What is pharmacognosy The term: medicinal plant, crude drugs, biologically active substances. The general characteristic of polysaccharides **Medicinal plants and medicinal plants**

materials containing polysaccharides

Plan

- 1. General characteristic
- **2.** Classification
- **3.** physical and chemical properties.
- 4. Identification and quantitative determination.
- 5. Pharmacological activity and medicinal use
- 6. Medicinal plants and crude drugs containing polysaccharides

Pharmacognosy may be defined as "an applied science that deals with the biologic, biochemical and economic features of natural drugs and their constituents,"

Pharmacognosy embraces a knowledge of the history, distribution, cultivation, collection, selection, preparation, commerce, identification, evaluation, storage, and use of native drugs and economic substances that affect on human health.

*Investigations of plant chemical constituents (biogenesis, ontogenic and environmental influences on accumulation of biologically active substances, the most convenient time and conditions of collection, drying and storage).

- *Standardization of medicinal plant materials (working out of Pharmacopoeia Articles, changing of existent analytic and normative documents, improvement of evaluation methods).
- *Investigation of plant resources (habitation, determination of collection volumes, restoration of precious species, introduction and selection).
- *Plant biotechnology the use of isolated plant cells for production of biologically active substances.

The term: medicinal plant, medicinal plant materials, crude drugs, biologically active substances

- * <u>Medicinal plants</u> are plants contained biologically active substances, collected and used for medical purposes.
- * Medicinal plant materials are entire medicinal plants or their parts, used in dried (sometimes in fresh) forms in order to obtain medicinal substances, plant drug preparations (phytopharmaceuticals), permitted for medicinal use.
- * <u>Crude drugs</u> are vegetable or animal drugs that consist of natural substances that have undergone only the processes of collection and drying.
- * <u>Biologically active substances</u> affect the biological process in human organism, may change the physiological state and function of the organism, may have the prophylactic, diagnostic or therapeutic effects and be used in manufacturing of medicinal preparations.

* CARBOHYDRATES are a group of primary product of photosynthesis consisting of carbon, hydrogen and oxygen atoms. The total formula is C_m(H₂Q)_n.



*Monosaccharides (C₆H₁₂O₆)

it is a simple carbohydrate, hydrolysis is not cleaved to smaller carbohydrates. e.g. glucose.

*Oligosaccharides (*oligos* is a Greek word that means "few") yields 2-10 monosaccharide units on hydrolysis. e.g. sucrose, raffinose.

***Polysaccharides** are hydrolyzed to more than 10 monosaccharide units. <u>*Cellulose*</u> is a polysaccharide molecule that gives thousands of glucose molecules when completely hydrolyzed.

Monosaccharides

- * Over 200 different monosaccharides are known.
- * Monosaccharides are classified according to:
- **1.**The number of carbon atoms present in the molecule.
- 2.Whether they contain an aldehyde or ketone group.
- * A monosaccharide containing <u>three</u> carbon atoms is called a *triose*; one containing <u>four</u> carbon atoms is called a *tetrose*.
- * A monosaccharide containing an <u>aldehyde</u> group is called an *aldose*; one containing a <u>keto</u> group is called a *ketose*.



D and L Designations of Monosaccharides

- The simplest monosaccharide is glyceraldehyde, which contains a stereocenter. Therefore, it exist in two enantiomeric forms.
- In 1906, (+)-glyceraldehyde is designated D-(+)- glyceraldehyde and (-)- glyceraldehyde is designated L-(-)- glyceraldehyde.
- * These two compounds serve as <u>configurational standards</u> for all monosaccharides.



*A monosaccharide whose highest numbered stereocenter (the penultimate carbon) has the same configuration as D-(+)- glyceraldehyde is designated as a D sugar; one whose highest numbered stereocenter has the same configuration as L-(-)- glyceraldehyde is designated as an L sugar.

*D and L designations are not related to the optical rotations of the sugars to which they are applied.

*One may encounter other sugars that are D-(+)- or D-(-)and ones that are L-(+)- or L-(-)-.

Structural formulas for Monosaccharides



Fisher

Haworth

*Not all carbohydrates exist in equilibrium with **six**-membered hemiacetal rings, in several instances the ring is **five** membered.

*If the monosaccharide ring is six membered, the compound is called a *pyranose* (e.g. β-Dglucopyranose); if the ring is five membered, the compound is designated as a *furanose*. (e.g. β-D-ribofuranose).



Sugars that contain nitrogen

1. Glycosylamines

A sugar in which an amino group replaces the anomeric –OH group.

*Adenosine is an example of a glycosylamine that is also called a **nucleoside**.



2. Amino sugars

A sugar in which an amino group replaces a nonanomeric –OH group. e.g. Dglucosamine.

*D-glucosamine can be obtained by hydrolysis of **chitin**, a polysaccharide found in the shells of lobsters and crabs and in the external skeletons of insects and spiders.



Sucrose



*Ordinary table sugar $(C_{12}H_{22}O_{11})$

*Acid hydrolysis yields D-glucose and D-fructose.

*Sucrose is a nonreducing sugar; it gives negative tests with Fehling's solution because neither the glucose nor the fructose portion of sucrose has a hemiacetal group (both carbonyl groups are present as full acetals (i.e. as glycosides). 16



Carbohydrate Antibiotics

- One of the important discoveries in carbohydrate chemistry was the isolation of the carbohydrate antibiotic called *streptomycin*.
- Streptomycin is made up of three unusual components.
- * The glycosidic linkage is nearly always α .



POLYSACCHARIDES are natural high-molecular-weight hydrocarbon polymers of monosaccharides (sugars) linked together through Q, form linear or branched chains. The generalformula of polysaccharides is (C_nH_{2n-2}Q_{n-1})_m. Homopolysaccharides (homoglycans) are formed from uniform monosaccharides

*



As usually in monosaccharides units are linked together through glycosidic



- **Starch** (*Amylum*) is generally a mixture of the glucans amylose and amylopectin. Amylose is a linear molecule composed of D-glucopyranose units uniformly linked by a 1,4-glucosidic bonds.
- Fermentation of amylose results in maltose. Amylopectin is the main component of starch. Glucose residues are linked by 1,4- and 1,6 links. Most starches have a similar ratio of amylose to amylopectin, ranging about 25 % to 75%.

Plant source of starch are

Solanum tuberosum L., Solanaceae (Amylum Solani 14-24%)

Triticum vulgare L,Poaceae (Amylum Tritici 57-75%),

Zea mays L., Poaceae (Amylum Maydis 62-70%),

Oryza sativa L., Poaceae (Amylum Oryzae 62-86%).

> Starch is a nutrient and demulcent, excipient for tablets, dusting powder for pills, emollient, indicator in iodometry.

Dextrine

Dextrines are low-molecular-weight glucans, formed as a result of partial destruction of starch under the action of ferments, acids, at temperature above 200°C. They are used as a source of readily digestable carbohydrate for infants, substitutes for natural gum, as adhesive.

Dextran

Dextran are synthesized by bacteria *Leuconostos mesenteroides* from sucrose, α -D-glucopyranose residues linked in a linear manner by 1-6 bonds and in a branched manner by 1-3,1-4 links with molecular weight of 10⁷-10⁸.

Partially hydrolyzed dextrans used for clinical purposes have average molecule weights of 40,000 to 80,000 and are used as plasma substitute in a solution in cases if shock caused by hemorrhage, trauma or severe burns, because their osmolality and viscosity resemble those of plasma.

Cellulose

- **Cellulose** is the principal structural element of the cell walls in higher plants.
- Linear polysaccharides composed of β -D-glucopyranose residues are linked by 1-4 glucosidic bonds.
- Monomer unit is a residue of cellobiose. Cellulose is unsoluble in most of solvents, partially destroyed in concentrated solutions of

mineral acids.





The hair of the seed of *Gossypium hirsutum L. (Malvaceae)* consists of 98% cellulose.





Gossypium barbadense L gives the best quality cotton; it is cultivated in Egypt, Turkmenia, Tadzykistan, Uzbekistan, U.S.A.

Purified cotton is freed from adhering impurities, deprived of fatty matter, bleached and sterilized.

According to the level of fat extraction and purity, cotton may be hygroscopic eye cotton, hygroscopic for surgical use and compressed.

Liniment of *Hossypolum*, antiviral preparation, used in cases of psoriasis, is obtained from roots and seeds of cotton.

Fructans are polysaccharides, formed by residues of D-Fructose. Fructans have storage and osmoregulating functions, sometimes their content reaches up to 30% of dried leaf mass.

Inulin is a D-fructan in which residues are linked in the linear manner by β -2,1 bonds.

Plants containing inulin are

Echinacea purpurea (cone flower), *Taraxacum officinale* (dandelion), *Inula helenium* (elecampane),

Cichorium intybus (blue dandelion).



Inulin stimulates the growth of bacteria in bowels (Bifidogenic action) increases glycolysis and regulates lipid metabolism (it is recommended in diabetes).

Heteropolysaccharides (heteroglycans)

Heteropolysaccharides (heteroglycans) consist of

different monosaccharides.

Heteroglycans are represented by

- gums,
- mucilages,
- pectins,
- polysaccharides obtained from sea products (algae).

Gums

<u>**Gums</u>** are polysaccharides containing calcium and magnesium salts of uronic acids and neutral monosaccharides, partially esterified.</u>

They are produced in higher plants *after injury* as protective agents.

Physical characters

Gums are insoluble in organic solvents.

Gums react with solution LiCl or iodine in KI to give violet colour.

Gums give a **pale red** (gum arabic) colour or **dusk-green** (tragacanth) color with Dragendorff' s reagent.

These hydrophilic colloids are useful as emulsifiers, gelatin agent stabilizers.

Gums are natural plant products that may be classified in:-

Arabin (water soluble gum)
 Gummi Armeniacae, Apricot gum

• **Bassorin** (water little soluble gum, swelling) *Gummi Tragacanthae*, Tragacanth gum

• Cerasin (water insoluble gum), Cherry gum











Pectins are polymers of uronic acids, Exists in: fruits (apple, plum, lemon, orange), bulbs (beet, carrot), stalks (linseed) yield a great amount of pectins. With the addition of sucrose or glucose at the pH (3.1)-(3.5) pectins form gels. Pectin is classified as a protective. It has a properties of colloidal absorption of toxins. It is of value in the treatment of <u>intestinal disorders</u> such as <u>diarrhea</u> and <u>dysentery</u>. Pectin in the form of pastes appears to have bacteriostatic activity. It is used in pharmacy as a stabilizer for gels and emulsions.

It has a commercial uses, one of the most common is the preparation of jellies

and jams.





Mucilages are heteroglycans, accumulated in some *uninjured plant*

parts. They are plant food reserve and water-hold substances.

Chemical classification:-

- glucomannans,
- galactomannans,
- gum-like mucilages of *Poaceae*.

Glucomannans occur in Liliaceae, Orchidaceae, Aroidae.

Galactomannans are reserve polysaccharides of Fabaceae seeds.

Linum spp, Plantago spp, Apiaceae contain gum-like mucilages.

Physical and chemical properties of polysaccharides

- •Polysaccharides are insoluble in Non-polar solvents.
- •Solubility of polysaccharides in water is different.
- •Some linear homopolysacharides (xylans, mannans, cellulose, chitin) are water insoluble due to their strong intermolecular associations;
- •Glycogen, dextrans are soluble in water;
- Pectins, agar, alginic acid form gel.
- •Polysaccharides are more soluble in alkaline solutions.
- •Polysaccharides are optically active substances.
- •Acid hydrolysis leads to formation of mono- and oligosaccharides.
- •OH groups may be etherified or oxidized.

*Obtaining and identification of polysaccharides

Obtaining polysaccharides

- Extraction in hot or cold water;
- \Box Precipitation by alcohol with ratio (1:3) (1:4).

For identification of polysaccharides may be used

- •Enzymatic or partially acid hydrolysis.
- •different types of chromatography or electrophoresis.
- •gel filtration,
- •infrared spectroscopy.

* Oxidation Reactions of Monosaccharides

A. Fehling's solution

- * A characteristic property of an aldehyde function is its sensitivity to oxidation.
- Carbohydrates that give positive tests with Fehling's solution are termed <u>Reducing Sugars</u>.
- Ketoses are also reducing sugars, since under the conditions of the test,
 ketoses equilibrate with aldoses by way of <u>enediol intermediates</u>, and
 the aldoses are oxidized by the reagents.

$$\begin{array}{c} O \\ R - CH \end{array} + 2Cu^{2+} + 5HO^{-} \longrightarrow R^{-}CO^{-} + V Cu_{2}O + 3H_{2}O \\ Aldehyde From copper(II) Hydroxide \\ sulfate ion \end{array} \quad Carboxylate \\ anion oxide \end{array} \quad Copper(I) Water \\ \end{array}$$

Qualitative determination of polysaccharides

<u>Starch</u>

Starch grains produce dark blue colour in Iodine solution.

Test for reducing sugars (with Fehling's reagent)



Brick-red sediment

Qualitative determination of polysaccharides

<u>Inulin</u>

Notice Inulin treated with Molish's reagent (20% ethanolic solution of α -naphtol with sulfuric acid, prepared *ex tempore*) results in **violet colour**.

<u>Mucilages</u>

Mucilages are identified by treating methylen blue (1:5000) resulting in blue colour.

Mucilages produce yellow colour in alkaline solution.

<u>Uronic acid</u>

Reaction with carbazole (*raspberry pink colour*)

Quantitative determination of polysaccharides

Content of polysaccharides is determined by the weight method (Gravimetric) with 96% ethanol Total content of the reducing monosacharides after hydrolysis can be determined by spectrophotometry (i.e., in pharmaceuticals *Mucaltin, Plantaglucid*)

Marshmallow root- Radices Althaeae Marshmallow leaf - Folium Althaeae officinalis Marshmallow - Althaea officinalis L., A. armeniaca Ten, Malvaceae

Native to Europe and Western Asia, cultivated in Bulgaria, Serbia, Russia.

In the autumn roots are dug up, washed, trimmed from the rootlets, scraped to remove the cork (Ph. Eur. allows peeled and unpeeled root), dried in the sun or in heated-sheds).

The leaves are collected from the plant during month since beginning of flowering, dried.

The drug consist of root pieces whose outer bark layers have been removed by peeling. The roots are almost cylindrical, yellowish white and bearing numerous bark fibers. The fracture is fibrous externally and granular internally, separated by the wellmarked dark brown cambium line.

The leaf fragments are finely tomentose to velvety on the upper and lower surfaces with characteristic palmate venation. The drug always contains pubescent fragments of petioles and occasionally, mericarpes, seeds and pieces of the inflorescence.



Ph. Eur.

Constituents:

*

Leaf: 6-10% mucilage consisting of different polysaccharides, mainly

galacturonorhamnan with arabinogalactans and glucans,; 1.4 – 2.6 % flavonoids including tiliroside, luteoline derivatives.

Root: 5-10% mucilage consisting of several polysaccharides including acidic galacturorhamnans and neutral α-glucans. Abundant starch, small amounts of flavonoids are present including their sulfates, as well as phenolic carboxilic acids,

scopoletin, amino acids.

Uses:-

Demulcent, inhibits mucociliary activity, stimulates phagocitosis.

Indication:

- *Leaf:* primarily as antitussive for dry cough as well as for inflammation of the mouth and throat. It is also used for inflammation of the mucous membranes of the gastrointestinal tract.
- *Root:* used as an antitussive especially for dry irritable cough and inflammation of the mouth and throat but not as expectorant.
- Also used, though less often, for gastroenteritis, and occasionally, it is applied as a cataplasm for skin inflammation or burns .

Interaction with other drug

The absorption of other drugs taken concomitantly may be delayed.

* Foalfoot leaf - Folia Farfarae BHP, DAB Foalfoot (coltsfoot) - Tussilago farfara L. Asteraceae

The drug is collected from wild population in Italy, in the Balkan countries, Ukraine. A genetically uniform, pyrrolizidine-alkaloid-free, cultivated variety, *Tussilago farfara* "Wien", has been developed recently.

An early flowering perennial herb. Yellow florets appear before leaves.

The leaves are thin, palmate and lobbed, about 20 cm in diameter with coarsely serrate margin and a distinct petiole. The lower surface is white felted, the upper surface is yellowish green, glabrous, wrinkled.

Constituents:

6-10% acidic mucilage, inulin; about 5% tannins and small amounts of flavonoids, various plant acids, triterpens and sterols.

In the drug of some origins pyrrolizidine-alkaloids and their Noxides, such as senkirkine, senecionine, tussilagine and isotussilagine, have been detected.

Indications:

For catarrhal inflammations, dry cough, acute and chronic irritations of the mouth and throat. The mucilage of the drug coats the mucous membranes with a layer that mitigate the effects of chemical and physical irritants and diminishes cough stimulus. © CNC Department, NUPh, 02.09.2015





Side effects

- * While tussilagine and isotussilagine pyrrolizidine-alkaloids (PAs) have a saturated necine structure (and are therefore non-toxic), senkirkine, senecionine have shown hepatotoxic and /or carcinogenic effects. Therefore coltsfoot leaves were no longer permitted in Austrian commerce.
- * In Germany the legislators enacted regulation in consideration of various expert opinions, which are articulated in the approved *Farfara folium* monograph of the Commission E. A compromise was reached by setting a maximum duration of use (not longer than 4-6 weeks per year) and also establishing a maximum daily dosage for the tea, equivalent to 10 µg PAs (with 1,2unsaturated necine structure, including their N-oxides). Compared to the fresh pressed juice or extracts (not more than 1 µg PAs)
- * **Phytomedicines:** tea, (daily dosage : 4.5-6g of dried herb) fresh pressed juice (in Germany)

fresh pressed juice (in Germany)

Psyllium seed - Semina Psyllii Black psyllium - Plantago psyllium Plantaginaceae (Isphagula, Plantago ovata)

Native to the Mediterranean region, where it is also cultivated(especially in France). The material of commerce is important from France.

The drug consist of ripe, whole, dry seeds, which are darkreddish brown and shiny with the elliptical -oblong shape, 2-3mm in length. The convex side shows a continuous groove with a round scar in the mid-section.

The seeds swell greatly in water and are rapidly surrounded by a colorless, transparent layer of mucilage.

Constituents:

10-12% mucilage, located exclusively in the epidermis, compoused mainly of xylose and galacturonic acid as well as arabinose and rhamnose; fatty oil, hemicellulose, proteins, small amounts of iridoid glicosides (aucubin). **Indication:**

- As the drug with strong swelling capacity, it is taken together with abundant liquid, as a laxative for treatment of constipation. By increasing the fill volume in the bowel, a dilation stimulus occurs which triggers defecation; at the same time the swollen mucilage facilitates the smooth passage of the bowel contents.
- Psillium is contraindicated in case of intestinal obstruction.
- Cholesterol lowering effects have been described for psillum seed mucilage.

Ph.Eur., USP



* Common plantain leaf- Folia Plantagi Visrainian Ph., Common plantain - Plantago major L. Plantaginaceae

The drug is collected from wild population in Ukraine during summer.

The leaves are thin, glabrous, elliptical, about 15 cm in length.

The light to grayish green leaves have almost parallel whitish green nerves that are prominent on the lower surface. Longitudinally grooved green to brown petiole are present.





Constituents: Up to 20% polysaccharides, including pectin, glycans, iridoid glicosides (aucubin, catalpol), flavonoids including luteolin, apigenin as well as their derivatives, tannins, vitamins: C,K.

Actions: Antiinflamatory, expectorant, wound healing, stimulates regeneration. Phytomedicines: tincture used to treat bronchitis, Plantaglucid, fresh pressed juice are used to treat gastritis with lower production of acids.

* Linseed- Semina Lini Linseed (Flaxseed)- Linum usitatissimum L, Linaceae

As one of the older cultivated plants many varieties are cultivated worldwide for the production fiber and linseed oil as well as for production of the seeds, which are used in medicine. The most important suppliers are Morocco, Argentina, Belgium and India.

The drug consist of mostly glossy brown to reddish brown ovoid seeds, 4-6 mm long, and 2-3 mm wide and 0,75-1,5 mm thick. One end is broadly rounded, and other end is conically pointed. A thick mucilage coating forms upon placing the seeds in water.

Constituents:

About 3-10% mucilage, localized in the epidermis, 25% dietary fibers, 25% protein as well as fatty oil (30-45%) with mostly triglycerides such as linolenic-, linoleic- and oleic acid, 0.7% phosphatides, sterols, and triterpenes with cholesterol, campesterol, stigmasterol, sitosterol, 0,1-1,5% of the cyanogenic glycosides linustatin and neolinustatin, 0.2% of the linear lignan, small amounts of the flavonoids.

Indication:

Mildly active bulk-forming laxative. Over-weight individuals should only use the whole seeds because of the considerable energy content. Consistent with the epidemiological studies, which can shown a relationship between the ingestion of foods that contain abundant dietary fibers (e.d. linseed) and diminished occurrence colon and breast cancers, the lignan occurring in linse a has been found to be of particular interest for the chemoprevention of carcinogenesis.

Ph. Eur.





Kelp - Thalli Laminariae Laminaria japonica Aresch. Laminaria saccharina (L.). Lam. Laminariaceae

All these plants grow on the coasts of Britain and Norway. The weeds are cut chiefly by hand, then spread out to dry in the sun. The species of Laminaria are olive-green to brown in colour and are from one to two meters long. When dried it become dull brown to nearly black and hard and brittle in texture. The odor of the drug resembles that of seaweed and the taste is saline and mucilaginous.

Constituents:

*

The seaweeds contain a large proportion of a mucilaginous substance named algin, which is the calcium salt of alginic acid, 1-3% of ash in which iodide (0.04%), bromide, chloride are present.

Indication:

Cholesterol lowering effects have been described for laminaria. Could be used for iodine therapy in hypofunction of the thyroid gland. It is promoted as "slimming remedy". The administration of iodine supposedly stimulate the production of thyroid hormones thus increasing the basal metabolic rate and the disintegration of fat deposits. Although "slimming remedies" which affect thyroid activity are to be strongly discouraged due to the possible side effects, the drug is still found as a component of a few herbal tea and medicines. © CNC Department, NUPh, 02.09.2015

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