UDC 547.458
DOI: 10.15587/2706-5448.2022.253302
Article type «Original research»

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ANALYSIS OF THE PHYSICAL AND CHEMICAL PROPERTIES OF NATURAL POLYSACCHARIDES AND THE EFFECT OF DISPERSED GLAUCONITE MINERAL ON THEM

The object of research is natural polysaccharides. One of the problems is the high cost and not always environmental friendliness of foreign analogues of these substances. Therefore, the methods of purification of polydisperse systems with the help of dispersed minerals, in particular separated dispersed mineral glauconite, purified and enriched up to 60 % of the initial content, are proposed.

The study used aqueous solutions of dextran and pectin, which added glauconite in the amount of 0.3 to 0.9 % by weight of the solution, heated to 60 °C and kept for 10 minutes. Using glauconite in the amount of 0.3 % by weight of the solution gave high quality indicators. Thus, the dependence of the viscosity of polysaccharides dextran and pectin on the concentration of the introduced mineral was studied. The lowest value of viscosity is observed when adding 0.3 % glauconite to the mass of the solution, with increasing concentration, the viscosity increases.

The process of interaction of dextran molecules with the surface of glauconite is due to the fact that the proposed method of studying the viscosity has a feature that connects neighboring mineral particles through the dextran bridge and the formation of a stable gel structure. These structures are manifested in the form of partial groups of glauconite. This provides the ability to obtain such an indicator as adsorption. The mechanism of interaction of dextran with glauconite is confirmed by the dependence of the amount of dextran adsorbed on the surface of the mineral. Thus, at low concentrations of glauconite – up to 0.3 % adsorption of dextran on the surface increases, and with increasing concentration of glauconite – greatly decreases. This is crucial for the technological parameters of the mineral when using it in preparation processes, in comparison with similar adsorbents of unnatural origin. This will provide the benefits of glauconite over the use in the food industry and the regulation of the physicochemical properties of industrial polydisperse solutions as inexpensive additives of natural origin (stabilizers, thickeners, etc.) that are harmless to human health.

Keywords: *food industry, complex sugars, gley use, dispersed glauconite mineral, gelation mechanism.*

Received date: 09.11.2021
Accepted date: 18.12.2021
Published date: 25.02.2022

How to cite

Tochkova, O. (2022). Analysis of the physical and chemical properties of natural polysaccharides and the effect of dispersed glauconite mineral on them. Technology Audit and Production Reserves, 1 (3 (63)), 16–22. doi: http://doi.org/10.15587/2706-5448.2022.253302

1. Introduction

Polysaccharides (polyoses, or complex sugars) are carbohydrates that consist of a number (from two to several thousand) of the same or different residues of monosaccharides (simple sugars) or related substances (e. g., uronic acids, amino sugars). Polysaccharides are built on the type of glucosides. The formation of polysaccharides from several molecules of monosaccharides occurs due to the copolymerization reaction with the release of water. The monosaccharide residues are bound by oxygen atoms.

Polysaccharides are divided into two major groups: oligosaccharides – low molecular weight polysaccharides that are soluble in water and able to crystallize; higher polyoses are high-molecular substances that are sparingly soluble or completely insoluble in water and, in most cases, do not crystallize.

Oligosaccharides are sweet to the taste; during hydrolysis, each molecule of oligosaccharide breaks down into a small number of molecules of monosaccharide. During the hydrolysis of polysaccharide molecules are formed: disaccharides, trisaccharides, pentoses, hexoses. The most important oligosaccharides are disaccharides: beet and cane sugar (sucrose), milk sugar (lactose), malt sugar (maltose).

Higher polyoses are structurally divided into homopolysaccharides and heteropolysaccharides. Homopolysaccharides consist of one monosaccharide residue or its derivatives. These include starch, glycogen, cellulose, lichen, dextran (consisting of glucose residues), inulin, levan (fructose residues), arabans (arabinose residues), pectic acid the main part of pectic substances (from galacturonic acid residues), chitin (from glucosamine residues). Heteropolysaccharides consist of residues of various monosaccharides and related substances. Heteropolysaccharides include hemicelluloses, plant gleys made from xylose, galactose, arabinose, uronic acid residues, free mucopolysaccharides or protein-bound (hyaluronic acid, chondroitin sulfuric acid and heparin). The structural elements of these substances are glucuronic acid, amino sugars, as well as polysaccharides of bacteria that play an important role in boosting immunity.

Polysaccharide molecules contain a number of free alcohol groups – the presence of hydroxyl groups in higher polyoses can be determined by acetylation or methylation. These and similar reactions are often used to determine the structure of polysaccharides. The decomposition of the polysaccharide molecule is carried out by hydrolysis (acid and enzymatic), which proceeds at different speeds depending on the structure of the polysaccharide and the reaction conditions.

The most common polysaccharides of various origins are given in Table 1.

Many polysaccharides are reserve substances (starch, glycogen, inulin, lichen), the decomposition products of which, as well as energy, are used by the body in vital processes. A number of polysaccharides play an important strength function of resistance (cellulose in plants, chitin in fungi and insects).

Humans consume large amounts of polysaccharides as valuable nutrients in the form of milk and beet sugar, as well as potato starch and grains. Glycogen polysaccharide in the human body is a reserve substance that is deposited mainly in the liver and muscles and undergoes continuous changes (glycolysis). It is necessary to support the processes of life. Some polysaccharides perform important specific functions in humans and animals, such as heparin, which prevents blood circulation, or hyaronic acid, which prevents the penetration of pathogenic microorganisms.

A large amount of polysaccharides in the form of cellulose and products of its processing is used for the manufacture of fabrics (linen, cotton, artificial silk), as well as paper, cellophane and more. Starch, acacia, dextran, milk and beet sugar, and some other polysaccharides are used in medicine to make blood substitutes, to reduce irritation caused by certain drugs, and to make pills and emulsions.

Polysaccharides are widely used in the food industry, in particular, as food additives. They give food the usual look, texture, texture. Polysaccharides of animal and vegetable origin (gelatin, guar, carob gley, carrageenan, pectin) have been used as stabilizers, gelling agents and thickeners. Some additives are obtained by modifying natural products (modified starches, carboxymethylcellulose).

The use of gleys in the food industry is a relatively new direction, and therefore promising for research.

2. The object of research and its technological audit

Despite the fact that different gleys in their structure belong to the same group of chemical compounds, they differ significantly in nature.

Thus, xanthan gley and special types of carboxymethylcellulose can maintain the «mass» in soft drinks by reducing sugar content. Arabian gley when dissolved in water forms transparent solutions, and tragacanth, slowly gaining water, forms a mucous mass.

Guar gley is a polysaccharide from the group of galactomannans, in which the side links of galactose depart from the main chain consisting of mannose. Moreover, one link of galactose has two links of mannose. The viscosity of a 1 % solution of guar (in distilled water) reaches 6000 mPa. Guar is well compatible with many food components and provides the final product with a long mucous texture. Very sensitive to pH, optimum pH 4. The highest effect of guar is achieved together with xanthan gley, for example, in the production of ketchup and mayonnaise.

Table 1

Polysaccharides of various origins

Marine plants	Terrestrial plants	Animal polysaccharides	Microbiological polysaccharides	Derivatives of polysaccharides
Agar agar Alginates Agaroid Karyaginan Laminarin Furcelleron	Araban Arabian gley Asparagosine Balsam resins Cherry gley Locust bean gley Graminin Guar gley Gum arabic Gummi-gutta Evernin Isolichenin Inulin Karain gley Starch Xylan Lichenin Manan Mesquite Goumi Pectin Sinistrin Plum gley Tragacanth Tragacanth gley Chollagum	Animal polysaccharides Galactogen Heparin Hyaluronic acid Glycogen (animal starch) Mucopolysaccharides Ovomucoid Chitin Chondroitin Sulfuric Acid	Microbiological polysaccharides Velan gley Galactocarolose Gelan gley Glucomanan Dextran Dextrin Xanthan Curdlan Levan Microorganism Manans Microfiber cellulose (cellulon) Polyulan Ramzan gley Saccharane Scleroglucan Saccharoglycan	Hydroxyethyl cellulose Hydroxylpropyl guar Hydroxypropylcellulose Carboxymethylcellulose (CMC) Methylhydroxy-ethylcellulose Modified starches Dextran derivatives Propylene glycol alginate

Locust bean gley is a polysaccharide galactomannan, but galactose has four levels of mannose. Locust bean soluble is soluble in hot water and reaches its highest viscosity at a temperature of more than 80 °C. Gives food systems a creamy structure. Very sensitive to acidic environments and reduces the effect at high temperatures.

Arabian gley has a high solubility, which allows to prepare solutions with 50 % gley content. The viscosity of solutions with a concentration of up to 25 % increases in proportion to the gley content, and 40 % solution forms an odorless glue. Arabian gley is used to create shiny surfaces for fruits, nuts, desserts.

Gleys also include substances obtained by biotechnology (xanthan, gelanic gley, dextran).

Xanthan gley is a polysaccharide obtained during the fermentation of *Xanthomonas campestris*. In the xanthan molecule, lateral units comprising two mannose units and one galactonic acid unit depart from the main unit having a cellulose structure.

Xanthan is very resistant to chemical and enzymatic action. It is soluble in hot and cold water, in solutions of sugar, milk, reaches significant viscosity even at significant concentrations. Xanthan is compatible with inorganic salts, which gives the products an «oily» structure. It is resistant to extreme temperatures and pH values. Under mechanical action, aqueous solutions of xanthan lose viscosity, but immediately restore it.

Gelan gley is a polysaccharide produced by the microorganism *Sphingomonas elodea*. The polymer is obtained by two acetyl substituents on the 3rd glucose. On average, 1 glycerate on the repeated chain and 1 acetate on 2 repeated chains. In the solid state, the polymer exists as a coaxial double helix with a triple step.

Gelan gley is formed at low concentrations when cooling hot solutions in the presence of cations capable of gelation. Such ions are magnesium, potassium. Sodium and calcium, on the other hand, prevent gley hydration, in which case a sequestrant is used that binds soluble calcium and thus promotes hydration. Gelanic gley exists in substituted and unsubstituted form. The properties of gley depend on the degree of substitution, with the substituted forms forming soft elastic gels, and the unsubstituted ones forming hard and brittle ones. A feature of the use of this gley is the formation of a gel in the presence of ions of salts of calcium, potassium, sodium. Their concentration significantly affects the modulus of elasticity and fragility of such gels. 60 % sucrose solution reduces the modulus of elasticity, but increases the fragility [1].

Gelane gley is not resistant to extreme temperatures, it is used as a thickener and stabilizer for jellies and desserts in the confectionery industry.

Dextran is obtained by culturing the microorganisms *Leuconostoc mesenteroides*, *Leuconostoc dextranicum*, *Streptobacterium dextranicum*, etc., in an environment containing sucrose or other carbohydrates, which include anhydride-D-glucopyranose units, including low molecular weight. Its molecular network consists of D-glucopyranose chains connected mainly by α-1.6-glycosidic connections. The macromolecules of different dextran preparations may contain different amounts of 1.2-1.2-, α-1.3- or α-1.4-glycosidic connections, by which the side links are attached to the main molecular chain. The molecules of the main molecular chain are practically unbranched, and the elementary chains are connected by 95 % a-1.6-glycosidic connections.

Dextrans formed by different strains differ in structure and properties, i. e. in molecular weight, degree of macromolecule branching, relative content of certain types of glycosidic bonds, solubility, optical activity, physiological action.

Decrease in molecular weight of dextran can take place by acid hydrolysis, enzymatic demopolization, alcoholism, heat treatment, treatment with hydrogen peroxide, γ-irradiation, ultraviolet and X-rays, ultrasound. Hydrochloric, sulfuric, phosphoric, nitric acids can be used. As a result of acid hydrolysis, the degree of branching of the dextran macromolecule decreases due to high resistance to acid hydrolysis of α-1.6-glycosidic connections.

To fractionate partially hydrolyzed dextran and determine its polydispersity, the method of fractional precipitation of dextran from solutions with the addition of precipitators, gel filtration using sephadex is used. Partially hydrolyzed dextran is soluble in water, formamide, dimethyl sulfoxide. Various alcohols and acetone do not dissolve dextran and precipitate it from solution.

Thus, *the object of research* is natural polysaccharides. And one of the problems is the high cost and not always environmental friendliness of foreign analogues of these substances. Therefore, the methods of purification of polydisperse systems with the help of dispersed minerals, in particular separated dispersed mineral glauconite, purified and enriched up to 60 % of the initial content, are proposed.

3. The aim and objectives of research

The aim of this research is to study the patterns of glauconite on the viscosity of aqueous solutions of polysaccharides.

To achieve this goal it is necessary to perform the following tasks:

1. Investigate the effect of glauconite on polydisperse systems (aqueous solutions of dextran and pectin).
2. Investigate the mechanism of gelation in aqueous solutions of dextran.

4. Research of existing solutions to the problem

The papers [2, 3] on the study of physicochemical properties of dextran produced by various microorganisms was performed by IR spectroscopy and thermogravimetric method. The 794 cm^{-1} absorption band is due to the presence of α-1.3-glycosidic bonds in the dextran macromolecules. An endothermic peak in the region of 130–310 °C was detected on the thermograms of the studied dextran samples. The peak in the region of 200 °C is characteristic of dextrans containing α-1.6-glycosidic bonds; 245 °C – for dextrans with α-1.3-glycosidic connection.

The structure of the macromolecule of dextran affects the nature of the sorption of water molecules by the polymer [4, 5]. In preparations with a high content of a-1.6-glycosidic bonds, the amount of adsorbed water increased with increasing relative elasticity of water vapor to 75–85 %, and then decreased. In the presence of α-1.3 and α-1.4-glycosidic bonds, the amount of adsorbed water increased monotonically with increasing relative elasticity of water vapor.

Dextran is also able to crystallize at appropriate heat treatment temperatures – at slow cooling from 190 to 20 °C or heating, as well as when treated with liquids in which it swells (water, formamide).

Crystallization of dextran during heat treatment leads to the appearance of new absorption bands in the IR spectra of the polysaccharide and to an increase in the relative intensity of absorption [6]. This phenomenon is explained by the predominance of certain rotary isomers that promote the crystallization process.

An important chemical characteristic associated with the structure of the dextran macromolecule is the optical activity of its solutions. It depends on the content of α-1.3-glycosidic bonds and the nature of the solvent. The value of $[\alpha]_D$ aqueous solutions of various dextran preparations ranges from +199° to +235°.

Macromolecules of dextran form structural associations with the solvent. The possibility of the formation of such associates is considered taking into account the helical structure of dextran, stabilized by intramolecular bonds and the nature of the hydrogen bonds formed in solution. The presence of other substances in aqueous solutions of dextran affects the shape of dextran macromolecules and the viscosity of solutions. It was shown [7] that in aqueous solutions of urea, glucose and concentrated salt solutions the degree of asymmetry of dextran macromolecules is greater, and in aqueous-methanolic solution – less than in water.

When studying the reactive properties of aqueous solutions of dextran (Mr=120000) in a wide range of concentrations, it was found [8] that a sharp change in these properties is observed at a concentration of 40–43 %. This phenomenon is related to the structure of the hydrate shell of the polymer macromolecule: a sharp change in the viscosity of the solution occurs when its composition corresponds to the formation of 1.5 layers of water molecules around each dextran molecule. The NMR (nuclear magnetic resonance) method was used to study the interaction of water with macromolecules of dextran dissolved in it [9], and electron microscopy was used to determine the size and configuration of macromolecules in solution.

Viscosimetry, as a method of determining the molecular weight of dextran, has known limitations. The study of various dextran preparations by light scattering allowed to establish [10] that in the case when 15–20 α-1.6-glycosidic bonds account for one glycosidic bond of another type, the molecular weight can be calculated by the formula:

$$[\eta] = 2.18 \cdot 10^{-5} \cdot \mu^{0.43},$$

where [η] is the calculated molecular weight; μ is dynamic viscosity, Pa·s.

The increased viscosity of aqueous solutions of hydrolyzed dextran is due to the addition of KSCN and $CaCl_2$ to the solution, and the addition of LiCl and KCl reduces it [11]. The viscosity of aqueous dextran solutions depends on the pH of the solution. The change in viscosity in this case is due to a change in the nature and number of intramolecular hydrogen bonds. In [11] it was investigated:

– the effect of solvents (water, formamide, methanol-water, dimethyl-formamide-water), the molecular weight of dextran (Mr=4100–32000), temperature on the viscosity of solutions, the conformational transition of the macromolecule of dextran in solution;
– determination of virial coefficients, refractive indices of aqueous solutions of dextran, heat and entropy of mixing dextran with water in a wide range of concentrations;
– osmotic pressure and light scattering in aqueous solutions of dextran.

Dextran derivatives, such as alkali and alkaline earth metal dextranates used in the synthesis of ethers, have also become widely used.

Oxidation of dextran with a mixture of dimethyl sulfoxide and acetic anhydride forms a polymer containing ketone groups. Dextran derivatives containing chemically attached drugs (tubazide, novocaine, serotonin, morphine, promedol, various antibiotics) were synthesized on the basis of dextran derivatives containing aldehyde, carboxyl and keto groups.

Determination of the viscosity of a solution of dextran sulfate at different ionic strength allowed to conclude about the high flexibility of macromolecules of dextran sulfate. Its ability to form compounds with different biopolymers allows the use of polymer for the separation and purification of proteins, nucleic acids, lipoproteins. Dextran sulfate enhances the antiviral activity of antiferol, inactivates the activity of enzymes from the group of proteinases and lipoprotein lipase. Its molecular weight significantly affects the degree of inactivation. Dextran sulfate is used for the synthesis of drugs and the manufacture of photographic film.

Dextran phosphates are synthesized by the interaction of dextran with phosphorus chloride in pyridine medium, followed by treatment of the reaction product with sodium. Dextran phosphates form complexes with lipoproteins. They are used in the production of polymer compounds and photographic materials.

Dextran esters are water-soluble products of the interaction of dextran with the active blue monochlorotriazine dye («Blue Dextran-2000»), which is used to determine the free pore volume in column gel filtration, as a substrate for evaluating the effectiveness of enzymes that hydrolyze dextran.

The product of the interaction of dextran carboxymethyl ether with the basic salt of aluminum is used to treat ulcers. Carboxymethyl ester of dextran is used for the synthesis of polymeric drug compounds (pills) of prolonged action, cosmetics, paints, varnishes.

In the interaction of dextran in the presence of sodium hydroxide with sulfate of γ-oxypropylsulfonic acid, chloromethylphosphonic acid and ethylene sulfide synthesized water-soluble sulfopropyl, phosphomethyl thioethyl ether dextran.

Dextran sulfopropyl ether is a strong polyelectrolyte. It also has anticoagulant ability and is used for the synthesis of polymeric drug compounds.

Diethylaminoethyl ether of dextran enhances the formation of interferon and antiviral resistance caused by the introduction of polynucleide cell culture animals. However, dextran diethylaminoethyl ether increases the infectious activity of viruses. These phenomena are due to the fact that this ester protects the nucleic acids of polynucleotides, forming compounds with them, from the destructive action of enzymes from the group of nucleases, reacting with the cell membrane, promotes the penetration of nucleotides and nucleic acids into the cell.

To obtain derivatives with a reticulate structure, known as Sephadex, dextran is treated with epichlorohydrin in an alkaline medium. Thus, varying the concentration of dextran and epichlorohydrin in the reaction medium, Sephadexes of different degrees of crosslinking are obtained, which have different properties to swell in water with different gel pores. Alkylation and acetylation of hydroxyl groups of dextran macromolecules in Sephadex yield their derivatives, which swell well in organic solvents and retain the ability to fractionate substances by molecule size.

Sephadex with ion exchange properties are widely used for the separation of biologically active substances (proteins, hormones, nucleic acids).

Dextran derivatives of the reticulate structure containing a residue of an organometallic compound are used to isolate proteins containing thiol groups.

The addition of cyanide-bromine insulin to the dextran polymer gave immunochemical activity lower than that of the original insulin, but with a stronger and longer lipoglycaemic effect. When administered in smaller doses, compared with the original insulin, induced the formation of certain enzymes in the liver of animals with diabetes.

In the sugar industry, polysaccharides present in diffusion juice, namely hemicellulose, dextran, levan, pectin, etc. have a negative effect on the technological process of sugar production.

Among them, dextran has the greatest impact on the quality of diffusion juice. In particular, its high concentration in the juice leads to a decrease in the filtering capacity of the diffusion juice, due to the formation of a gel-like structure, which, in turn, can even lead to complete shutdown of the plant.

Thus, the results of the analysis allow to conclude that natural polysaccharides are widely used in many industries as inexpensive, natural and safe for human health substances.

5. Methods of research

Model aqueous solutions of dextran and pectin with glauconite additives 0.3–0.9 % by weight of the solution were prepared for the study. The samples were kept at 60–65 °C for 10 minutes, cooled to room temperature and the viscosity of these solutions was determined on a Hepler viscometer (Spain). It should be noted that in some solutions of dextran with glauconite additives it was possible to visually observe gel spherical formations with a size of 2–3 cm, which showed high resistance to mechanical mixing of solutions.

6. Research results

As can be seen from Fig. 1, the concentration dependence of the viscosity of aqueous dextran solutions in the concentration range of 0.05–0.5 % is linear with a slight increase in viscosity.

The addition of glauconite to these solutions leads to a significant change in the concentration dependence: with increasing concentration from 0.25 to 0.35 %, there is a sharp increase in the viscosity of aqueous-dextran solutions several times. This behavior of the viscosity of the solutions can be explained by the formation of strong bonds between glauconite particles and dextran molecules. As is known [12], the surface of glauconite particles is partially montmorillonized. As a result, various molecules of organic substances with a branched molecular structure can be adsorbed into the interlayer space of the mineral. For polysaccharides, as for other macromolecular structures of nutrients, an increase in temperature above 60 °C leads to a transition from tangled structures to branched [13]. This causes increased adsorption capacity to the surface of layered dispersed minerals.

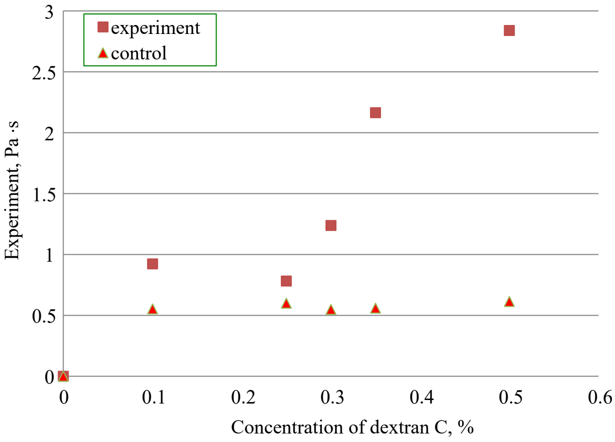
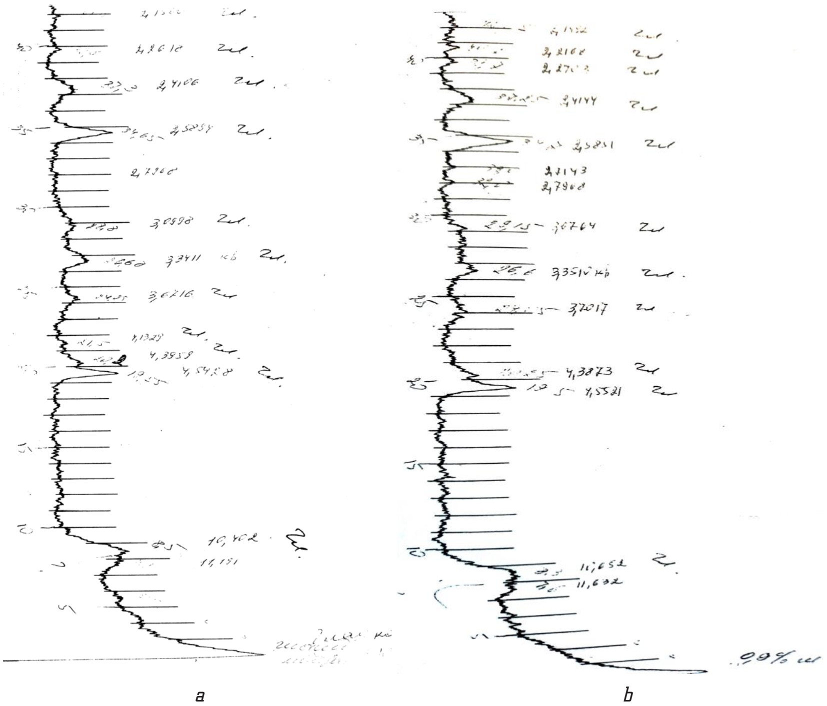


Fig. 1. Concentration dependence of the effective viscosity of aqueous dextran solutions with added 0.3 % glauconite – ■ and without it – ▲

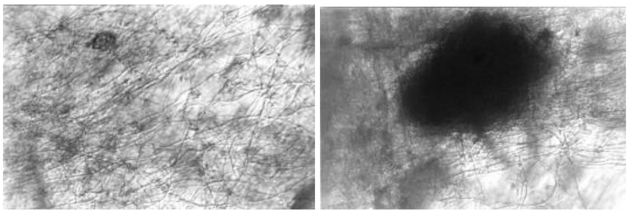
This conclusion is confirmed by the analysis of radiographic diagrams (Fig. 2), they show the appearance near the peak of 11.19 nm weakly intense diffraction peak of 11.63 nm. Diffraction peaks on radiographs with $h=11.63$ nm indicate the penetration of adsorbed molecules of alcohols, ethylene glycols in the interlayer space of molecules.

The specific shape of glauconite particles and the interaction of linear dextran molecules with their surface can lead to the connection of neighboring mineral particles through the dextran bridge. And also to the formation in this way of stable gel-like structures that appear on microphotographs as partial groupings of glauconite (Fig. 3).



a *b*

Fig. 2. Radiograph: *a* – glauconite; *b* – glauconite after interaction with dextran



a *b*

Fig. 3. Microphotographs:
a – dextran solution; *b* – dispersion of glauconite-dextran-water (×360)

The mechanism of interaction of dextran with glauconite is confirmed by the dependence of the amount of dextran adsorbed on the surface of the mineral on the concentration (Fig. 4). It is seen that at low concentrations up to 0.3 % the adsorption of dextran on the surface of glauconite increases, and with increasing concentration – decreases sharply.

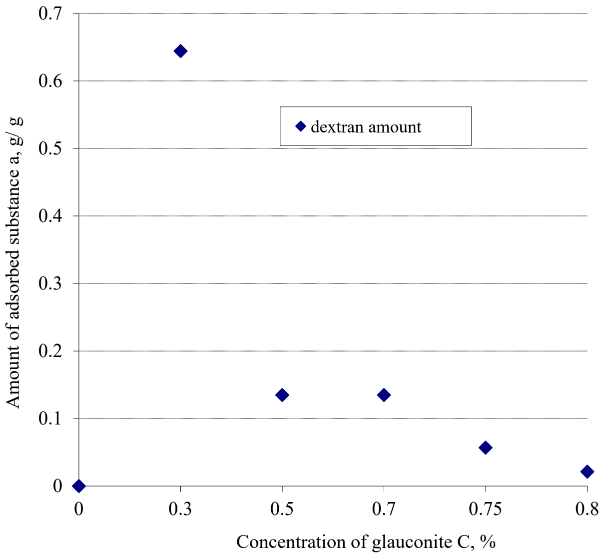


Fig. 4. Dependence of the amount of adsorbed dextran on the surface of glauconite

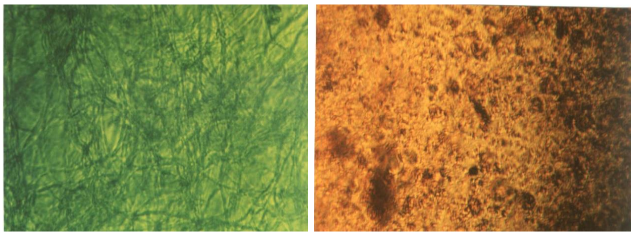
Unlike dextran, the globular structure of pectin is an intertwined long strands of molecules of polymeric structures (Fig. 5).

The complex behavior of the dependence of the viscosity of pectin solutions on the amount of introduced glauconite is explained by the nature of its gelation. Thus, when adding glauconite in the amount of 0.3–0.5 % to the mass of pectin solution with different content (200, 400, 600 mg/100 ml) there is a wavy nature of the dependence of viscosity on mineral content (Fig. 6). This is described by a nonlinear equation with a degree of reliability $R^2=1$. According to Einstein's equation:

$$\eta=\eta_0(1+\alpha\cdot\varphi),$$

where η_0 is viscosity of the dispersion medium; α is particle shape coefficient (≈2.5); φ is the volume concentration of the dispersed phase. Increasing the volume fraction of the dispersed phase in the solution should lead to a gradual increase in viscosity.

Cited in Fig. 6 ascending dependence indicates the complex nature of the interaction of the dispersed phase and the molecules of the dispersion medium. In this case, the addition of a small amount of glauconite 0–0.5 % between the particles and molecular chains of pectin forms strong bonds, which increases the viscosity of the solution.



a *b*

Fig. 5. Microphotography: *a* – pectin; *b* – pectin treated with glauconite

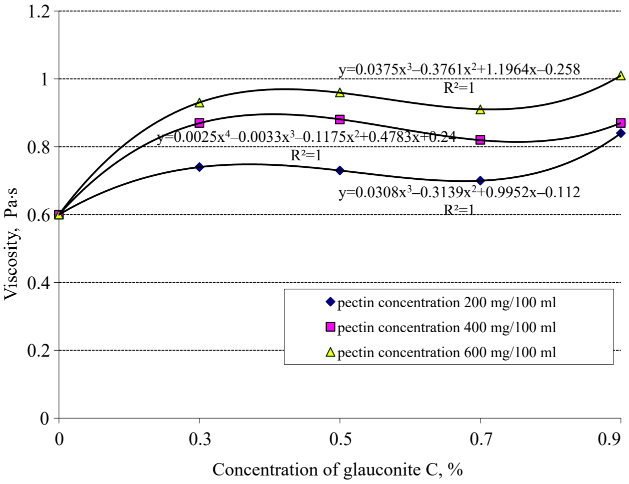


Fig. 6. Dependence of effective viscosity of aqueous solutions of pectin of different concentration on glauconite additives

With an increase in glauconite content from 0.5 to 0.7 %, the viscosity decreases and then increases again. This behavior can be explained by the oriented action of mineral particles on the ordered structural elements of pectin-glauconite, which are formed at low concentrations of the mineral. A further increase in the viscosity of the solution with an increase in the concentration of glauconite above 0.7 % is explained by Einstein's law. Therefore, the optimal concentration of glauconite, which creates the highest rate of gelation, is 0.5 % by weight of the pectin solution.

7. SWOT analysis of research results

Strengths. The positive effect of glauconite on aqueous solutions of polysaccharides is to peptize the grains of natural glauconite in dispersed solutions. This is crucial for the technological parameters of the mineral when using glauconite in the preparation process.

Weaknesses. The disadvantage of this study is that glauconite, like all clay dispersed minerals, is prone to deaggregation.

Opportunities. Studies show a clear relationship between the concentration of polysaccharide and the amount of mineral added. This allows extensive use of research data in the food industry (confectionery, canning) to regulate the physicochemical properties of industrial solutions as inexpensive, natural additives (stabilizers, thickeners, etc.) that are harmless to human health.

Threats. The implementation of research results requires government support from both scientists and industry. Because it is a guarantee of the development and implementation of efficient and safe technologies in many industries.

8. Conclusions

1. As a result of the separation process, the dispersed mineral glauconite was cleaned of waste rock, increasing its concentration to 60 % of the initial content. On the basis of X-ray, microscopic methods, it was found that with an increase in the concentration of glauconite from 0.35 to 0.5 % there is a sharp increase in the viscosity of aqueous-dextran solutions several times. This is due to the formation of strong bonds between glauconite particles and dextran molecules, due to the partially montmorilized surface of glauconite.

2. The mechanism of gelation of aqueous solutions of dextran was studied. It was found that for polysaccharides, as well as for other macromolecular structures of nutrients, increasing the temperature above 60 °C dispersed minerals and the formation of stable gel-like structures. As a result, various molecules of organic substances with a branched molecular structure can be adsorbed into the interlayer space of the mineral. Thus, with the introduction of 0.3 % of separated glauconite, the adsorption process increased by 76 %, compared with the addition of 0.7 % of glauconite to the mass of the solution. That is, the optimal concentration of separated glauconite is 0.3 % of glauconite by weight of dextran solution.

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