniments

Castor Oil – Oleum Ricini Castor seed – Semina Ricini Castor bean – Ricinus communis L. Fam - Euphorbiaceae

* Act.const.

Oil (40-60%): Triricinoleine, ➤ Enzyme Lipase;

Proteine (till 20%);

≻Toxic lectin (ricin) (till 1%) glycoprotein

>Alkaloid (ricinine).

May be obtained by: Hot pressing (to destroy ricin)
Usage:

Laxative, one of the component of *Urolesan*, *Essenciale*.

Sunflower oil – Oleum Helianthi– Sunflower seeds Semina Helianthi Sunflower– Helianthus annus L. Fam. Asteraceae

* Act.const.

Oil (up to 35%): Triglyceride of linoleic and linolenic acids

- ➤ Carbohydrates (24-27%);
- > Protein (13-20%);
- > Chlorogenic acid (до 2%);

Carotenoids (up to 11 mg/100 g).May be obtained by cool pressing.

***** Usege:

Cholagogue The oil is used for culinary purposes, and it is base for liniments. © CNC Department, NUPh, 02.09.2015

Corn Oil– Oleum Maydis Embryos of corn– Embryonis Maydis Corn– Zea mays L. Fam . Poaceae

* Act.const.

*****Usage:

>Oil (up to 60%): Triglyceride of linoleic and oleinic acids;

>Protein (13-18%);

Carbohydrates: Starch (up to 70%);

>tocopherol and caroteneMay be obtained by: cool expression.

Hypocholesteremic, cholagouge.

As a component of a number of specialty dietary supplements. Liniments. Food industry. © CNC Department, NUPh, 02.09.2015

Pumpkin oil – Oleum seminis Cucurbitae Pumpkin seed-Semina Cucurbitae Pumpkin – Cucurbita pepo L. Fam. – Cucurbitaceae

* Act.const.

>oil (50%): Triglyceride of palmitic and stearic acids (30%), oleic (25%) and linolenic (45%) acids; >phytosterins: campesterol, stigmasterol, cucurbitol;

≻aminoacid: cucurbitin (до 11%) Witamin B group, C, E, carotenoid, Organic acids.

* Usege:-

Seeds – anthelmintic agent,

oil and phytomedicine, containing oil – Cholagouge, Hypocholesteremic, - to treat prostatitis.

NH,

Linseed oil - Oleum seminisLini Linseed- Semina Lini Linseed - Linum usitatissimum L. Fam. Linaceae

* Act.const.

> Oil 35-45%: Triglycerides of oleic,
 linoleic, linolenic, palmitic, stearic acids;

> About 3-10% mucilage, localized in the epidermis;

- Ensyms;
- > Cyanogenic glucosides : linamarin;
- Protein (18-33%);
- >Carotenoid,

>Organic acids.

May be obtained by: cool expression.

Usage:

(Oleum Lini) - Hypocholesteremic, reparative; «Linetol» is recommended to treat atherosclerosis.

Soybean oil Oleum Sojae Soybean seeds-Semina Glycine Soybean – Glycine hispida (Moench.) Maxim. Fam. Fabaceae

* Act.const.

Oil (up to50%): Triglycerides of linolic, oleic, palmatic and linolenic acids;

Proteins (30-40%);

Phospholipids: lecithins, cephalin;

Ænszyme- urease;

Hsoflavones glycosides;

CH2-O-C-R' CH-O-OH <u>с</u>–р–о–х CH2-O

0

* Usage

Component of : *«Essenciale»* - hepatoprotective

Food industry

Cacao butter – Butyrum Cacao (Oleum Cacao) Cacao seeds or cacao beans – Semina Cacao Cacao tree – Theobroma cacao L. Fam. – Sterculiaceae

* Act.const.

Solid fat: Triglycerides of stearic,
 laurinic, palmatic, oleic acids
 Theobromine, caffeine

May be obtained by hot expression.Usage: - a suppository base.

Cod-liver oil or fish oil - Oleum Jecoris Cod- Gadus callarias L., Fam. Gadidae.

*Act.const.

- Oil 50%: Triglycerides of unsaturated acids chiefly docosahexaenoic and eicosapentanoic acids .

vitamines: A and D2,

- Lecithin
- microelement: Fe, Mg, Ca, Mn, Cl, Br, J
- Usage:-
- is emploued as nutritive and is particulary valuable in rickets and tuberculosis.

Waxes – are esters resulting from condensation of high-molecularweight acids ($C_{24} - C_{36}$) and high-molecular-weight alcohols ($C_{16} - C_{36}$), also waxes may contain paraffins.

Classification

•Plant waxes :- Jojoba .

•Animal waxes:- Bee wax, spermaceti, lanolin

Plant waxes

Jojoba oil is a liquid wax expressed from seeds of *Simmondsia chinensis*(Link) Scheider (Fam. Buxaceae). The plant is a bushy shrub native to the arid regions of northern Mexico and to the southwestern United States.

*Act.const.

45 to 55% of an <u>ester mixture</u> (not triglycerides)

The major components are eicosenoic acid and alcohols (eicosenol, decosenol).

*****Usage.

Emollients and agents of pharmaceutic necessity.

Yellow wax or beeswax

alkyl esters s (about 72%), chiefly myricyl palmitate;
free wax acids (about 14%), especially cerotic acid and its homologs;
hydrocarbons (12%);

minor constituents, including pollen, and propolis (bee glue).

*****Usage.

Wax is a stiffening agent and is an ingredient in ointments and in cold creams. It is also used as a base for cerates and plasters. Commercially, it is contained in a

number of polishes.

Wool fat Lanolin

is the purified, fetlock substance from the wool of the sheep. Ovis aries Linne.

✤ Usage. Lanolin is used as a water-absorbable ointment base. Lanolin is an ingredient in many skin creams and cosmetics

Spermaceti (Cetaceum)

is a waxy substance obtained from the head of the whale (*Physeter macrocephalus L*.)

Spermaceti consists of a mixture of hexadecyl esters of fatty acids

 Usage. Spermaceti is a emollient ingredient of ointments, creams and other cosmetics.
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The prostaglandins

The prostaglandins are a group of modified C20 fatty acids.

The basic prostaglandin skeleton is that of a cyclized C20 fatty acid containing a cyclopentane ring, a C7 side-chain with the carboxyl function, and a C8 side-chain with the methyl terminus.

Prostaglandins are biosynthesized from three essential fatty acids,

- eicosatrienoic acid (dihomo-γ-linolenic acid),
- eicosatetraenoic acid (arachidonic acid),
- eicosapentaenoic acid,

which yield prostaglandins of the 1-, 2-, and 3- series, respectively.

The prostaglandins are now known to occur widely in animal tissues, but only in tiny amounts.

The prostaglandins are active at very low, <u>hormone-like</u> concentrations and can regulate <u>blood</u> <u>pressure</u>, <u>contractions of smooth muscle</u>, <u>gastric</u> <u>secretion</u>, and <u>platelet aggregation</u>.

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