

Brief information about the project

Name of the project	AP26104459 " Creation of a biosurfactant- and biopolymer-producing microbial consortium for enhanced oil recovery".
Relevance	The project focuses on studying oil-mobilizing metabolites, particularly biopolymers, produced by indigenous microorganisms isolated from oilfields in Western Kazakhstan, and creating an active consortium based on these microorganisms to increase the mobility of viscous oil. The main approach involves a comprehensive study of microorganisms that produce oil-mobilizing metabolites and forming a microbial consortium that produces both biosurfactants and biopolymers for enhanced oil recovery. The consortium will be evaluated through model and bench-scale tests. The final outcome is the selection of an active microbial consortium capable of producing biosurfactants and biopolymers, and the assessment of its effectiveness under extreme reservoir conditions (high temperature, pressure, and salinity).
Purpose	The objective of the project is to create a biosurfactant- and biopolymer-producing microbial consortium to enhance oil recovery from reservoirs.
Objectives	1. Selection of active biopolymer-producing microorganisms 1.1. Screening of biopolymer-producing microorganisms 1.2. Determination of the physicochemical characteristics of oil-thinning microbial biopolymers Screening for active biopolymer-producing microorganisms targeting viscous oil will be conducted using previously isolated indigenous cultures from oil reservoirs through qualitative and quantitative methods. Additionally, the presence of genes responsible for biopolymer synthesis in the selected microorganisms will be determined. The selected active strains will be identified based on 16S rRNA. Biopolymer identification will be performed using infrared (IR) spectroscopy and mass-spectroscopy, and the comprehensive characterization of the biopolymer will be conducted. 2. Creation of a biopolymer- and biosurfactant-producing microbial consortia 2.1. Whole-genome analysis of biopolymer- and biosurfactant-producing strains 2.2. Study of the compatibility of active biopolymer- and biosurfactant-producing microbial strains. Whole-genome analysis of one or more biopolymer- and biosurfactant-producing strains will be performed. Biosurfactant-producing strains selected in the framework of a previous project will be used. Whole-genome analysis will be conducted in the laboratory of collaborator

	Professor Izabela Świącicka (Poland). The study of strain compatibility will focus on identifying competition for nutrients, the production of inhibitory compounds, and the synergistic capacity for synthesizing target metabolites in the consortia. 3. Ex-situ microbial enhanced oil recovery 3.1. Study of the key properties of the microbial consortia for enhanced oil recovery 3.2. Optimization of conditions to improve the oil recovery factor (ORF) The target activities of the created microbial consortia, such as emulsifying activity, surface tension reduction, and others, will be assessed both in the consortia and in monoculture to optimize and enhance the synergy of the microbial strains. Optimization will consider the concentration of microorganisms, strain ratios in the consortia, and the selection of carbon and nitrogen sources in the growth medium. The final stage will be the assessment of the oil recovery efficiency using the consortia under ex-situ conditions.
Expected and achieved results	Results achieved (year 1): • Screening and sampling: viable native strains have been isolated from oil samples from Western Kazakhstan. The primary selection of the most active producers of biopolymers was carried out. • Identification: The genetic identification of the selected cultures (16S rRNA) has been performed and the study of their morphological and tinctorial properties has begun. • Analysis of metabolites: The first IR spectrometry data confirming the chemical structure of the isolated microbial biopolymers were obtained. Expected results (years 2 and 3): • Genome-wide analysis: detailed genetic mapping of key strains will be performed (together with partners from Poland) to identify the genes responsible for biosurfactant synthesis. • Creation of an association: a stable microbial "team" (association) will be formed, where the strains do not compete, but enhance each other's action (synergy). • Bench tests: in laboratory conditions (<i>ex-situ</i>), optimal dosages and conditions (T, P, salinity) will be determined for maximum oil displacement. • Economics and implementation: the cost of industrial application of the technology will be calculated and a patent application will be prepared. The new producer strain will replenish the National Fund of Microorganisms. The final effect: The project will create a scientific and practical base for the introduction of "green" MEOR technologies in mature fields of Kazakhstan, ensuring import substitution and environmental safety of oil production.
Research team members with their identifiers (Scopus Author	1. Kaiyrmanova Gulzhan, Candidate of Biological Sciences, Associate Professor, h-index – 5, Researcher ID:

ID, Researcher ID, ORCID, if available) and links to relevant profiles	A-8951-2015, ORCID: 0000-0001-8486-0566, Scopus Author ID: 56044521600. 2. Yernazarova Aliya, Candidate of Biological Sciences, h-index – 6, Researcher ID: B-2441-2014, ORCID: 0000-0001-5195-1795, Scopus Author ID: 55649077100. 3. Magmiyaev Ratbek, h-index – 1; Researcher ID: AGM-4258-2022, ORCID: 0000-0002-0096-6046, Scopus Author ID: 57218991361. 4. Shaimerdenova Ulzhan, PhD, h-index – 2; Researcher ID: AGI-8419-2022, ORCID: 0000-0001-7399-7639, Scopus Author ID: 57219003283. 5. Asylbek Alisher, ID: KCJ-9643-2024, ORCID: 0009-0004-0991-5474.
Usage	Oil producing companies, oilfield service enterprises, scientific institutes, universities
Priority compared to real-world alternatives	The project is characterized by the use of native microorganisms from oil fields in Western Kazakhstan, which ensures their high adaptation to extreme reservoir conditions and increased efficiency compared to foreign strains. Unlike existing analogues, it is proposed to create a synergistic association of microorganisms simultaneously producing biosurfactants and biopolymers, which provides a comprehensive effect on oil viscosity and fluid mobility. An additional advantage is the focus on high-viscosity oils and conducting model and bench tests that are close to real reservoir conditions.
List of publications with links to them	Shaimerdenova Ulzhan, Kaiyrmanova Gulzhan, Assylbek Alisher, Nurmakhan Zhandar, Yernazarova Aliya. Biotechnological solutions based on <i>Bacillus subtilis</i> for microbial enhanced oil recovery. Fifth International Conference of the Society of Environmental Sustainability. <i>Environmental Sustainability</i> (2026). https://doi.org/10.1007/s42398-025-00408-1
Patents	-