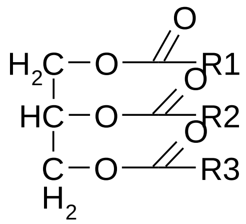
Lecture "FATS AND FAT-LIKE SUBSTANCES"

Fats are complex mixtures of organic substances of plant and animal origin, which are mainly mixtures of various glycerides, i.e., esters of glycerol and high-molecular-weight fatty acids, with the general formula:



R_1, R_2, R_3 - radicals (fatty acid residues)

Fats are multi-component lipids.

Glycerides (acylglycerols) are single-acid: R1=R2=R3 and multi-acid (mixed): R1≠R2≠R3.

Single-acid triglycerides are rare in nature. Examples are olive oil (glycerol esterified with oleic acid) and castor oil (glycerol esterified with ricinoleic acid).

The vast majority of fats are mixtures of various glycerides. Currently, there are over 1,300 different fats known, differing in their fatty acid composition.

More than 200 fatty acids have been identified in natural fats. Fatty acids typically have one carboxyl group and an unbranched hydrocarbon chain with an even number of carbon atoms, ranging from 8 to 24.

The most common:

1. *Marginal or saturated acids* ($C_nH_{2n+1}COOH$):

$C_{15}H_{31}COOH$ - palmitic acid;

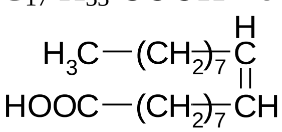
$C_{17}H_{35}COOH$ - stearic acid.

2. *Unsaturated or monounsaturated acids.*

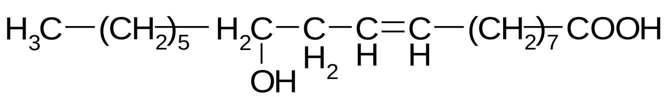
In most vegetable oils, the double bond is located between the 9C and 10C atoms of the carbon chain. If there are more than one double bond (the number of double bonds can range from 1 to 9), they are usually located every three carbon atoms. The carbon chain fragment adjacent to the carboxyl group ($={}^{9}CH$ - (CH2)7 - COOH) is free of double bonds.

2.1. *Acids with a one double bond:*

$C_{17}\ H_{33}\ COOH$ - Oleic acid occurs naturally in the cis form:



$C_{17}H_{32}OHCOOH$ - ricinoleic (oxyoleic) acid:



2.2. *Acids with two double bonds:*

$C_{17}H_{31}COOH$ - linoleic acid:

$$CH_3\text{-}(CH_2)_4\text{-}{}^{13}CH={}^{12}CH\text{-}{}^{11}CH_2\text{-}{}^{10}CH = {}^{9}CH\text{-}(CH_2)_7\text{-}COOH$$

2.3 *Acids with three double bonds:*

$C_{17}H_{29}COOH$ - linolenic acid:

$CH_3 - CH_2 -{}^{16}CH ={}^{15}CH - CH_2 -{}^{13}CH ={}^{12}CH - CH_2 -{}^{10}CH={}^{9}CH - (CH_2)_7 - COOH$

There are fatty acids that have more than three double bonds. For example, fish oil contains arachidonic acid, which has four double bonds, and marine animal fat contains clupadonic acid, which has five double bonds.

In addition to triglycerides, fats contain sterols (phytosterols and zosterols, respectively), pigments (chlorophyll and carotenoids), fat-soluble vitamins (A, E, D, K, and F), free fatty acids, proteins, mucus, and other substances.

There are several classifications of fats:

1. By chemical composition (single-acid and mixed).
2. By origin (plants and animals).
3. By consistency solid (dense) and liquid (soft).
4. By physical and chemical properties (by the property of drying) - drying, semi-drying, non-drying.

Physical properties. Fats at normal temperature have a dense or soft consistency. Fatty oils are thick, transparent liquids.

Fats leave a greasy stain on paper, which spreads even more when heated (unlike essential oils).

The color, smell and taste of fats depend on the accompanying substances. The coloration is more often white or yellowish. The smell is absent or faint, specific. The taste is delicate and buttery, less often unpleasant, like castor oil.

Fats are lighter than water, with a density of 0.910 to 0.970.

Most fats are optically inactive. The exception is castor oil.

The refractive index (refraction coefficient) is characteristic and constant for each oil. For example, olive oil has a refractive index of 1.46-1.71. The higher the molecular weight of the glycerides and the more double bonds, the higher the refractive index.

All fats are insoluble in water, slightly soluble in ethanol, and easily soluble in ether, chloroform, and petroleum ether. The exception is castor oil, which is easily soluble in 96% ethanol and difficult to dissolve in petroleum ether.

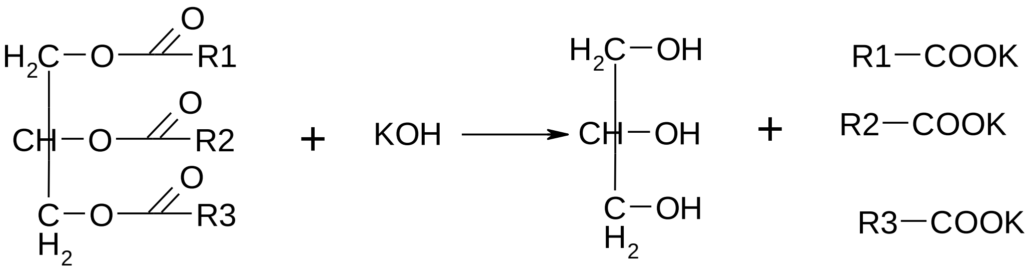
Fats themselves are good solvents for many drugs (camphor, hormones, essential oils, etc.). Fats mix well with each other.

The chemical properties of fats are due to the presence of:

1) complex etheric bonds;
2) double bonds in hydrocarbon radicals of fatty acids;
3) the presence of glycerin in the fat.

1.1. Fats are easily hydrolyzed by enzymes to form glycerol and fatty acids. Enzymatic hydrolysis occurs in stages. Lipase is found in all seeds of oil-bearing plants. Hydrolysis is facilitated by moisture and high temperatures. This leads to hydrolytic rancidity of the fat. This property is taken into account during the storage of fats.

1.2. Fats are broken down by alkalis to form glycerol and fatty acid salts. Salts are called soaps: potassium soaps are liquid, and sodium soaps are solid. The process is called saponification.



The property is used in the analysis of fats. It is the basis for the production of soaps and shampoos.

2. Hydrogen, halogens, and oxygen can be attached to double bonds of fatty acids.

2.1. Hydrogenation of fats (hydrogenation of fats) occurs at elevated temperatures in the presence of a catalyst (nickel). Unsaturated fatty acids are converted into saturated fatty acids, and liquid oils are transformed into solid oils. This process produces fatty oils, which are used in medical practice as ointment and suppository bases (butyrol) and in the food industry (margarine production).

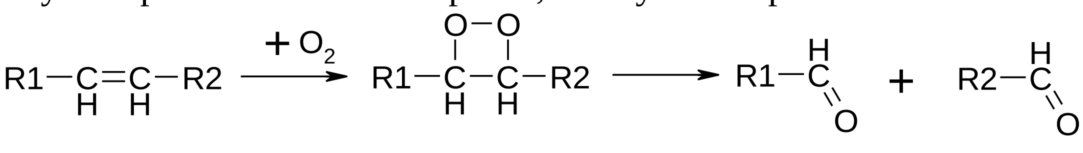
2.2. The addition of halogens is used in the analysis of fats to determine the chemical constant, the iodine number.

2.3. The addition of oxygen from the air leads to the oxidation and rancidity of fats. There are two types of oxidation: chemical oxidation (aldehyde oxidation) and biochemical oxidation (ketone oxidation) caused by microorganisms.

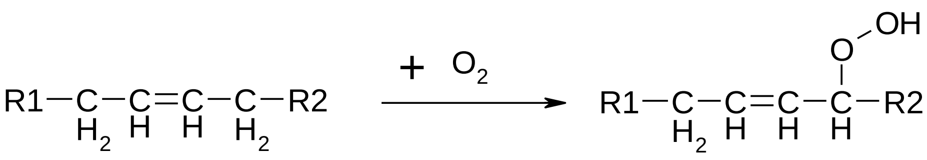
Fats acquire a specific taste and odor and become unsuitable for consumption. The color of the fat changes (often, the fat becomes colorless), and its physical and chemical properties also change: the density and acid number increase, while the iodine number and viscosity decrease.

There are 3 types of oxidative rancidity:

a) non-enzymatic - oxygen is attached to double bonds, forming peroxides; when fatty acid peroxides are decomposed, aldehydes are produced.



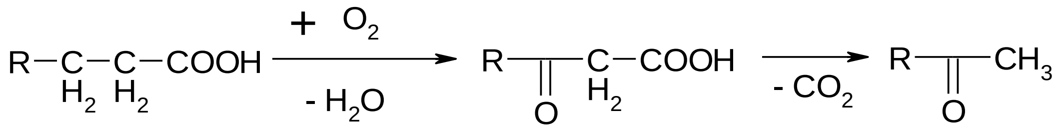
b) enzymatic, involving lipoxidases and lipoxygenases, which produce hydroperoxides.



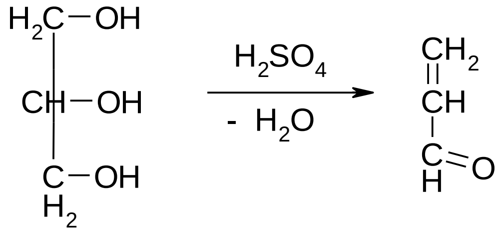
Hydroperoxides are capable of oxidizing biologically active substances contained in oil, such as carotenoids. Hydroperoxides undergo decomposition to form aldehydes and ketones.

This property is taken into account during the storage and analysis of fats.

c) enzymatic (ketone) oxidation occurs with the participation of microorganisms.



3. Glycerol, which is part of the fat, undergoes oxidation and dehydration when the fat is heated with concentrated sulfuric acid. This results in the formation of acrolein, an unpleasant-smelling aldehyde. The acrolein test is used to distinguish between fats and fat-like substances.



Drying is a complex physical and chemical process. When oil is exposed to air for a long enough time, it undergoes oxidation, condensation, polymerization, and colloidal transformations. As a result, a transparent, resin-like, elastic, or solid film forms on the surface of the oil.

Oils that do not form a film are known as non-drying oils. The main component of these oils is oleic acid glycerides (with a single double bond).

Oils that form soft films are called semi-drying oils. The main component in these oils is linoleic acid glycerides (with 2 double bonds).

Oils that form a thick film are called drying oils. The main component in these oils is linolenic acid glycerides (with 3 double bonds).

The spread of fats in nature.

Fats are widely distributed in plant and animal organisms. Fats are part of all plant and animal cells.

For practical use, plants and their organs where fats accumulate in increased quantities are important. In plants, fatty oils are mainly accumulated in fruits (olive, sea buckthorn) and seeds (flax, sunflower, corn, etc.). Their content varies from 2-3% to 70% and higher.

In seeds, fats are localized mainly in the cells of the parenchyma tissue of the endosperm; they are in a very finely dispersed state, in the form of an emulsion with proteins and carbohydrates. In a living plant, fats are always present in a liquid state.

Plants of many families, especially the Asteraceae, Cruciferae, Apiaceae, Rosaceae, Euphorbiaceae, Papaveraceae, Lamiaceae, and others, accumulate fats.

In the animal body, fat is stored in special fat cells in the subcutaneous tissue and in the omentum. The liver of some animals and fish (cod liver) is rich in fat.

The process of fat formation and accumulation depends on environmental factors and the genetic characteristics of species and cultivars. Plants in northern and temperate regions produce fats rich in unsaturated acid radicals, while plants in southern regions, subtropical zones, and tropical regions often produce fats with a dense consistency and high levels of saturated acid triglycerides.

Increased moisture content and the use of potassium and phosphorus fertilizers have a positive effect on the accumulation of fats, increasing the oil content by 4-5% or more. At the same time, the quality of the oil changes, with an increase in the amount of unsaturated acids. In contrast, nitrogen fertilizers reduce the synthesis of fats and promote the synthesis of protein. On fertile soils, the accumulation of fats is also reduced.

Methods of extracting fats from raw materials and their purification

Fats are extracted from oil plants by pressing or extraction. Pressing can be cold or hot.

For medical purposes, the oils are obtained by cold pressing, i.e. without roasting the seeds and in cold presses. At the same time, the oil output is lower and the quality is better. This method produces oils used for parenteral use (almond, peach, i.e. non-drying oils).

Oils obtained by hot pressing are contaminated with foreign substances (resins, phytosterols, and proteins) and have a slightly acidic reaction due to the partial breakdown of triglycerides. They are used after purification for external and internal applications, but not for parenteral use.

Fat extraction is carried out using gasoline, hexane, dichloroethane, and other extractants. The resulting oils have an unpleasant taste and odor. They are used in technical applications and are not used in medicine.

The production of animal fats is carried out by thawing. There is a distinction between wet and dry methods. According to the first method, raw materials are treated with hot steam at a pressure of 3-4 atm or in autoclaves. According to the second method, the fat is melted over an open fire. The melted fat is drained into settling tanks to separate water and proteins. To improve the quality of fat, it is further melted, defended, and refined.

Fat purification (refining) is carried out to remove impurities trapped in the fat during its production. The purification method depends on the nature and composition of the impurities. Refining methods:

1. The mechanical method involves settling, centrifugation, and filtration, which helps to separate mechanical impurities (such as fragments of parenchyma and vessels).

2. The coagulation method is used to remove protein and mucus substances. It involves passing hot steam at a temperature of around 60°C. After coagulation, the fat is settled and filtered.

3. Neutralization method (alkaline cleaning) - to remove free fatty acids. At the same time, fats are clarified. Soaps are washed with water.

4. Freezing method - to remove saturated fatty acid glycerides from non-drying medical oils used for parenteral application.

To remove foul-smelling substances (volatile fatty acids), the deodorization method is used. The oil is treated with superheated steam under vacuum. Medical oils are not deodorized with oxidizing agents.

Fat storage

Fats are stored in glass or metal containers filled to the top, without access to oxygen, moisture and direct sunlight. It is stored in a cool and clean room, in conditions that do not allow the development of microorganisms. They are stored according to the general list.

In medical practice, fats are used that must be standardized, i.e. meet the requirements of GPA 1.5.2.0002. SP XV edition. The purpose of the analysis is to establish the authenticity (correspondence to the nature of the oil) and quality (correspondence to the requirements of the National Standard) of the fatty oil.

Authenticity is characterized by the quantitative ratio of triglycerides, the qualitative composition of fatty acid radicals, and the presence of accompanying substances typical for this oil.

To establish authenticity, organoleptic and numerical indicators are determined, and specific reactions are performed.

1. Organoleptic indicators: color, taste, and smell.

The color and transparency of liquid fats are determined by placing the test oil in a transparent glass cylinder and observing it in daylight.

The taste and smell are determined by spreading the oil on filter paper.

2. Numerical indicators are physical and chemical constants.

Physical constants include solubility in ethyl alcohol, melting point for solid fats, density, and refractive index. These constants are characteristic and constant for each oil.

Solubility depends on the composition and structure of triglycerides. Triglycerides of low-molecular-weight saturated fatty acids dissolve quite well in ethyl alcohol. Triglycerides of high-molecular-weight saturated acids dissolve in alcohol only when heated to 60 °C. Triglycerides of unsaturated acids practically do not dissolve in alcohol.

The melting point (solidification) depends on the structure of triglycerides. Cocoa butter (olein-stearin-palmitin) melts at 30-34 °C. Castor oil solidifies into a white ointment-like mass when cooled to -16 °C.

Density - by this constant, you can judge not only the authenticity of this oil, but also to which group it belongs:

- in oils non-drying density 0.913-0.925;

in oils drying density 0.920-0.940.

Density is determined using a pycnometer in accordance with the requirements of the OFS "Density".

Refractive index - The refractive index, in combination with other indicators, can be used to distinguish one fat from another. For example, the refractive index of olive oil is 1.46-1.71, while that of flaxseed oil is 1.48-1.87. The higher the number of double bonds and the higher the molecular weight of the glycerides, the higher the refractive index. Determined in accordance with the requirements of the General Pharmacopoeia "Refractometry".

pH. The pH of the aqueous extract of fatty oil should be between 5.8 and 7.0. Determined in accordance with the requirements of the General Pharmacopoeia "Ionometry". A sample of oil weighing between 2.0 and 5.0 g (the specific weight of the sample should be specified in the pharmacopoeia article or regulatory documentation) is shaken for 10 minutes with 25 ml of water.

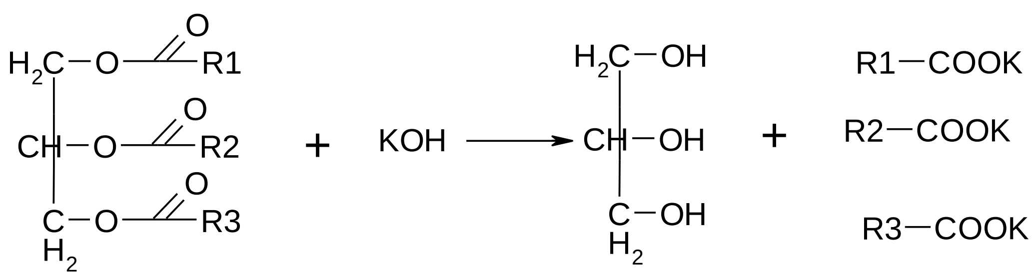
Chemical constants: acid number, ether number, saponification number, iodine number, and peroxide number.

The acid number (AN) is the amount of mg of potassium hydroxide required to neutralize the free acids present in one gram of the fat being tested. It is determined by direct alkalimetric titration after dissolving the oil in a mixture of ethanol and ether. The indicator used is phenolphthalein. The acid number of fatty oils intended for the preparation of parenteral medicines should not exceed 0.56.

$C_{15}H_{31}COOH + KOH = C_{15}H_{31}COOK + H_2O$

The saponification number (S.N.) is the amount of mg of potassium hydroxide required to neutralize free acids and saponify the esters contained in 1 g of the oil under study. It is determined by the reverse titration method. The excess KOH is titrated with a HCl solution. The indicator is phenolphthalein.

$C_{15}H_{31}COOH + KOH = C_{15}H_{31}COOK + H_2O$



$KOH + HCl = KCl + H_2O$

The saponification number characterizes the average molecular weight of glycerides and is inversely proportional to it. A significant portion of medical fats is composed of a mixture of palmitic, stearic, oleic, linoleic, and linolenic acids, which have similar molecular weights, resulting in similar saponification numbers for medical fats, typically ranging from 170 to 200.

The ether number (e.n.) is the amount of mg of caustic potassium required to neutralize the acids formed during the hydrolysis of the esters contained in 1 g of the fat being studied.

The iodine number (i.n.) is the amount of grams of iodine bound by 100 g of the substance under study.

This indicator characterizes the average degree of unsaturation of the fatty acid radicals of glycerides, revealing the ratio of saturated and unsaturated acids in the oil.

The value of the iodine number can be used to determine the drying properties of the oil:

- The iodine number of solid fats ranges from 20 to 60 (the iodine number of cocoa butter is 32-38).
- The iodine number of non-drying oils is 80-100.
- The iodine number of semi-drying oils is 110-160.
- The iodine number of drying oils is 170-200.

The GPh XI offers a iodochlorometric method for determining the iodine value. The GPh X offers two methods for determining the iodine value: iodobromometric and iodochlorometric. These methods are titrimetric (reverse titration) and are based on the ability of fatty acid radicals in the oil to attach halogens to double bonds.

The oil is dissolved in an organic solvent, and an excess of iodine monochloride (iodine monobromide) is added. Halogens are gradually added to the double bonds, starting with the double bonds farthest from the ether group.

$R – CH{=}CH – R_1 + ICl = R – CHI – CHCl – R_1$

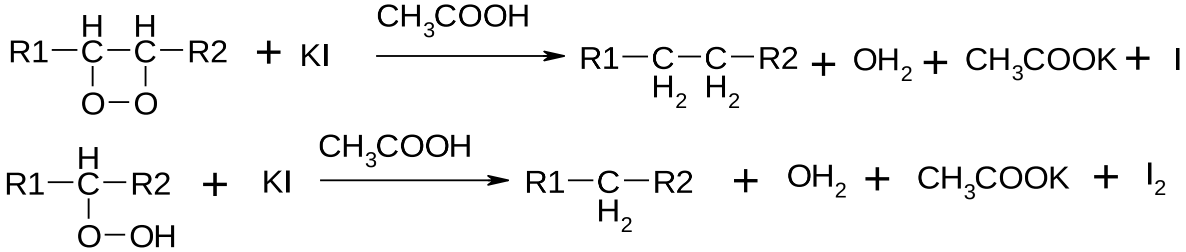
After 1 hour, a solution of potassium iodide and water are added. Iodine monochloride (iodine monobromide) that is not consumed during the reaction interacts with potassium iodide, releasing free iodine, which is then titrated with a solution of sodium thiosulfate in the presence of a starch solution.

$ICl + KI = I_2 + KCl$

$I_2 + 2\ Na_2S_2O_3 = 2\ NaI + Na_2S_4O_6$

The acid number, the saponification number, and the iodine number are indicators of both authenticity and quality.

The peroxide number (p.n.) is an indicator of the quality of fatty oil. It is regulated by state industry standard (SIS) T 26593-85. The method is based on the ability of peroxides and hydroperoxides in the oil sample to oxidize potassium iodide. The released iodine is titrated with a sodium thiosulfate solution in the presence of a starch solution.



$I_2 + 2\ Na_2S_2O_3 = 2\ NaI + Na_2S_4O_6$

The "**Oxidation Index**" (OI) is determined by spectrophotometry.

To do this, about 0.4 g (an accurate навеска) of the test substance is placed in a 50-ml measuring flask, 15 ml of hexane is added, mixed, and the volume of the solution is brought to the mark with the same solvent and mixed again.

The optical density of the test solution is measured at a wavelength of 232 nm in a cuvette with a layer thickness of 10 mm.

The oxidation index is calculated using the following formula:

ИО= A232/(a×2)×l,

Where:

A232 - is the optical density of the test solution at a wavelength of 232 nm;

a - is the weight of the fatty oil, g;

l - is the thickness of the cuvette layer, cm.

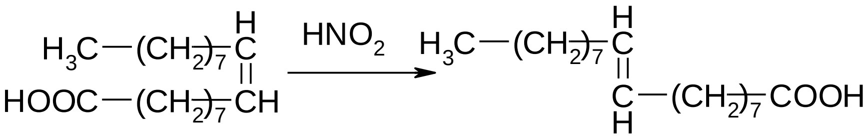
Chemical constants for determining volatile acids in fat

The Reichel-Meisler number determines the amount of volatile, water-soluble acids. This number shows the amount of ml of a 0.1N caustic alkali solution required to neutralize the water-soluble volatile fatty acids contained in 5 g of fat.

The Polenske number determines the amount of volatile, water-insoluble acids. This number shows the number of ml of a 0.1N caustic alkali solution required to neutralize the water-insoluble volatile fatty acids contained in 5 g of fat.

Specific qualitative reactions authenticity are provided by private articles on the corresponding fatty oils. These reactions are carried out on fatty acid radicals and on accompanying substances (natural impurities that enter the fat during the extraction from plant and animal objects):

• on fatty acid radicals in almond, peach and olive oil, the elaidin test (test for oleic acid) is carried out: under the influence of nitrous acid, the cis-form of oleic acid (liquid oil) turns into a trans-form (oil crystallizes after 2-8 hours).



oleic acid elaidic acid ($t_{пл.}$=38 ºC)

• *for natural impurities:*

Lipochromes are determined:

➢ in almond and peach oils: reaction with concentrated sulfuric acid and fuming nitric acid - almond oil gives a yellow color, peach, apricot, and plum oils give a red color;

➢ in fish oil: reaction with concentrated sulfuric acid in chloroform - rapid color changes are observed: yellow to blue-violet to brown;

➢ in sunflower oil (unrefined oil of the highest and first grade is allowed for medical use) and linseed oil: a reaction with concentrated nitric acid and resorcin in benzene produces a transient blue-violet coloration.

Vitamin A is determined in fish oil: a reaction with antimony chloride produces a temporary blue color.

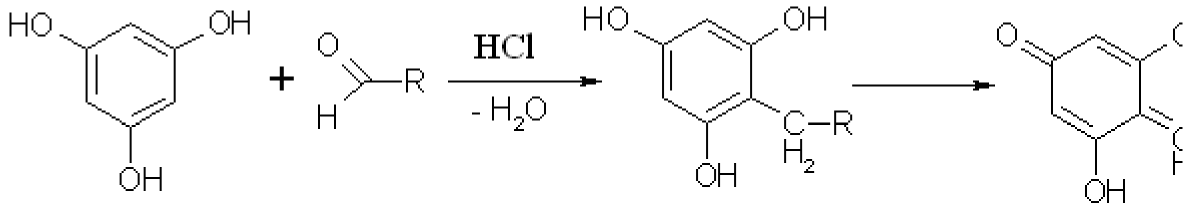
The quality of fats is characterized by the preservation of their constituent components and the absence of impurities and adulterants.

The presence of hydrolysis products (excess acids) and oxidation products (fat decomposition products) can be determined by changes in organoleptic and numerical indicators.

During the oxidation of fats, the color changes (lipochromes become decolorized), and a pungent odor and irritating taste appear due to the presence of peroxides, aldehydes, and ketones.

Impurities of oxidation products change the melting and solidification temperature interval, increase the solubility in alcohol, increase the density and refractive index (physical constants); increase the acid number, saponification number, peroxide number (increases the number of low-molecular-weight oxidation products) and decrease the iodine number.

A special Kreis test is carried out for the presence of peroxides, aldehydes, ketones (test for rancidity of oil). The oil is shaken with equal volumes of concentrated hydrochloric acid and an ethereal solution of floroglucin - there should be no pink staining. The determination is based on the formation of a para-quinoid structure.



A test is performed to determine the method of fat extraction, which involves identifying the presence of substances that are soluble in organic solvents, such as extractants and fats. These substances are present in fatty oils obtained through hot pressing and extraction.

A test with concentrated sulfuric acid and chloroform is performed to determine the color of the oil. Cold-pressed oils will turn red-brown due to oxidation, dehydration, and polymerization, while hot-pressed or extracted oils will turn black-brown.

QUANTITATIVE DETERMINATION

The quantitative determination of biologically active substances in fatty oils is carried out using gas chromatography, high-performance liquid chromatography, and other methods specified in pharmacopoeial articles or regulatory documents for specific types of fatty oils.

Fat-like substances (lipoids) are esters of monohydric high-molecular-weight alcohols and higher fatty acids (waxes, lanolin, and spermacet).

Lanolin (Lanolinum) is a fat-like substance obtained by purifying wool wax, which is extracted from the water after washing sheep's wool. It is an ester of cholesterol and higher fatty acids, as well as free sterols.

When wool is washed with hot water and alkali, an emulsion liquid is obtained, which includes lanolin components and other substances. The emulsion is then centrifuged to produce crude lanolin, which is subsequently melted, oxidized, neutralized, dried, filtered, and packaged as finished lanolin.

Lanolin consists of esters of cholesterol and isocholesterol with cerotic and palmitic acids.

Spermacetum is a wax—like substance produced by cooling liquid animal fat enclosed in a fibrous spermaceti sac in the head of a sperm whale (and other cetaceans), as well as in fat. The content of spermaceti proper in spermaceti oil ranges from 8 to 20%. It is extracted from the cavities first when slaughtering a sperm whale, because it crystallizes at a temperature of 6 ° C. Spermacet, which is contained in lard (raw lard), is first melted and spermacet is extracted from the resulting fat by cooling, then it is purified from the fatty fraction by pressing and by heating with alkali.

Bee wax (Cera) is a metabolic product secreted by bees to the skin surface of the underside of the abdominal rings in the form of small transparent leaflets. Bees build honeycombs out of wax.

After removing the honey, the honeycombs are squeezed out and melted in hot water for cleaning. The wax layer on the surface of the water is removed, melted again, filtered through a cloth and poured into molds. This is how natural (yellow wax) is obtained – Cera flava (FS.2.7.0004 GF XV).

Next, it is exposed to light or UV rays and produces white wax – Cera alba (FS.2.7.0003 GF XV). It is a complex ester of monoatomic alcohols with fatty acids, mainly an ester of mellisyl alcohol with palmitic acid.

Ways of raw material use and medical application

All types of raw materials (fruits and seeds of plants, cod liver, etc.) containing fatty oils are used to extract fatty oil in its pure form. The raw materials are processed at food industry plants. For medical purposes, fats are purchased.

Flax seeds and bitter almond seeds are used to prepare extemporaneous dosage forms whose pharmacological effect is associated with other groups of biologically active substances. A mucus solution is obtained from flax seeds, and bitter almond water is obtained from almond seeds.

Fats are used:

1. as medicines;
2. as suppositories and ointment bases;
3. as solvents for medicines and extractants.

1. As a medicine, fats are used for internal and external use.

When taken orally, fatty oils have a laxative, anti-sclerotic, anti-rickets, and hepatoprotective effect.

The laxative effect is most pronounced in castor oil - castor seed oil (Ricinus communis L.) from the family. Euphorbiaceae. In the human body, castor oil is hydrolyzed. Free ricinoleic acid irritates the intestinal walls, enhances peristalsis and facilitates the evacuation of intestinal contents. The effect appears after 2-5 hours. Castor oil disrupts digestion in the small intestine, so it is used only to a limited extent.

Almond, olive, sesame, and other oils have a mild laxative effect on chronic constipation. Fatty oils soften the fecal masses and promote their evacuation.

Fatty oils have an anti-sclerotic (hypocholesterolemic, hypolipidemic) effect. The most pronounced effect is observed with flaxseed, sunflower, corn, peanut, and cotton oils. The biochemical relationship between unsaturated fatty acids and blood levels of lipoproteins and cholesterol has not been fully elucidated, but the fact is undeniable.

The complex of unsaturated fatty acids, especially linolenic acid, which is easily converted into arachidonic acid in the body, is not initially synthesized in the human body and must be obtained from food. These acids are known as vitamin F. They act as tissue regulators in the body, participating in the construction of cell membranes and the synthesis of prostaglandins. The derivatives of eicosapentaenoic acid, which has five double bonds, exhibit vasodilating properties and reduce blood clotting.

Linetol, a mixture of ethyl esters of unsaturated fatty acids, and Lipostabil, a hypolipidemic agent based on unsaturated fatty acids, are obtained from linseed oil. Eikonol is obtained from fish tissue oil (polyunsaturated fatty acids).

Purified fish oil for internal use and vitaminized cod liver oil have an antirachitic effect. Due to its high content of vitamins A and D, fish oil is used for the prevention and treatment of hypo- and avitaminosis.

Hepatoprotective effect have drugs: "Essentiale", containing soybean oil phospholipids, "Cholenol" and "Tykveol", containing pumpkin seed oil.

Fats are used for parenteral nutrition in the postoperative period, with extensive burns, severe infectious diseases, stomach and esophagus cancer. Produce drugs "Intralipid" and "Lipofundin" - this is a fat emulsion from purified soybean oil.

When applied externally, vegetable oils and fish oil promote tissue regeneration and wound healing, including the healing of ulcers. This effect is due to the high content of carotenoids and vitamins A and E in fats.

Fats and fatty acid esters are part of liniments (A.V. Vishnevsky's balsamic liniment, syntomycin liniment, streptocide liniment, boron-zinc liniment, Alorom liniment, dermatological tar liniment), ointments (for frostbite, Konkov's ointment, Vulnuzan ointment, Essaven-gel ointment), aerosols (Vinizol, Kamfomen, Levovinizol, Livian, Lifuzol), and suppositories (antiseptic biological suppositories).

2. Cocoa butter and fatty base are used as suppository bases. Prostopin rectal suppositories, polyoxidonium rectal suppositories, and lutenurine balls are produced.

Pork fat is used as an ointment base. Pork fat is used to prepare ointment for frostbite, Biopin ointment, and lead plasters (simple and complex).

3. Non-drying fatty oils, such as olive oil, almond oil, and peach oil, are the most valuable solvents for medicinal products. These oils are used in the production of camphor injection solutions, sex hormones (Synestrol, Progesterone,

Tetrasterone, Proloteston), anabolic steroids (Silabolin), and oral medications (Pinabin, Cistenal, and Olimetin).