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OBTAINING BIOPOLYMER AEROGELS FOR USE IN PHARMACEUTICALS AND MEDICINE

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Abstract: The process of obtaining airgel particles based on a biopolymer has been studied. It is shown how the concentration of starting substances affects the characteristics of the resulting samples. A series of experiments on the sorption of distilled water was carried out. The results obtained showed the promise of using biopolymer-based airgel particles as liquid sorbents.

Keywords: Airgel, supercritical fluids, pharmaceuticals, biopolymers, medicine.

INTRODUCTION: Airgel is a unique material that has a wide range of applications in various fields of industry. One of the advantages of aerogels is the possibility of their production from biodegradable organic substances, for example, biopolymers such as alginate, chitosan, pectin and others [1]. The structures of these biopolymers are shown in Figure 1. Aerogels based on biopolymers have such properties as high porosity (up to 98%), low density (up to 0.2 g/cm3) and high specific surface area (up to 600 m2/g). Aerogels are of greatest interest in based on biopolymers are presented for use in medicine and pharmaceuticals.

MATERIALS AND METHODS: The process of obtaining aerogels based on biopolymers includes the following main stages: preparation of solutions of starting substances, production of a gel, multi-stage replacement of the solvent that is located in the pores of the gel with a corresponding solvent that dissolves in a supercritical fluid environment [2]. The final stage of producing aerogels is supercritical drying in special high-pressure reactors. Such materials can only be obtained using supercritical technologies, since supercritical fluids do not create surface tension in the pores of the dried body and when they are removed, the porous structure remains intact.

RESULTS AND DISCUSSION: To study the process of producing aerogel particles based on biopolymers, an amino sugar was chosen, namely a cationic polysaccharide, which is a derivative of chitin. This biopolymer contains protonated amino groups, which allows its gelation process to be carried out using ionic cross-linking agents (anions or polyanions) due to electrostatic interactions.

The process of producing airgel particles based on the selected amino sugar includes the following stages: preparation of the initial amino sugar solution; preparing a solution of sodium hydroxide, which is a cross-linking agent; obtaining gel particles; step-by-step replacement of solvent (isopropyl alcohol); supercritical drying. As part of the experimental studies, the concentration of the initial amino sugar solution was varied, which was 1% and 2%.

To prepare the initial solution of amino sugar, it is dissolved in a 0.5 M solution of acetic acid of a given volume for 24 hours at room temperature and constant stirring. Next, prepare a 4M alkali solution by dissolving a portion of sodium hydroxide in the required amount of distilled water. To obtain gel particles, a solution of amino sugar is injected dropwise into the alkali solution through a needle. Gel formation occurs due to the fact that after dissolving an amino sugar in an acid, the amino group NH2, under the action of hydrogen cations H+, transforms into the protonated form NH3+. After dropwise introduction of an amino sugar solution into an alkali, the protonated form again passes into the NH2 group, due to which gel particles are formed. The stage of replacing the solvent with isopropyl alcohol is carried out step by step in order to minimize the shrinkage of the resulting gel particles in steps of 30%-60%-90%-100%-100%.

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Supercritical drying of gel particles is carried out at a temperature of 40 °C, a pressure from 120 to 140 atm, and a carbon dioxide flow rate of 0.2 kg/h. Drying time 6 hours.

In order to evaluate the influence of the structural characteristics of the airgel on their sorption properties, a series of experimental studies on the sorption of distilled water were carried out. The experiment is carried out in Petri dishes into which 10 pre-weighed airgel particles are placed. Then 2 ml of distilled water is added to the Petri dish, the dish is closed with a lid and left for 10 minutes. After a specified time, the particles are weighed again. Changes for each sample are repeated 3 times. The results are shown in Table 1.

Table 1. Results of the study of sorption capacity

Concentration of the initial solution when obtaining airgel particles	Mass of particles before sorption, g	Mass of particles after sorption, g	Mass difference, g	Average sorption capacity, g/g	Average value
1%	0.0035	0.0203	0.0168	4.8	7.0
	0.0028	0.0326	0.0298	10.6	
	0.0029	0.0194	0.0165	5.7	
2%	0.0062	0.0315	0.0253	4.1	6.2
	0.0051	0.0319	0.0268	5.3	
	0.0030	0.0303	0.0273	9.1	

CONCLUSION: The results obtained showed that the maximum value of sorbed water (10.6 g of water per 1 g of airgel particles) corresponds to airgel particles obtained at an initial solution concentration of 1%, which is 1.16 times greater compared to the maximum value of sorbed water in the case of airgel particles obtained at concentration 2%.

It has been shown that biopolymer-based airgel particles have a high sorption capacity and can be used as medical sorbents. Further research is planned to conduct studies to evaluate the feasibility of using biopolymer-based airgel particles in drug delivery systems.

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