

Brief information about the project

Name of the project	AP26199543 Bacterial exopolysaccharides as the basis of biocomposite materials: characteristics, fermentation, modifications and possibilities of their application in biotechnology and ecology.
Relevance	Kazakhstan has developed a sugar industry development plan through 2026, which will increase sugar production from domestic raw materials to 250,000 tons annually within the next five years. The sugar production process generates secondary resources: pulp, molasses, and filter cake, most of which are not processed. Molasses and filter cake are used in yeast production, ethyl alcohol production, and as a feed additive, while filter cake is used for soil alkalization and fertilizer production. According to literature, the highest yield of levan was obtained with a molasses medium, while the cost of xanthan gum was reduced with the use of molasses. Furthermore, it is known that modification of native EPS improves its various physicochemical and functional properties. Various modifications have been used, including physical, chemical, biological, and enzymatic ones, which improve the biological activity of EPS. To produce a low-cost nutrient medium, waste from starch factories will be used instead of commercial sugars. Optimization of EPS production conditions for the strains is planned, including cultivation duration, temperature, pH, carbon source, and its quantity. At this stage of the research, a nutrient medium containing one of the sugar mill wastes used—molasses or filter cake—will be selected. Studies will be conducted on modifying native EPS. Chemical modification will include substitution of hydroxyl groups in the EPS structure through acetylation and carboxymethylation, which enhance their biological activity. The rheological and gelling properties of native and modified exopolysaccharides will be studied to assess their potential for use in the oil industry as components of drilling fluids to increase oil recovery and clean up oil-contaminated ecosystems, as well as in the food and pharmaceutical industries. Their potential for application will be assessed by the ability of EPS to thicken tests using skim milk and flour dough by adding various concentrations of native and modified EPS. The EPS of the new strains, which possess good thermal stability, rheological, and gelling properties, are promising for use as structuring or thickening agents in oil drilling fluids and in the bioremediation of contaminated soils, as well as in food products and cosmetics. The practical significance of the project lies in the discovery and application of new strains capable of producing polysaccharide with high yields and the required technological properties.
Purpose	To optimize the conditions for the production of exopolysaccharides based on the composition of the medium and growing conditions (duration of cultivation, temperature, pH, source of sugar industry waste and its quantity), to characterize and modify native exopolysaccharides produced by new strains, and to assess the prospects for using native and modified exopolysaccharides in the cleanup of contaminated soils, agriculture, oil and food industries.
Objectives	1) Isolate and characterize exopolysaccharides in new bacterial strains of the genera <i>Mucilaginibacter</i>, <i>Sphingomonas</i>, <i>Agrobacterium</i>, <i>Xanthomonas</i>, <i>Rhizobium</i>, <i>Lactiplantibacillus</i> and <i>Lactococcus</i>. 2) Optimize EPS production conditions in promising strains based on medium composition and growth conditions (growth duration, temperature, pH, carbon source, and its amount) and modify native EPS. 3) Study the rheological and gelling properties of native and modified exopolysaccharides to assess their potential for use in ecology, the oil industry, and agriculture.
Expected and achieved results	Bacterial exopolysaccharides (EPS) hold great promise for practical applications, but their industrial production is limited. This is due to

	the low productivity of bacterial strains and the high cost of the resulting products. Bacteria known in the scientific literature produce EPS in insignificant quantities, up to approximately 10 g/L, depending on the producing microorganism and growth conditions. Among microbial EPS, only gellan, xanthan, dextran, and levan are produced on an industrial scale. To increase the profitability of EPS use, it is necessary to isolate new, highly productive bacterial strains and reduce the cost of culture media. Growing conditions for EPS producers are crucial, and most researchers believe that high EPS yields require a significant carbohydrate and organic nitrogen content in the culture medium. Optimizing the cultivation of EPS producers on carbohydrate-containing waste is important for the commercialization of the strain and EPS.
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Использование	The use of EPS in new microbial strains in various fields of ecology and biotechnology includes applications as stabilizers, regulating the rheological properties of drilling fluids, as matrices for immobilizing oil-oxidizing microorganisms, and potentially for pharmaceuticals. The ability of EPS in low concentrations to increase viscosity and form gels will be exploited to enhance oil recovery.
Приоритет в сравнении с реальными аналогами	Bacterial exopolysaccharides represent the most promising platform for creating biocomposite materials because they: combine the properties of polymers and biological systems; surpass their counterparts in environmental friendliness and functionality; provide flexibility in materials engineering; and have high potential in ecology and biotechnology.
List of publications with links to them	Utility model 2024/1263.2 <i>Sphingomonas sp.</i> MPK rhizosphere strain producing exopolysaccharide.
Patents	