

Kurta S.A. Chemistry and Technology of Natural Carbohydrates

Lecture №1

Content module 1. Introduction. Carbohydrates.

Topic 1. Tasks of the discipline and its importance in training

Topic 2. Classification and nomenclature of carbohydrates. History of viticulture and winemaking.

Topic 3. Theoretical foundations of alcohol fermentation, chemistry and kinetics of the process.

Purpose: to give the student the necessary knowledge about the chemical properties, structure, classification, origin of names, production, use, use, distribution of carbohydrates and natural di- and polysaccharides, to systematize and summarize material on natural carbohydrates and polysaccharides studied during previous years; to acquaint with all typical classes of carbohydrates and natural di- and polysaccharides; to teach students the rules of work in the chemical laboratory, safety; to acquire skills of independent work on synthesis, isolation, study of properties and establishment of structure of carbohydrates and di- and polysaccharides.

Plan

1. Introduction to the chemistry of carbohydrates and polysaccharides.

2. Chemical composition of grapes and wine.

2.1. Monosaccharides

2.2. Polysaccharides

3. A brief history of the development of viticulture and winemaking

Lecture content

1. Introduction

Carbohydrates are the class of biomolecules that are the largest in nature of all biomass. Carbohydrates account for approximately 80% of the dry weight of plants and 2% of animals.

Carbohydrates are extremely common in flora and fauna and are extremely important in life processes because they are a source of energy for biological systems. Along with proteins, nucleic acids and lipids, they are the main components from which the cells of humans and animals are formed. In nature, approximately 80% of the dry weight of plants and 2% of the dry weight of animals are carbohydrates. The synthesis of carbohydrates from CO₂ and H₂O under the action of light and the natural catalyst of chlorophyll (photosynthesis) is the basis of the vital activity of plant organisms. Carbohydrates, one of the main foods, are found in grains, potatoes, fruits and vegetables. They are widely used for the production of alcohol, man-made fiber, paper, explosives and more.

Purpose - classification, origin, structural features, production, study of chemical properties, application, use, distribution of carbohydrates and natural polysaccharides.

The task is to help students study in detail the class of organic compounds - carbohydrates and polysaccharides.

Structure and scope of work - the work consists of: annotation, table of contents, introduction, 6 sections, questions for self-control, a list of sources used. The work is presented on 99 pages, contains 120 formulas and 23 references to literature sources.

The paper systematizes and summarizes for the first time a huge amount of material published in well-known publications and monographs on the chemistry of carbohydrates and natural polysaccharides and presented in a concise form, about 39 pages, in Ukrainian, which allows students and graduate students to quickly get acquainted with all typical classes of carbohydrates. and natural polysaccharides.

Carbohydrates play a significant role in the complex biochemical processes of metabolism of living organisms and disruption of their metabolism leads to some diseases (diabetes, liver damage, nervous system, etc.). Carbohydrates such as ribose and deoxyribose are part of nucleic acids that preserve and reproduce genetic information.

In living organisms, carbohydrates perform certain functions, the most important of which are structural, energy, protective, transport. Carbohydrates act as transporters - removed from the body and disinfect the substance. The function of biologically active compounds is monosaccharides, carbohydrates play a key role in the processes of molecular cognition.

Carbohydrates are compounds of the general formula $C_n(H_2O)_n$, with which their name is connected (K. Schmidt, 1844 - carbon and water). According to the chemical classification, carbohydrates belong to hydroxyaldehydes or hydroxyketones, ie, to compounds that contain both hydroxyl groups and aldehyde or ketone. Carbohydrates are also called sugars, or saccharides (carbohydrates).

For Ukrainian chemical terminology of carbohydrates, the question of using the original terms sugar and sugar has not yet been finally resolved. According to the recommendations of UNCOHITERN, it is proposed to follow the rule: the word sugar corresponds to the English term sacchar, for example, saccharide, polysaccharide, sucrose, etc. ; and the word sugar is the English term sugar, for example, the class of sugars, aminosugar, and so on.

Because carbohydrates belong to a common class of natural compounds, IUPAC rules allow the use of trivial names for them. Such names for the simplest carbohydrates end in -osa (ribose, glucose, fructose, sucrose).

Carbohydrates are divided into two major groups: monosaccharides and polysaccharides.

Monosaccharides (monos) are simple carbohydrates that are not able to hydrolyze to form the simplest carbohydrates. Polysaccharides are carbohydrates that can be hydrolyzed to monosaccharides.

The general name of monosaccharides consists of the name of the numerator, which corresponds to the total number of carbon atoms (tri-, tetra-, penta-, hexa-, etc.), and the ending -oz. For example, carbohydrates with four carbon atoms -

tetroses, with five - pentoses, etc.

According to the functional group, monosaccharides are divided into aldose (aldehyde + oza, hydroxyaldehyde) and ketosis (ketone + oza, hydroxyketones). The full common name of the monosaccharide is formed from the prefix aldo- or keto-, to which is added the name of the numerator and the ending (suffix) -osa. For example, pentose $C_5H_{10}O_5$ monosaccharides are called aldepentoses with an aldehyde group (ribose, arabinose, xylose, lyxose) and ketopentoses with a carbonyl group (ribulose, xylulose), and hexoses $C_6H_{12}O_6$ are called aldohexoses, respectively. Of the natural saccharides, pentoses and hexoses are the most important, and trioses (glycerol aldehyde, dihydroxyacetone) are not considered saccharides due to the significant difference in their chemical properties from the properties of other monosaccharides, and tetroses do not occur in nature.

Polysaccharides are divided into sugar-like or oligosaccharides (disaccharides, trisaccharides, etc.) and non-sugar-like (starch, cellulose, or fiber).

The presented work will help the teacher, student to get acquainted with the basic chemical composition, with the applied sensory analysis of wines, their range and quality indicators, as well as attributes during their consumption.

2. Chemical composition of grapes and wine

The chemical composition of grapes and wine includes compounds of different classes - carbohydrates, organic acids, phenolic, nitrogenous, mineral and other substances. In the grape cluster, they are unevenly distributed. For example, sugars are concentrated in the juice of berries, phenolic compounds in the skin of grapes, combs and seeds, aromatic - in the skin.

In the process of processing grapes, they turn into wine, as well as undergo complex transformations and serve as inaccurate formation of new compounds. These transformations of grapes will differ in their chemical composition.

2.1. Monosaccharides

Monosaccharides contained in grape wine are presented in (table.1.1).

Pentoses are monosaccharides that are contained in plants in a free state in small quantities. They are mainly the main part of complex polysaccharides - pentosans.

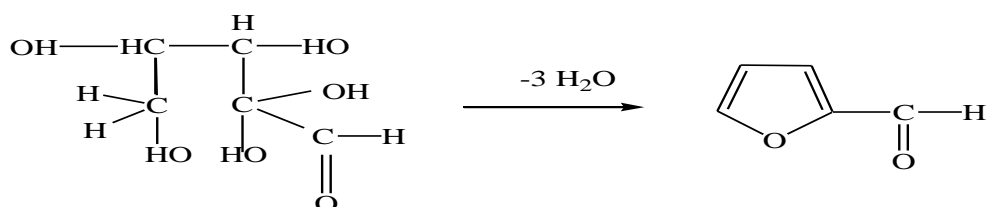
Table 1.1 Monosaccharides contained in grape wine

Monosaccharides contained in grapes and wine	Monosaccharide content in grapes (wort) g / l	The content of monosaccharides in wine g / l
L-arabinosis	Pentoses: In white-0.2-0.8	In red-0.2-0.7
D-kenlose	In red-0.4-1.5	In white-0.4-1.4
D-glucose	Hexose: Up to 250	In dry 0.2-0.8
D-fructose	Up to 100	In dry 1-2

Pentoses are characterized by all the characteristic reactions of monosaccharides - they reduce the Fehling liquid, when interacting with phenylhydrazine form ozazones, which can give esters, as well as glycosides. When pentose is restored, the corresponding pentahydric alcohols (for example, arabite and xylitol) are formed.

Unlike hexoses, pentose is not fermented by yeast. Therefore, when quantifying hexose in wine by methods that use a felting fluid, pentose causes inflated results.

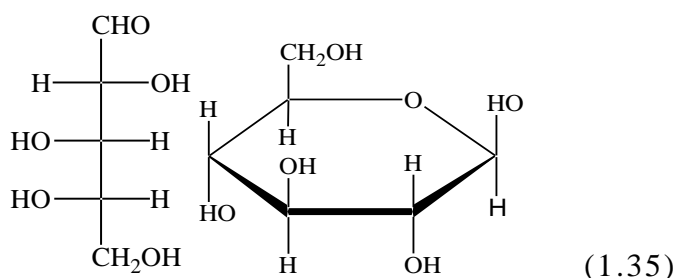
A characteristic general reaction to pentoses is the reaction of furfural formation upon cleavage of three water molecules from pentose. The reaction is carried out by heating with moderately dilute hydrochloric or sulfuric acid:



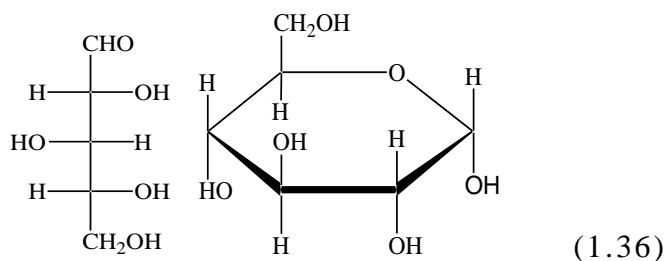
Furfural is a liquid with a pleasant smell of "rye bread crust". It is formed by the action of pentose not only mineral but also organic acids, but the reaction with organic acids is slower.

Of the pentoses found in grapes and wine, L-arabinose and D-xylose predominate. L-arabinose is a part of gum, mucus, pectin and hemicelluloses.

D-xylose (wood sugar) is not found in all wines. Grapes contain little of it. It is part of xylans, gums and mucus.



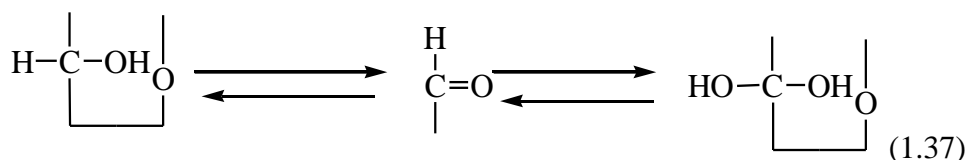
β -pyranose form L-arabinose



β -pyranose form D-xylose

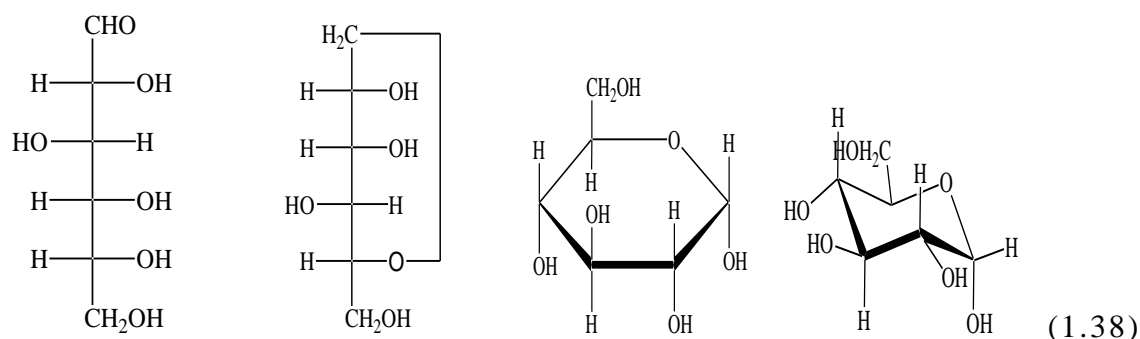
Pentol is usually found in red wine almost twice as much as in white wines. This enrichment of wines is due to the hydrolysis of pentosans, which are contained in the solid part of the berry and in the ridges. Oak barrels can also be a source of pentose in wines. Also a source of pentose can be aminosaccharides, pigments of grapes.

Hexoses. Unlike pentoses, hexoses in the free state in nature are more common and in greater quantities. Grapes contain the largest amount of D-glucose and D-fructose. D-glucose (grape sugar, dextrose). In addition to grapes, it is found in honey and fruits. D-glucose is an aldehyde alcohol. All aqueous solutions of glucose along with the aldehyde form - oxoform (I) always contain tautomeric cyclic (semi-acetal) forms (furanose and pyranose), ie α - and β -D-glucose. The amount of non-cyclic form is about 1%.



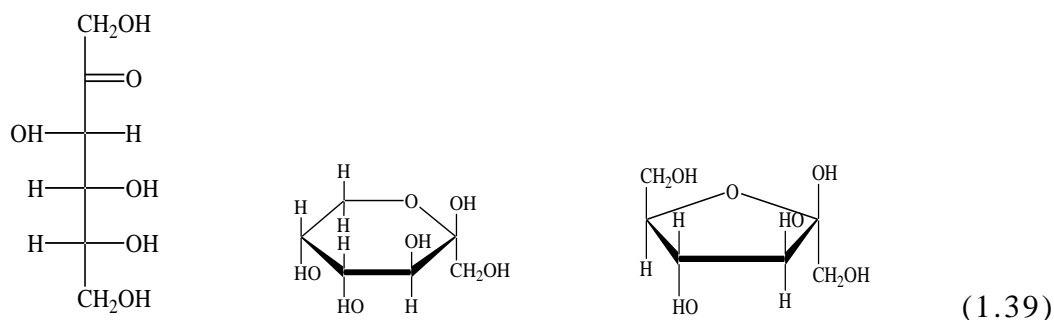
Due to the different specific rotation of α ($[\alpha]_{20} = +110.1^\circ$) and β -D glucose ($[\alpha]_{20} = +19.3^\circ$), both forms in aqueous solutions are subjected to mutarotation. The final specific rotation $[\alpha]_{20D} = +52.5^\circ$ is set, which does not change further and corresponds to the state of equilibrium between α and β forms. Crystalline D-glucose is usually α -form.

Fisher's projection formula and Havers' perspective formula are used to represent cyclic forms of glucose. Recently, conformational formulas have also been used for this purpose, more accurately reproducing mannose molecules and explaining a number of facts that the cyclic formula does not correspond to. Various ways of depicting the α -D-glucose molecule are discussed below:



D-glucose is a colorless crystalline substance. Depending on the crystallization conditions, it can be obtained in the form of anhydrous crystals (when crystallized from methyl alcohol) or with one molecule of water - when crystallized from aqueous solutions. D-glucose is resistant to oxygen in neutral or weakly acidic solutions. In an alkaline environment under the action of oxygen, it is destroyed. D-glucose is well fermented by yeast. In grapes, its content together with D-fructose is 10-30% or more.

D-fructose (berry sugar, levulose). In addition to grapes, it is found in bee honey. D-fructose is a ketoalcohol. In aqueous solutions it is in oxoform, as well as cyclic - α and β -fructopyranose and α and β -fructofuranose forms. Fructofuranose is a part of polysaccharides and glycosides. In the crystalline state, D-fructose is in β -forms.



D-fructose is hygroscopic, soluble in water to form a thick syrup. Easily soluble in hot alcohol.

Like D-glucose, D-fructose reduces the felting fluid and salts of heavy metals, oxidizing itself. The first products of oxidation of D-fructose are glycolic acid and trioxybutyric; with further oxidation, formic, oxalic and tartaric acids can be formed. Reduction of D-fructose leads to the appearance of D-mannitol and D-sorbitol, and heating in the presence of strong acids - to the formation of oxymethylfurfural. Most of the yeast completely ferments D-fructose.

At the beginning of the formation of grapes, the total amount of monosaccharides is approximately 1% and is represented mainly by glucose. Fructose appears a little later. During the period of berry pouring, the ratio of glucose to fructose approaches 1. This ratio at the moment of technological maturity of grapes, depending on the variety and ecological conditions, can be 0.7-1.5. Saccharides accumulate in the berry as the grapes ripen fairly evenly. The average daily increase in saccharides before ripening berries is from 0.2 to 0.5%.

In favorable years with good farming techniques in some grape varieties, the average daily increase in saccharides could reach 1%. In general, the content of saccharides during the period of physiological maturity of berries averages 17-25% in technical grape varieties. It depends on the grape variety, environmental conditions and agricultural techniques. The sugar content of dried grapes used for the production of some types of wines (Muscat, Tokay) reaches 35-50%. However, the absolute amount of saccharides in wilted grapes is reduced due to their destruction. Fructose undergoes the greatest changes, as a result of which the ratio of glucose to fructose increases markedly.

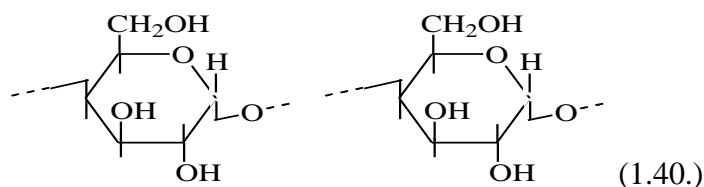
In dry table wines, the total amount of saccharides ranges from 0.07 to 0.4%. The content of some is (in g / l): fructose 0.1-2.0; glucose 0.2-0.8; xylose - up to 0.4, arabinose 0.2-1.4. Rhamnose in dry table wines found about 1 milligram / liter. The ratio of glucose to fructose is 0.3-1.6.

Most strains of yeast ferment glucose better. Meanwhile, some species (such as Sauternian yeast) have been identified that ferment fructose better. There is an opinion that the reason is not in the form of yeast, but in the initial sugar content of the wort. Thus, when the sugar content in the wort is up to 20%, the yeast ferments glucose faster, and when the sugar content is from 20 to 25%, they ferment glucose and fructose equally. If the sugar content of the wort is more than 25%, then fructose ferments faster.

When obtaining dry wines, the quantitative ratio of glucose to fructose in the wort and wine does not matter, because all the sugar is fermented into alcohol. For strong and dessert wines, this ratio, on the contrary, is very important, because fructose is almost twice as sweet as glucose. Therefore, in the manufacture of wines of these types, it is desirable to use grape varieties in which at the stage of technical maturity, the ratio of glucose to fructose would be less than one.

2.2. Polysaccharides

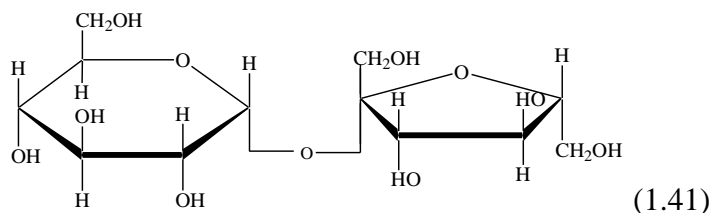
Polysaccharides - high molecular weight non-sugar carbohydrates of General formula $(C_6H_{10}O_5)_n$. They are products of condensation of a large number of monos molecules by analogy with disaccharides. Monos residues are connected by an ether bond (glucoside), which is formed by the glucoside hydroxyl of one molecule of monos and the fourth hydroxyl of the second molecule of monos in α - or β -form:



The main representatives of polysaccharides are starch and cellulose.

Polysaccharides of the I order. I-order polysaccharides contain a relatively small number of monos residues (up to 10-12). They are easily soluble in water, and in pure form are crystalline substances. Grapes contain more sucrose and small amounts of maltose, melibiose and raffinose. D-glycero-, D-mannoctuloses, mannoheptuloses, altroheptuloses were found in wines.

Sucrose (cane, beet sugar). Widespread in plants. Especially a lot of it in sugar cane, sugar beet, from which sucrose comes. It is believed that in higher plants it is the main soluble reserve carbohydrate. Sucrose is a disaccharide consisting of α -glucopyranose (I) and β -fructofuranose (II), connected (1.2 bonds) due to their glycosidic hydroxyl (1- α -D-glucopyranosido-2- β -D-fructofuranoside).



Saccharose

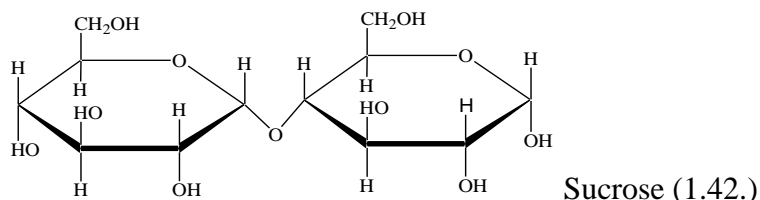
Sucrose does not contain free glycosidic hydroxyl and does not show mutarotation. It does not reduce the felling fluid and does not form hydrazines and azozones. Sucrose is well soluble in water. In 100 g of water at a temperature of 12.5 °C, it dissolves 199 g, at 20 °C - 204 g, at 45 °C - 245 g, at 100 °C - 487 g. In absolute alcohol, sucrose is sparingly soluble. Sucrose is insoluble in ether and chloroform. When it is dissolved in water, the volume decreases. During the heating of sucrose at a temperature above the melting point (190-200 °), it is dehydrated to form various polymeric products — caramels, organic (in particular, humic) acids, and other little-studied compounds. These products, called "color", are used in cognac production to add color to cognacs.

Depending on the degree of dehydration, the following caramels are distinguished - caramel, caramel and caramel. In the formation of these caramels in the first case is removed - 10.5% water, in the second - 14% and in the third - 18%. Caramels are difficult to dissolve even in hot water, so to obtain color caramelization is stopped at the stage of caramel. The resulting color is added to the humic acids formed.

In the wort of European grapes, sucrose is very small and for a long time it was believed that it is not in it at all, so the detection of sucrose in grape wines used to be a sign of wine adulteration. Recently, however, the presence of sucrose in European grape varieties has been proven, although its amounts are insignificant (0.056-3.93%). NM Sisakyan and SA Marutyan, studying Armenian, Georgian, Azerbaijani, Hungarian, French and American grape varieties, found that the sucrose content in them ranges from 0.2 to 1.5%. Up to 5% of sucrose is found in American grapes, and up to 7.2% in grapes of some Michurin varieties, and its content naturally increases as the grapes ripen.

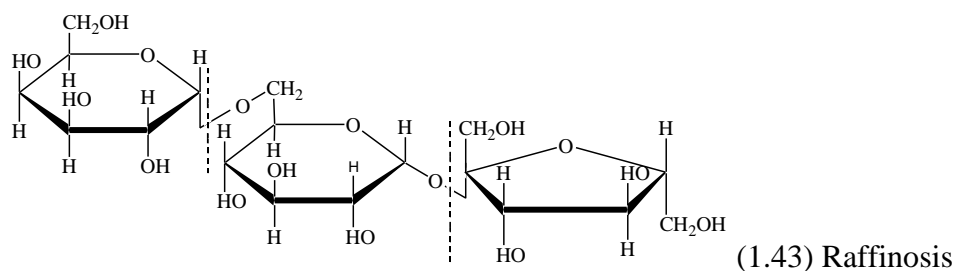
Sucrose appears in the berry when it reaches the appropriate level of glucose and fructose. However, this level can vary from 4.5 to 22% depending on the variety. Apparently, this circumstance can explain that sucrose has not been found in many European varieties for a long time.

Using chromatographic methods, sucrose was found in small quantities in dry wines, as well as glucose and fructose. Maltose (malt sugar) is formed by the breakdown of starch by amylase. In the free state is contained in plants in small quantities. It consists of two molecules of α -D-glucose, interconnected by a bond between the first and fourth atoms (1,4- α -glucose glucoside):



Melibiosis is part of raffinose. It consists of glucose and galactose in pyranose forms, connected by the primary alcohol group of α -D-glucose and hemiacetal hydroxyl of α -D-galactose. Fermented by bottom-fermented yeast. In grapes and wine is contained in small quantities.

Raffinose in grapes is contained in small quantities. Raffinose is a trisaccharide consisting of α -D-galactose, α -D-glucose, α -D-fructose.



In enzymatic hydrolysis, raffinose can be cleaved to fructose and melibiose or galactose and sucrose, in acid hydrolysis to monoses.

Raffinose does not restore the felting liquid and has no sweet taste.

Polysaccharides of the II order. Second-order polysaccharides are high-molecular substances containing from several tens to several thousand monosaccharide residues. They are either insoluble in water or form viscous colloidal solutions. In grapes and products of its processing are found

pentosans, starch, glycogen, cellulose, pectin

substances, gums, dextrans. (Table 1.2)

Table 1.2

The content of polysaccharides in grapes

Polysaccharides of the 2nd order	Content of polysaccharides in wort, g/l	Content of polysaccharides in wine, g/l
Pentosans	0,3-2	0,2-1,5
Starch Traces	Traces	0
Glycogen	0	Traces
Cellulose	0	0
Pectin compounds	0,5-2	0,1-1
Gum	0,3-4	0,2-3
Dextrans	0-1	Traces

Pentosans are part of hemicelluloses. Easily hydrolyzed by mineral acids with the formation of the corresponding pentoses. When dissolved in water give colloidal solutions, from which they are precipitated by alcohol. Fehling fluid is not reduced. Among pentosans the most known are arabans and xylans, creating L-arabinose and D-xylose during hydrolysis, respectively. Of the pentosans, the Arabs predominate in the wine. Their ratio to xylans is 3: 1. This is due to the fact that arabans are well soluble in water, while xylans are poorly soluble and therefore less well extracted by wort. In grapes of normal maturity, the content of pentosans ranges from 0.41 to 0.48%.

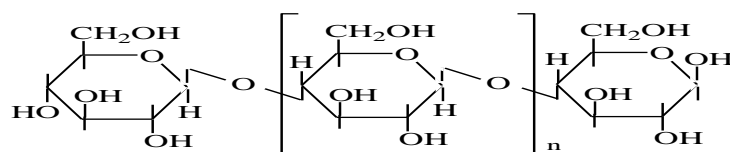
Starch in grapes is present in leaves, peduncles, ridges, as well as in green fruits. Starch is composed of two polysaccharides of amylose and amylopectin. In different plants, the ratio of amylose and amylopectin is different. In most cases, amylose 10-20%, amylopectin 80-90%. Glucose residues are bound together by the first and fourth carbon atoms (α -1,4 glucoside bond). Amylose is easily soluble in warm water, gives a blue color with iodine. In the amylopectin molecule, the chains of glucose residues are highly branched. At the points of branching of the chain of glucose residues linked as in amylose 1,4-glucoside bond, there are other bonds, namely α -1,6-glucosidic bonds. Recently, 1,3-glucosidic bonds (0.5-1% of the total number of glucosidic bonds) have been detected in the amylopectin molecule. Its molecular weight is much higher than that of amylose.

When boiled with acids, starch forms α -D-glucose. With a weaker effect of acids, such as 7.5% HCl for 7 days at room temperature, the so-called "soluble starch" is formed (used in the manufacture of starch paste, preparation of the indicator used in iodometric reactions). Under the action of the enzyme amylase, which is contained in large quantities in the sprouted grain, in saliva and in the juice secreted by the pancreas, there is an enzymatic saccharification of starch to maltose.

Glycogen is animal starch. Contained in human and animal body tissues, fungi and yeast. Plays an important role in the conversion of carbohydrates in the animal body and in yeast during alcoholic fermentation. It is of interest as a reserve nutrient in yeast cells. In yeast, in terms of dry weight, glycogen can contain up to 32%. The source of glycogen in wine is wine yeast. It is not found in grapes. Glycogen is similar in structure to amylopectin. The molecular weight of glycogen is much higher. When boiled with acids, glycogen forms α -D-glucose. Glycogen dissolves in hot water, forming opalescent solutions. With iodine, glycogen solutions give a color from burgundy to reddish brown, depending on the origin of glycogen.

Cellulose. Makes up the bulk of the cell walls of the plant, including the vine. Present alone or together with another compound, such as lignin. Cellulose contains from 1,400 to 100,000 glucose

residues. Cellulose forms long fibers that can be seen under an electron microscope. When boiled for a long time with mineral acids, cellulose hydrolyzes to β -D-glucose. Cellulose is insoluble in water.



Cellulose (1.44)

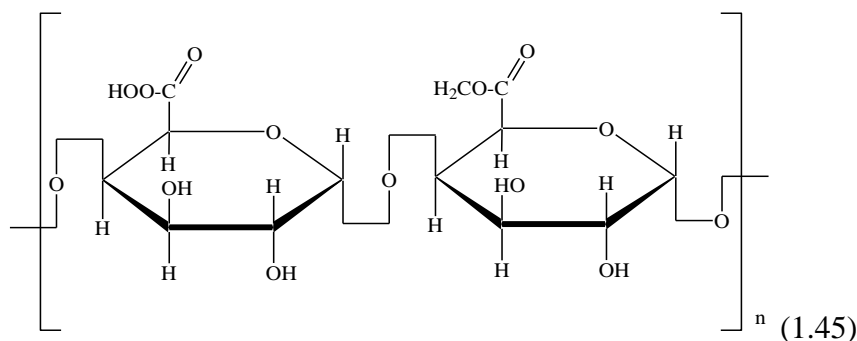
Pectin compounds are gel-like amorphous substances. They are part of the primary cell walls and connecting plates. They surround the microfibrils of cellulose. Pectin compounds are involved in regulating the water regime of plant tissues, due to their ability to retain large amounts of water. In their composition, in addition to galacturonic acid, the following sugars are: D-galactose, L-rhamnose, L-arabinose, D-xylose. Alkaline salts of pectic acid are readily soluble in water. In the form of calcium pectate, it is easily precipitated from solution. This is used to quantify pectin. Fractionation of pectic acid, partially hydrolyzed by yeast endopolygalacturonase and carrot polygalacturonase, yielded fractions containing galacturonic acid and neutral sugars - galactose, arabinose, xylose and rhamnose. In the composition of pectic acid found pectic acids with colloidal properties, free from methoxyl groups. Pectic acid contains about 100 galacturonic acid residues. Salts (pectates) of alkali metals of pectic acid are soluble in water, salts of polyvalent metals are practically insoluble.

Thus, the main component of pectic substances are polygalacturonic acids. Each group of pectin substances differs in molecular weight, degree of methoxylation, acetyl number, composition, neutral sugars. Despite significant advances in recent years in the study of pectin, much remains unclear in their structure and properties. Thus, to date, no exact difference has been established in the structure of soluble pectin and protopectin, it has not been possible to isolate protopectin in its native form and to determine its relationships with other polysaccharides.

Pectic substances of different plants in their composition have much in common. However, at the same time there is a wide variation of molecular weight, degree of methoxylation, ratio and composition of individual fractions. Grapes and wines contain all groups of pectin. In the wort, soluble pectin is about 50%, pectic acid - 30%, pectic acid - 20%. Protopectin is found in all parts of the vine except the juice. The high hardness of unripe berries is due to protopectin. As the grapes ripen, the protopectin turns into soluble pectin and the berry softens. During overripening, soluble pectin is partially hydrolyzed to form pectic acid and methanol. Grape pectin contains about 6% of methoxyl groups and 1.0-1.5% of acetal groups. Its ash content is 1.0-1.8%. The viscosity of 0.5% solutions of grape pectins, depending on the variety and method of selection varies widely (from 1.4 to 2.3-10⁻⁸ m³ / s). As a rule, grape pectin has a weak jelly-forming ability (pressure below 21.28 kPa).

The content of pectin substances in grapes depends on the variety, the degree of maturity and usually ranges from 0.5 to 2 g / l. In nutmeg varieties it is higher and is 3-4 g / l. Red grapes contain more pectin than white. Many of them are in the ridges (from 0.5 to 1.6%). Protopectin consists of polygalacturonic acids associated with other compounds - starch, cellulose, galactan, araban. It is insoluble in water, is part of the cell walls and middle plates of young tissues. To remove it from plant tissues, dilute solutions of hydrochloric and oxalic acids, ammonium oxalate and citric acid and other solvents are used.

The chemical nature of protopectin is poorly understood, because it can not be isolated unchanged from plants. It is believed that the carboxyl groups in the molecule of protopectin are combined with molecules of cellulose, proteins and other components of cell walls by polyvalent metals (usually Ca). In acid hydrolysis (dilute acids) or enzymatic hydrolysis, protopectin is converted to soluble pectin. Pectin has no odor. The basis of the soluble pectin molecule is galacturonic acid - a polymer of galacturonic acid (galacturonan). Polygalacturonic acid consists of D-galacturonic acid residues, partially methoxylated (from 30-80%) and connected by α -1,4-bonds:



It is established that the composition of the soluble pectin molecule also includes neutral sugars, more or less well connected to the main chain. The amount of neutral sugars in the pectin molecule is 10-12%. Of the sugars found in the form of polysaccharides and partly in the free form of arabinose and galactose. Sometimes significant amounts of xylose and rhamnose are found in pectin.

Studies of pectins derived from plant tissues (suspension of white maple callus, beans, apple, cambial apple pectin and callus of wild grape galls), as well as pectin from ripe apples, showed that these pectins differ in content and ratio neutral sugars: arabinose, galactose, rhamnose, xylose.

3. A brief history of the development of viticulture and winemaking

Drunken drinks have been known since ancient times. Wine was especially popular among all peoples. According to ancient mythology, the patron saint of viticulture and winemaking is the god Dionysus, who is also called Bacchus and Bacchus. At the same time, there are legends about the origin of the plant that produces wine. According to these legends, Bacchus, finding a small vine, wanted to transplant it, for which he placed it in a bird's bone, but along the way the plant began to grow so fast that it was necessary to look for another container for it. He then placed it in the lion's bone and then in the donkey's bone. Arriving in Naxos, he planted a vine in the ground with these three bones. That is why the one who drinks wine, first sings like a bird, then becomes a lion and eventually turns into a donkey ... Also, ancient legends say: when Noah planted a vine, the devil watered it with the blood of sheep, lions, monkeys and pigs, so when consuming wine a person can look like these animals. Wine is one of the oldest alcoholic beverages. It was made mainly from grapes. The first grape-like plants grew in many countries of the world 70 ... 110 million years ago (Cretaceous period of the Mesozoic era). Scientists have found such plants in Siberia, Kazakhstan, the Urals, Sakhalin and more.

Society develops and man acquires, accumulates and improves the experience of cultural viticulture and winemaking. Gradually, various ways of caring for the vine developed. These methods depended on the level of development of society. Six thousand years ago, vines were grown in Egypt and Mesopotamia. In ancient Greece, three thousand years ago, viticulture was an independent strong

branch of agricultural production. Winemaking is also widely developed, where wine and bread were the main products that met the basic needs of man, and were symbols and signs of a happy life. From Greece, the culture of grapes and winemaking penetrated to the west - in southern Italy and Sicily. In Italy, viticulture has found excellent conditions for its development.

At the beginning of the I century AD. France was considered a country with an independent grape culture and wine technology. In the middle of the century, the main outstanding wine-growing regions of France were identified. These are Champagne, Bordeaux, Burgundy, Languedoc and others. Many years of effective experience of French growers and winemakers has had a great impact on the relevant sectors of agriculture and industry in other countries. These are the countries of the Caucasus and Central Asia, although archaeological expeditions during excavations have led to the conclusion that wine in these regions appeared as early as 2000-1500 BC. From Europe, many varieties of grapes and methods of winemaking were imported to the island. Madeira, and then to South Africa, Australia, Japan and Korea.

In China, viticulture developed before our era. In North America, the culture of grapes has a thousand-year history and was first described by the Vikings.

The history of the development of viticulture and winemaking in Ukraine dates back to antiquity. The fact that viticulture and winemaking here was one of the most important occupations, as evidenced by the images of grapes on some coins of III and II centuries BC. of the city of Thira. For two and a half millennia, periods of prosperity alternated with recessions or the complete demise of viticulture and winemaking due to either military action or the underestimation of this highly profitable and much-needed sector of the economy.

The Greeks, who established their colonies in the Crimea, in the region of the Don, Dnieper, Bug, Dniester and Danube, imported their grapes here, grew them and engaged in winemaking. From here, viticulture spread to other regions of Ukraine and Moldova, which have favorable conditions for grape cultivation.

Viticulture and winemaking in the Crimea was well developed in the late VI century. B.C. Equipment and reservoirs were found that testify to the intensive development of these crops and technologies in Chersonesos, Pantikapaion, Tiritap, as well as in Olbia, on the shores of the Boer Estuary and other cities in southern Ukraine.

Historical data confirm that by the XI-XII centuries AD. viticulture and winemaking also developed in the territory of northern Ukraine, where most of the vineyards belonged to monasteries, mostly to the Kiev-Pechersk Monastery.

In the XIX century. grape and wine industry in the modern borders of Ukraine was not developed, but in the early XX century. began a significant rise of viticulture and winemaking, the development of new lands for vineyards. In the Yalta region in the late XIX century. Massandra industrial winery with a winery and cellars was founded, which was later transferred to the Special Department.

A great contribution to the development of the industry was made by the founder of domestic winemaking, Prince LS Golitsyn, who in his estate "New World" near Sudak mastered the production of champagne, the classic bottle method.

In terms of vineyard area, Ukraine ranked 3rd in the former USSR, and 2nd in terms of wine production. Consumption of grape wine per capita in Ukraine per year was in 1980. - 16.9 l / person, in 1997. - 1.0 l / person. Over the past 20 years, the area of vineyards in Ukraine has decreased 1.6 times, grape wine production - 5.6 times, wine consumption per capita - 16 times. In Ukraine, the largest areas of vineyards were in 1971. (188 thousand hectares). According to this indicator, Ukraine ranked fourth among the former Soviet republics. The area of vineyards has decreased by 50% since 1971. Conventionally, this period can be divided into three stages:

- transfer of vineyards to grafted culture (1971-1984)
- the period of the anti-alcohol campaign (1985-1988)
- the period after perestroika (1988)

The biggest damage to the wine industry was caused by the anti-alcohol campaign, when a large part of the Crimean vineyards were cut down.

Until the early 1990s, Ukrainian winemaking was one of the significant sources of replenishment of the state budget. At various international competitions of wines, cognacs and champagnes, vintage products of the republics of the former USSR invariably won Grand Prix cups, gold and silver medals.

The sharp decline in household incomes has reduced demand for wine products that were not essential. Volumes of grape wine production in 1998 decreased compared to 1990. at 73%. Viticulture and winemaking in Ukraine were closely connected with other republics of the former Soviet Union. So wine equipment was made and delivered to Ukraine from Georgia, Russia, Moldova. Ukrainian wine was exported largely to Russia. With the collapse of the USSR, these ties were broken and all issues of winemaking in Ukraine must now be resolved independently.

Recently in Ukraine the demand for wine products is increasing, the wine market is becoming more saturated, the need for specialists in grape and wine specialties is increasing.

Sommelier courses open, where you can learn a lot of interesting information about the origin, composition and properties of wine, the basic rules of wine tasting, what wine to serve and much more.

Recommended Books

1. Курта С.А., Лучкевич Є.Р., Матківський М.П. Хімія органічних сполук. Підручник для вищих навчальних закладів. м. Івано-Франківськ: Прикарпат.нац.ун-т ім. В.Стефаника, 2013. – 599 с. вид-во. Прикарпат. нац. у-ту. Авторські права захищені свідоцтвом про реєстрацію авторського права на твір № 52578 від 13.12.2013 р. державним департаментом інтелектуальної власності МОН України.
2. Курта С.А. Природні вуглеводи і полісахариди. Навчальний посібник. ISBN 978-966-8969-84-3. Видав: Супрун В.П.76025, Івано-Франківськ, вул. В.Великого,12,аХ
Тел.: (0342) 71-04-40, e-mail: printsv@ukr.net, Свід. про внесення до Держреєстру від 17.10.2005р. Серія ІФ №25. – 100с.
3. Ластухін Ю.О., Воронов С.А. Органічна хімія.- Л.: Центр Європи, 2006.- 867
4. Несмеянов А.Н., Несмеянов Н.А. Начала органической химии: В 2 кн. –

- М.; Л: Химия, 1969-1970.- Т.1 – 663 с.; Т.2.- 824 с.
5. Петров А.А., Бальян Х.В., Трощенко А.Т. Органическая химия.- М.: Высш. шк., 1981.- 592
 6. Сайкс П. Механизмы реакций в органической химии.- М.: Химия, 1991.- 447с
 7. Дрюк В.Г., Малиновский М.С. Курс органической химии.- К.: Высш. шк., 1987.- 400 с.
 8. Ганущак М.І., Кириченко В.І., Клим М.І., Обушак М.Д., Будова і реакційна здатність органічних сполук.- К.: НМК ВО,1992.- 216 с.
 9. Нейланд О.Я. Органическая химия.- Высш. шк., 1990.- 751 с.
 10. Домбровский А.В.,Найдан В.М. Органічна хімія.-К.:Вища шк.,1992.- 503 с.
 11. Краснов К.С. Молекулы и химическая связь.- М.: Высш. шк.,1977.- 280с.
 12. Киприанов А.И. Введение в электронную теорию органических соединений.- К.: Наук. Думка., 1965.- 179 с.
 13. Соколов В.И. Введение в теоретическую стереохимию. М.:Наука,1979.-243 с.
 14. Потапов В.М. Стереохимия.- М.: Химия, 1988. 463 с.
 15. Ковтуненко В.О. Загальна стереохімія. – К,ЗАТ “Нефтегес”,2001.- 340 с
 16. Вакарчук Л.Т. Технологія переробки винограду. — М.: Мир, 1990.-243с.
 17. Валуйко Г. Г. Виноградні вина.М.: Харчова промисловість,1978.-320с.
 18. Кишковский З.М., Мержиниан А.А. Технология вина. — М.:Легкая и пищевая промышленность, 1984. – 504с.
 19. Кишковский З. Н., И.М.Скурихин И. М. Химия вина .М.:-1975. – 432с.
 20. Технологическое оборудование предприятий бродильной промышленности под редакцией — М.: Легкая и пищевая промышленность, 1983. – 464с.
 21. Рибера-Гайон П. Теория и практика виноделия. — М.:Мир, 1972.,207-222 с.
 22. Кретьова И.Т. Технологическое оборудование предприятий бродильной промышленности. М.:Легкая и пищевая промышленность, 1983

Questions for self-control

1. Monosaccharides. Classification. Structure, properties of glucose, fructose, mannose, galactose, ribose, arabinose and xylose. The concept of glucoside hydroxyl and its features.
2. Chemical properties of monosaccharides. Aldonic, sugar and uronic acids, hydrazones and ozones, fermentation of monosaccharides.
3. Monosaccharides. Structure of glucose and fructose. Fisher's projection formulas, Collie-Tolens cyclic formulas, Hawards perspective, conformational formulas.
4. Chemical composition of grapes and wine.
5. History of viticulture and winemaking.