

ISSN 2518-1483 (Online),
ISSN 2224-5227 (Print)

**ACADEMIC JOURNAL
OF PHYSICAL AND CHEMICAL SCIENCES**

**№2
2026**

ISSN 2518-1483 (Online),
ISSN 2224-5227 (Print)

2026 • 2



ACADEMIC JOURNAL OF PHYSICAL AND CHEMICAL SCIENCES

PUBLISHED SINCE JANUARY 1944

ALMATY, NAS RK

Editor-in-Chief:

ZHURINOV Murat Zhurinovich, Doctor of Chemical Sciences, Professor, Academician of IAAS and NAS RK, General Director of the Research Institute of Petroleum Refining and Petrochemicals (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=6602177960> <https://www.webofscience.com/wos/author/record/2017489>

Editorial Board:

KALIMOLDAYEV Maksat Nuradilovich, Doctor of Physical and Mathematical Sciences, Professor, Academician of NAS RK (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=56153126500>, <https://www.webofscience.com/wos/author/record/2428551>

ADEKENOV Sergazy Mynzhasarovich, Doctor of Chemical Sciences, Professor, Academician of NAS RK, Director of the JSC "Phytochemistry Research and Production Center", (Karaganda, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=7006153118>, <https://www.webofscience.com/wos/author/record/48648658>

RAMAZANOV Tlekkaul Sabitovich, (Deputy Editor-in-Chief), Doctor of Physical and Mathematical Sciences, Professor, Academician of NAS RK (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=6701328029>, <https://www.webofscience.com/wos/author/record/13503476>

ABIEV Rufat, Doctor of Technical Sciences (Biochemistry), Professor, Head of the Department of Optimization of Chemical and Biotechnological Equipment, St. Petersburg State Technological Institute (St. Petersburg, Russia), <https://www.scopus.com/authid/detail.uri?authorId=6602431781>, <https://www.webofscience.com/wos/author/record/1405661>

OLIVIERO Rossi Cesare, PhD (Chemistry), Professor at the University of Calabria (Calabria, Italy), <https://www.scopus.com/authid/detail.uri?authorId=57221375979>, <https://www.webofscience.com/wos/author/record/399768>

TIGINYANU Ion Mihailovich, Doctor of Physical and Mathematical Sciences, Academician, President of the Academy of Sciences of Moldova, Technical University of Moldova (Chisinau, Moldova), <https://www.scopus.com/authid/detail.uri?authorId=7006315935>, <https://www.webofscience.com/wos/author/record/524462>

SANG SU Kwak, PhD (Biochemistry, Agricultural Chemistry), Professor, Chief Scientist, Research Center for Plant Systems Engineering, Korea Research Institute of Bioscience and Biotechnology (KRIBB), (Daecheon, Korea), <https://www.scopus.com/authid/detail.uri?authorId=59286321700>, <https://www.webofscience.com/wos/author/record/30028581>

BERSIMBAYEV Rakhmetkazhi Iskenderovich, Doctor of Biological Sciences, Professor, Academician of NAS RK, L.N. Gumilyov Eurasian National University (Astana, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=7004012398>, <https://www.webofscience.com/wos/author/record/19854255>

CALANDRA Pietro, PhD (Physics), Professor, Institute for the Study of Nanostructured Materials (Rome, Italy), <https://www.scopus.com/authid/detail.uri?authorId=7004303066>, <https://www.webofscience.com/wos/author/record/616360>

BOSHKAEV Kuantai Avgazyevich, PhD, Associate Professor, Department of Theoretical and Nuclear Physics, Al-Farabi Kazakh National University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=54883880400>, <https://www.webofscience.com/wos/author/record/2080231>

BURKITBAEV Mukhambetkali, Doctor of Chemical Sciences, Professor, Academician of NAS RK, (Almaty, Kazakhstan) <https://www.scopus.com/authid/detail.uri?authorId=8513885600>, <https://www.webofscience.com/wos/author/record/29017135>

QUEVEDO Hernando, Professor, National Autonomous University of Mexico (UNAM), Institute of Nuclear Sciences (Mexico City, Mexico), <https://www.scopus.com/authid/detail.uri?authorId=55989741100>, <https://www.webofscience.com/wos/author/record/30353742>

ZHUSUPOV Marat Abzhanovich, Doctor of Physical and Mathematical Sciences, Professor of the Department of Theoretical and Nuclear Physics, Al-Farabi Kazakh National University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=6602166928>, <https://www.webofscience.com/wos/author/record/566>

KOVALEV Alexander Mikhailovich, Doctor of Physical and Mathematical Sciences, Academician of NAS of Ukraine, Institute of Applied Mathematics and Mechanics (Donetsk, Ukraine), <https://www.scopus.com/authid/detail.uri?authorId=7202799321>, <https://www.webofscience.com/wos/author/record/65533963>

TAKIBAEV Nurgali Zhabagaevich, Doctor of Physical and Mathematical Sciences, Professor, Academician of NAS RK, Al-Farabi Kazakh National University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=24077239000>, <https://www.webofscience.com/wos/author/record/1671760>

KHARIN Stanislav Nikolaevich, Doctor of Physical and Mathematical Sciences, Professor, Academician of NAS RK, Kazakh-British Technical University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=6701353063>, <https://www.webofscience.com/wos/author/record/2023295>

ABISHEV Medeu Erzhanovich, Doctor of Physical and Mathematical Sciences, Professor, Corresponding Member of NAS RK, (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=26530759900>, <https://www.webofscience.com/wos/author/record/1556025>

ABILMAGZHANOV Arlan Zainutallaevich, PhD in Chemistry, First Deputy Director General of JSC "Institute of Fuel, Catalysis and Electrochemistry named after D.V. Sokolsky", (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57197468109>, <https://www.webofscience.com/wos/author/record/2024265>

ACADEMIC JOURNAL OF PHYSICAL AND CHEMICAL SCIENCES.

ISSN 2518-1483 (Online), ISSN 2224-5227 (Print)

Owner: «Central Asian Academic Research Center» LLP (Almaty).

The certificate of registration of a periodical printed publication in the Committee of Information of the Ministry of Information and Social Development of the Republic of Kazakhstan № **KZ93VPY00121157** issued **05.06.2025**

Thematic scope: *physics and chemistry*.

Periodicity: 4 times a year.

<http://reports-science.kz/index.php/en/archive>

Бас редактор:

ЖҰРЫНОВ Мұрат Жұрыңұлы, химия ғылымдарының докторы, профессор, ХҒАҚ және ҚР ҰҒА академигі, Мұнай өңдеу және мұнай-химиясы ғылыми-зерттеу институтының бас директоры (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=6602177960%3Cp%3Ehttps://www.webofscience.com/wos/author/record/2017489>

Редакция ұжымы:

КАЛИМОЛДАЕВ Максат Нұрәділұлы, физика-математика ғылымдарының докторы, профессор, ҚР ҰҒА академигі (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=56153126500>, <https://www.webofscience.com/wos/author/record/2428551>

ӘДЕКЕНОВ Серғазы Мыңжасарұлы, химия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, "Фитохимия" ғылыми-өндірістік орталығы " АҚ директоры (Қарағанды, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=7006153118>, <https://www.webofscience.com/wos/author/record/48648658>

РАМАЗАНОВ Тілеккабыл Сәбитұлы, физика-математика ғылымдарының докторы, профессор, ҚР ҰҒА академигі, (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=6701328029>, <https://www.webofscience.com/wos/author/record/13503476>

ӘБИЕВ Руфат, техника ғылымдарының докторы (биохимия), профессор, Санкт-Петербург мемлекеттік технологиялық институты «Химиялық және биотехнологиялық аппаратураны оңтайландыру» кафедрасының меңгерушісі, (Санкт-Петербург, Ресей), <https://www.scopus.com/authid/detail.uri?authorId=6602431781>, <https://www.webofscience.com/wos/author/record/1405661>

ОЛИВЬЕРО Росси Сесаре, PhD (химия), Калабрия университетінің профессоры (Калабрия, Италия), <https://www.scopus.com/authid/detail.uri?authorId=57221375979>, <https://www.webofscience.com/wos/author/record/399768>

ТИГІНЯНУ Ион Михайлович, физика-математика ғылымдарының докторы, академик, Молдова Ғылым Академиясының президенті, Молдова техникалық университеті (Кишинев, Молдова), <https://www.scopus.com/authid/detail.uri?authorId=7006315935>, <https://www.webofscience.com/wos/author/record/524462>

САНГ-СУ Квак, PhD (биохимия, агрохимия), профессор, Корея Биология және биотехнология ғылыми-зерттеу институты (KRIIBV), өсімдіктердің инженерлік жүйелері ғылыми-зерттеу орталығының бас ғылыми қызметкері, (Дэчон, Корея), <https://www.scopus.com/authid/detail.uri?authorId=59286321700>, <https://www.webofscience.com/wos/author/record/30028581>

БЕРСІМБАЕВ Рахметқажы Ескендірұлы, биология ғылымдарының докторы, профессор, ҚР ҰҒА академигі, Л.Н. Гумилев атындағы Еуразия ұлттық университеті. (Астана, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=7004012398>, <https://www.webofscience.com/wos/author/record/19854255>

КАЛАНДРА Пьетро, PhD (физика), нанотехнология материалдары зерттеу институтының профессоры (Рим, Италия), <https://www.scopus.com/authid/detail.uri?authorId=7004303066>, <https://www.webofscience.com/wos/author/record/616360>

БОШКАЕВ Қуантай Авғазыұлы, Ph.D. Теориялық және ядролық физика кафедрасының доценті, әл-Фараби атындағы Қазақ ұлттық университеті (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=54883880400>, <https://www.webofscience.com/wos/author/record/2080231>

БҮРКІТБАЕВ Мұхамбетқали, химия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=8513885600>, <https://www.webofscience.com/wos/author/record/29017135>

QUEVEDO Hernando, профессор, Мексика ұлттық автономиялық университеті (UNAM), Ядролық ғылымдар институты (Мехико, Мексика), <https://www.scopus.com/authid/detail.uri?authorId=55989741100>, <https://www.webofscience.com/wos/author/record/30353742>

ЖҮСІПОВ Марат Абжанұлы, физика-математика ғылымдарының докторы, теориялық және ядролық физика кафедрасының профессоры, Әл-Фараби атындағы Қазақ ұлттық университеті (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=6602166928>, <https://www.webofscience.com/wos/author/record/566>

КОВАЛЕВ Александр Михайлович, физика-математика ғылымдарының докторы, Украина ҰҒА академигі, Қолданбалы математика және механика институты (Донецк, Украина), <https://www.scopus.com/authid/detail.uri?authorId=7202799321>, <https://www.webofscience.com/wos/author/record/65533963>

ТАКИБАЕВ Нұрғали Жабағұлы, физика-математика ғылымдарының докторы, профессор, ҚР ҰҒА академигі, Әл-Фараби атындағы Қазақ ұлттық университеті (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=24077239000>, <https://www.webofscience.com/wos/author/record/1671760>

ХАРИН Станислав Николаевич, физика-математика ғылымдарының докторы, профессор, ҚР ҰҒА академигі, (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=6701353063>, <https://www.webofscience.com/wos/author/record/2023295>

ӘБІШЕВ Медеу Ержанұлы, физика-математика ғылымдарының докторы, профессор, ҚР ҰҒА академигі, (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=26530759900>, <https://www.webofscience.com/wos/author/record/1556025>

ӘБІЛМАҒЖАНОВ Арлан Зайнуталлайұлы, химия ғылымдарының кандидаты, Д.В. Сокольский атындағы "Отын, катализ және электрохимия институты" АҚ Бас директорының бірінші орынбасары, (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=57197468109>, <https://www.webofscience.com/wos/author/record/2024265>

ACADEMIC JOURNAL OF PHYSICAL AND CHEMICAL SCIENCES

ISSN 2518-1483 (Online), ISSN 2224-5227 (Print)

Меншіктеуші: «Орталық Азия академиялық ғылыми орталығы» ЖШС (Алматы қ.).

Ақпарат агенттігінің мерзімді баспасөз басылымын, ақпарат агенттігін және желілік басылымды қайта есепке қою туралы ҚР Мәдениет және Ақпарат министрлігі «Ақпарат комитеті» Республикалық мемлекеттік мекемесі **05.06.2025 ж.** берген № **KZ93VPY00121157** Куәлік.

Тақырыптық бағыты: *физика, химия.*

Мерзімділігі: жылына 4 рет.

<http://reports-science.kz/index.php/en/archive>

Главный редактор:

ЖУРИНОВ Мурат Журинович, доктор химических наук, профессор, академик МАН и НАН РК, Генеральный директор НИИ нефтепереработки и нефтехимии (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6602177960%3Cp%3Ehttps://www.webofscience.com/wos/author/record/2017489>

Редакционная коллегия:

КАЛИМОЛДАЕВ Максат Нурадилович, доктор физико-математических наук, профессор, академик НАН РК (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=56153126500>, <https://www.webofscience.com/wos/author/record/2428551>

АДЕКЕНОВ Сергезы Мынжасарович, доктор химических наук, профессор, академик НАН РК, директор АО "Научно-производственного центра "Фитохимия" (Караганда, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=7006153118>, <https://www.webofscience.com/wos/author/record/48648658>

РАМАЗАНОВ Тлеккабул Сабитович, (заместитель главного редактора), доктор физико-математических наук, профессор, академик НАН РК (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6701328029>, <https://www.webofscience.com/wos/author/record/13503476>

АБИЕВ Руфат, доктор технических наук (биохимия), профессор, заведующий кафедрой «Оптимизация химической и биотехнологической аппаратуры», Санкт-Петербургский государственный технологический институт (Санкт-Петербург, Россия), <https://www.scopus.com/authid/detail.uri?authorId=6602431781>, <https://www.webofscience.com/wos/author/record/1405661>

ОЛИВЬЕРО Росси Чезаре, доктор философии (PhD, химия), профессор Университета Калабрии (Калабрия, Италия), <https://www.scopus.com/authid/detail.uri?authorId=57221375979>, <https://www.webofscience.com/wos/author/record/399768>

ТИГИНЯНУ Ион Михайлович, доктор физико-математических наук, академик, президент Академии наук Молдовы, Технический университет Молдовы (Кишинев, Молдова), <https://www.scopus.com/authid/detail.uri?authorId=7006315935>, <https://www.webofscience.com/wos/author/record/524462>

САНГ-СУ Квак, доктор философии (PhD, биохимия, агрохимия), профессор, главный научный сотрудник, Научно-исследовательский центр инженерных систем растений, Корейский научно-исследовательский институт бионауки и биотехнологии (KRIBB), (Дэжон, Корея), <https://www.scopus.com/authid/detail.uri?authorId=59286321700>, <https://www.webofscience.com/wos/author/record/30028581>

БЕРСИМБАЕВ Рахметкажи Искендинович, доктор биологических наук, профессор, академик НАН РК, Евразийский национальный университет им. Л.Н. Гумилева (Астана, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=7004012398>, <https://www.webofscience.com/wos/author/record/19854255>

КАЛАНДРА Пьетро, доктор философии (PhD, физика), профессор Института по изучению наноструктурированных материалов (Рим, Италия), <https://www.scopus.com/authid/detail.uri?authorId=7004303066>, <https://www.webofscience.com/wos/author/record/616360>

БОШКАЕВ Куантай Авгазыевич, PhD, преподаватель, доцент кафедры теоретической и ядерной физики, Казахский национальный университет им. Аль-Фараби (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=54883880400>, <https://www.webofscience.com/wos/author/record/2080231>

БУРКИТБАЕВ Мухамбеткали, доктор химических наук, профессор, академик НАН РК, (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=8513885600>, <https://www.webofscience.com/wos/author/record/29017135>

QUEVEDO Hernando, профессор, Национальный автономный университет Мексики (UNAM), Институт ядерных наук (Мехико, Мексика), <https://www.scopus.com/authid/detail.uri?authorId=55989741100>, <https://www.webofscience.com/wos/author/record/30353742>

ЖУСУПОВ Марат Абжанович, доктор физико-математических наук, профессор кафедры теоретической и ядерной физики, Казахский национальный университет им. аль-Фараби (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6602166928>, <https://www.webofscience.com/wos/author/record/566>

КОВАЛЕВ Александр Михайлович, доктор физико-математических наук, академик НАН Украины, Институт прикладной математики и механики (Донецк, Украина), <https://www.scopus.com/authid/detail.uri?authorId=7202799321>, <https://www.webofscience.com/wos/author/record/65533963>

ТАКИБАЕВ Нурғали Жабағаевич, доктор физико-математических наук, профессор, академик НАН РК, Казахский национальный университет им. Аль-Фараби (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=24077239000>, <https://www.webofscience.com/wos/author/record/1671760>

ХАРИН Станислав Николаевич, доктор физико-математических наук, профессор, академик НАН РК (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6701353063>, <https://www.webofscience.com/wos/author/record/2023295>

АБИШЕВ Медеу Ержанович, доктор физико-математических наук, профессор, академик НАН РК, (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=26530759900>, <https://www.webofscience.com/wos/author/record/1556025>

АБИЛМАТЖАНОВ Арлан Зайнуталлаевич, кандидат химических наук, первый заместитель генерального директора АО «Институт топлива, катализа и электрохимии им. Д.В. Сокольского», (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57197468109>, <https://www.webofscience.com/wos/author/record/2024265>

ACADEMIC JOURNAL OF PHYSICAL AND CHEMICAL SCIENCES

ISSN 2518-1483 (Online), ISSN 2224-5227 (Print)

Собственник: ТОО «Центрально-азиатский академический научный центр» (г. Алматы).

Свидетельство № KZ93VPY00121157 о повторной регистрации периодического печатного издания информационного агентства, информационного агентства и сетевого издания, выданное Республиканским государственным учреждением «Комитет информации» Министерства культуры и информации Республики Казахстан 05.06.2025

Тематическая направленность: физика, химия.

Периодичность: 4 раза в год.

<http://reports-science.kz/index.php/en/archive>

© ТОО «Центрально-азиатский академический научный центр», 2026

CONTENTS

PHYSICS

Koshtybayev T.B., Aliev Sh., Aliyeva M.E., Zhavliyeva A.T. Covariant approach to the kinetic theory of plasma in a strong electromagnetic field.....	13
Kemelbekova A., Shongalova A., Bondar E., Otunchi Ye. Recycling technologies for spent lithium-ion batteries: environmental impact, recovered products, and future development trends.....	25
Koilyk N., Baimbetova G., Dalelkhankyzy A., Kaptagay G., Primkulova Zh. Simplification of the fermionic dynamical symmetry model for identical particles and its mapping into bosonic space.....	38
Massak B., Agyl-Mussapar O., Amangeldinova S., Kurmangaliyeva V., Snow M. Constraints on Yukawa-Type short-range interactions from neutron interferometry data.....	60
Nurbayev B.M., Dmitriyeva E.A. Tin-based perovskites.....	70
Nurtazina A.S., Zhubaev A.K. Study of the effect of highly dispersed ochre on the kinetic characteristics of epoxy composites.....	92
Shokanov A.K., Khamrayev Sh.I., Smikhan Y.A. Mössbauer studies of fly ash-based tracers.....	103
Ualikhanova U.A., Kurban Y.Y., Syzdykova A.M., Altayeva G.S., Altaibayeva A.B. Breaking the degeneracy between metric and teleparallel gravity theories through multi-messenger gravitational-wave astronomy.....	119
Zhadyranova A.A., Yerzhan B. Dynamics of bounce regimes in modified teleparallel gravity.....	134
Zhusupova N.K. Application of machine learning methods in the analysis of gravitational waves and cosmological models.....	151

CHEMISTRY

Aubakirov Ye., Akhmetova F., Tashmukhambetova Zh., Toshtay K., Amantaiuly K. Conversion of Polymer Waste into Synthetic Fuel via Modification of Taizhuzhen Zeolite with Tungsten Salts.....	164
Auyeshov A.P., Eskibayeva Ch.Z., Ibrayeva A.M., Alzhanov K.B., Dikanbayeva A.K. Physicochemical study of serpentinite waste and phosphoric acid products.....	175
Bayeshova A.K., Bayeshov A., Tuleshova E.Zh. Reduction of copper ions by zinc in the presence of titanium(iv) ions in sulfuric acid solutions.....	188

Fazylov S.D., Syzdykov A.K., Pustolaikina I.A., Kazhmuratova A.T., Tazhibay A.M. Production of α -, β -, γ -oligosaccharide clathrate cytosine complexes.....	200
Jalmakhanbetova R.I., Yelshibayeva A.M., Zhumagaliyeva Zh.Zh., Mukusheva G.K. Terpenoid compounds of <i>Artemisia terrae-albae</i> growing in the Turkestan Region of Kazakhstan.....	213
Kapizov O.S., Mukhanov D.K., Dzheldybaeva I.M., Seisenov E.B., Akimbayeva A.B. Sustainable recycling of ferrosilicon machining chips from metallurgical plants into high-performance silicon-carbon anodes.....	228
Massalimova B.K. Wastewater treatment methods for heavy metal removal: production of activated carbon from biomass.....	244
Nurtai Zh., Orynassar R., Aimaganbetova Z.K., Zhanturina N.N. Simulation of kinetic parameters of vinyl ester resin samples with diatomite and dimethyl methylphosphonate fillers.....	272
Sagyntayeva A., Zhanikulov N., Sudarev E., Kaiyrbaeva M., Zhakipbayev B. Research on the quality of raw materials for obtaining gypsum-cement-pozzolanic composite material.....	286
Satayeva S., Yermukhanova S., Urazova A., Mendygaliyeva A., Sabitov B. Obtaining benzene by photocatalytic oxidation of toluene.....	302
Sdikova G.Zh., Dalabayeva N.S., Sarova N.B., Muhtar T.Zh., Zhaltirbayeva N.K. Efficiency of phosphorus-containing inhibitors in protecting steel against corrosion.....	315
Shaimardan M., Azhikhanova Z., Abutalip M., Toktarbaiuly O. Isolation and Characterization of lignin from <i>Phlomis tuberosa</i> L. biomass via acid treatment.....	329
Yesimsiitova Z.B., Seisenova A., Oryngaliyeva S.Zh., Sanuar A., Manap K.R. Obtaining carbonized materials from rice husk using a mobile pyrolysis plant for energy applications.....	338
Zhetenova M.S., Suleimenova M.Sh., Nuraly A.M., Mutushev A.Zh., Kalimoldina L.M. Development and research of carotenoid-containing extracts obtained from plant raw materials.....	353
Zhortarova A.A., Kubicek V., Salkeyeva L.K., Ibrayev M.K., Seidakhmetova R.B. Synthesis and investigation of biological activity of 1,3-Bis(4-Phenylthiazol-2-yl)-2,4-Bis(N,N- Diethylamino)-1,3-Diaza-2,4-Diphosphétidine.....	367
Zhumabek M., Tungatarova S.A., Murzin D.Yu., Baizhumanova T.S. Structural and catalytic properties of SCS-derived Co-Al-Mg-Mn catalysts in dry reforming of methane.....	383

МАЗМҰНЫ

ФИЗИКА

Қоштыбаев Т.Б., Алиев Ш., Алиева Е.М., Жавлиева А.Т. Күшті электромагниттік өрістегі плазманың кинетикалық теориясына коварианттық көзқарас.....	13
Кемелбекова А., Шонғалова А., Бондарь Е., Отунчи Е. Пайдаланылған литий-ионды аккумуляторларды қайта өңдеу технологиялары: экологиялық әсері, алынатын өнімдер және болашақ даму бағыттары.....	25
Қойлық Н.О., Байымбетова Г.А., Дәлелханқызы А., Қаптағай Г.А., Примкулова Ж.Е. Бірдей бөлшектер үшін фермионды динамикалы-симметриялық модельді ықшамдау және оны бозондық кеңістікке бейнелеу.....	38
Масақ Б., Ағыл-Мұсапар О., Амангелдинова С., Курманғалиева В., Сноу М. Нейтрондық интерферометрия негізінде юкава типті қысқа-қашықтықтағы өзара әсерлесулерге шектеулер қою.....	60
Нұрбаев Б.М., Дмитриева Е.А. Қалайы негізіндегі перовскиттер.....	70
Нуртазина А.С., Жубаев А.К. Дисперстілігі жоғары охраның эпоксидті композиттердің кинетикалық сипаттамаларына ықпалын зерттеу.....	92
Шоканов А.К., Хамраев Ш.И., Смихан Е.А. Ұшқыш күл негізіндегі трассерлердің мессбауэрлік зерттеулері.....	103
Уалиханова У.А., Құрбан Е.Е., Сыздыкова А.М., Алтаева Г.С., Алтайбаева А.Б. Көп арналы гравитациялық-толқындық астрономия арқылы метрикалық және телепараллельді гравитация теорияларының айырмашылығын зерттеу.....	119
Жадыранова А.А., Ержан Б. Модификацияланған телепараллель гравитациядағы серпіліс режимдерінің динамикасы.....	134
Жусупова Н.К. Машиналық оқыту әдістерін гравитациялық толқындар мен космологиялық модельдерді талдауда қолдану.....	151

ХИМИЯ

Аубакиров Е., Ахметова Ф., Ташмухамбетова Ж., Тоштай Қ., Амантайұлы Қ. Тайжүзген цеолитін вольфрам тұздарымен модификациялау арқылы полимер қалдықтарын синтетикалық отынға түрлендіру.....	164
Ауешов А.П., Ескибаева Ч.З., Ибраева А.М., Алжанов К.Б., Диканбаева А.К. Серпентинит қалдықтарының фосфор қышқылымен әрекеттесу өнімдерінің физика-химиялық зерттелуі.....	175

Башова А.К., Башов А.Б., Түлешова Э.Ж.

Мыс иондарын күкіртқышқылды ерітінділерде титан (IV) иондары қатысында мырышпен тотықсыздандыру.....188

Фазылов С.Д., Сыздықов А.К., Пустолайкина И.А., Қажмұратова А.Т., Тәжібай А.М.
Цитизиннің α -, β -, γ -олигосахаридтермен клатраттыкешендерін алу.....200

Джалмаханбетова Р.И., Елшібаева А.М., Жумагалиева Ж.Ж., Мукушева Г.К.
Қазақстанның Түркістан өңірінде өсетін *Artemisia terrae-albae* терпеноидты қосылыстары.....213

Капизов О.С., Муханов Д.К., Желдыбаева И.М., Сейсенев Е.Б., Акимбаева А.Б.
Металлургиялық зауыттардың ферросилиций жоңқаларын жоғары өнімді кремний-көміртекті анодтарға тұрақты қайта өңдеу.....228

Масалимова Б.К.
Ауыр металдардан ағын суларды жою әдістері: биомассада белсендендірілген көміртек алу.....244

Нуртай Ж., Орынбасар Р.О., Аймағанбетова З.К., Жантурина Н.Н.
Диатомит пен диметил метилфосфонат толтырғыштары бар винилэфир шайыр үлгілерінің кинетикалық параметрлерінің модельдеу.....272

Сағынтаева А., Жаниқұлов Н., Сударев Е., Қайырбаева М., Жакипбаев Б.
Гипс-цемент-пуццоланды композициялық материал алу үшін қажетті шикізаттардың сапасын зерттеу.....286

Сатаева С., Ермуханова С., Уразова А., Мендығалиева А., Сабитов Б.
Толуолдың фотокаталитикалық тотығуы арқылы бензол алу.....302

Сдикова Г.Ж., Далабаева Н.С., Сарова Н.Б., Мұхтар Т.Ж., Жалтырбаева Н.К.
Фосфор ингибиторлардың болаттың жемірілуіне қарсы тиімділігі.....315

Шаймардан М., Ажиханова Ж., Әбутәліп М., Тоқтарбайұлы О.
Phlomis Tuberosa L. өсімдігі биомассасынан лигнинді қышқылдық өңдеу арқылы бөліп алу және сипаттау.....329

Есимсиитова З.Б., Сейсенова А., Орынғалиева С.Ж., Сануар А., Манап К.Р.
Энергиялық қолдану үшін жылжымалы пиролиз қондырғысын пайдалану арқылы күріш қауызынан көміртекті материалдар алу.....338

Жетенова М.С., Сүлейменова М.Ш., Нұралы Ә.М., Мутушев А.Ж., Калимолдина Л.М.
Өсімдік шикізатынан алынған құрамында каротиноид бар сығындыларды әзірлеу және зерттеу.....353

Жортарова А.А., Kubicek V., Салькева Л.К., Ибраев М.К., Сейдахметова Р.Б.
1,3-бис(4-фенилтиазол-2-ил)-2,4-бис(N,N-диэтиламино)-1,3-диазо-2,4-дифосфетидиннің
синтезі және биологиялық белсенділігін зерттеу.....367

Жұмабек М., Тунгатарова С.А., Мурзин Д.Ю., Байжуманова Т.С.
SCS әдісімен дайындалған Co–Al–Mg–Mn катализаторларының метанның құрғақ
реформингіндегі құрылымдық және каталитикалық қасиеттері.....383

СОДЕРЖАНИЕ

ФИЗИКА

Коштыбаев Т.Б., Алиев Ш., Алиева М.Е., Жавлиева А.Т.

Ковариантный подход к кинетической теории плазмы в сильном электромагнитном поле.....13

Кемелбекова А., Шонгалова А., Бондарь Е., Отунчи Е.

Технологии переработки отработанных литий-ионных аккумуляторов: экологическое воздействие, получаемые продукты и будущие направления развития.....25

Қойлық Н.О., Баймбетова Г.А., Дәлелханқызы А., Қаптағай Г.Ә., Примкулова Ж.Е.

Упрощение фермионной динамико-симметрической модели для идентичных частиц и её отображение в бозонное пространство.....38

Масақ Б., Ағыл-Мұсапар О., Амангелдинова С., Курмангалиева В., Сноу М.

Ограничения на юкавовские короткодействующие взаимодействия на основе нейтронной интерферометрии.....60

Нурбаев Б.М., Дмитриева Е.А.

Перовскиты на основе олова.....70

Нуртазина А.С., Жубаев А.К.

Исследование влияния высокодисперсной охры на кинетические характеристики эпоксидных композитов.....92

Шоканов А.К., Хамраев Ш.И., Смихан Е.А.

Мёссбауэровские исследования трассеров на основе летучей золы.....103

Уалиханова У.А., Курбан Е.Е., Сыздыкова А.М., Алтаева Г.С., Алтайбаева А.Б.

Разрешение вырождения метрических и телепараллельных теорий гравитации посредством многоканальной гравитационно-волновой астрономии.....119

Жадыранова А.А., Ержан Б.

Динамика отскоковых режимов в модифицированной телепараллельной гравитации.....134

Жусупова Н.К.

Применение методов машинного обучения при анализе гравитационных волн и космологических моделей.....151

ХИМИЯ

Аубакиров Е., Ахметова Ф., Ташмухамбетова Ж., Тоштай К., Амантайулы К.

Конверсия полимерных отходов в синтетическое топливо путем модификации цеолита тайжугзен солями вольфрама.....164

Ауешов А.П., Ескибаева Ч.З., Ибраева А.М., Алжанов К.Б., Диканбаева А.К. Физико-химическое исследование продуктов взаимодействия серпентинитовых отходов и фосфорной кислоты.....	175
Башова А.К., Башов А.Б., Тулешова Э.Ж. Восстановление ионов меди цинком в присутствии ионов титана (IV) в растворах серной кислоты.....	188
Фазылов С.Д., Сыздыков А.К., Пустолайкина И.А., Кажмуратова А.Т., Тажибай А.М. Получение α -, β -, γ -олигосахаридных клатратных комплексов цитизина.....	200
Джалмаханбетова Р.И., Елшыбаева А.М., Жумагалиева Ж.Ж., Мукушева Г.К. Терпеноидные соединения <i>Artemisia terrae-albae</i> , произрастающего в Туркестанском регионе Казахстана.....	213
Капизов О.С., Муханов Д.К., Желдыбаева И.М., Сейсенов Е.Б., Акимбаева А.Б. Устойчивая переработка стружки ферросилиция металлургических заводов в высокопроизводительные кремний-углеродные аноды.....	228
Масалимова Б.К. Методы очистки сточных вод от тяжелых металлов: получение активированного угля из биомассы.....	244
Нуртай Ж., Орынбасар Р.О., Аймаганбетова З.К., Жантурина Н.Н. Моделирование кинетических параметров образцов винилэфирных смол с наполнителями из диатомита и диметилметилфосфоната.....	272
Сагынтаева А., Жаникулов Н., Сударев Е., Кайырбаева М., Жакипбаев Б. Исследование качества сырья для получения гипсо-цементно-пуццоланового композиционного материала.....	286
Сатаева С., Ермуханова С., Уразова А., Мендыгилиева А., Сабитов Б. Получение бензола методом фотокаталитического окисления толуола.....	302
Сдикова Г.Ж., Далабаева Н.С., Сарова Н.Б., Мухтар Т.Ж., Жалтырбаева Н.К. Эффективность фосфорсодержащих ингибиторов против коррозии стали.....	315
Шаймардан М., Ажиханова Ж., Абуталип М., Токтарбай О. Выделение и характеристика лигнина из биомассы <i>Phlomis Tuberosa</i> L. с помощью кислотной обработки.....	329
Есимсиитова З.Б., Сейсенова А., Орынгалиева С.Ж., Сануар А., Манап К.Р. Получение карбонизированных материалов из рисовой шелухи с использованием мобильной пиролизной установки для энергетических применений.....	338

**Жетенова М.С., Сулейменова М.Ш., Нуралы А.М., Мутушев А.Ж.,
Калимолдина Л.М.**

Разработка и исследование каротиноидсодержащих экстрактов, полученных
из растительного сырья.....353

Жортарова А.А., Kubicek V., Салькева Л.К., Ибраев М.К., Сейдахметова Р.Б.

Синтез и исследование биологической активности 1,3-бис(4-фенилтиазол-2-ил)-2,4-
бис(N,N-диэтиламино)-1,3-диазо-2,4-дифосфетидина.....353

Жумабек М., Тунгатарова С.А., Мурзин Д.Ю., Байжуманова Т.С.

Структурные и каталитические свойства Co–Al–Mg–Mn катализаторов, приготовленных
методом SCS, для сухого риформинга метана.....383

ACADEMIC JOURNAL
OF PHYSICAL AND CHEMICAL SCIENCES
ISSN 2224-5227
Volume 2.
Number 358 (2026), 213–227

<https://doi.org/10.32014/2026.2518-1483.448>

UDC: 547:615
IRSTI: 31.23:31.27.22

©Jalmakhanbetova R.I.^{1*}, Yelshibayeva A.M.¹, Zhumagaliyeva Zh.Zh.²,
Mukusheva G.K.³, 2026.

¹L.N. Gumilyov Eurasian National University, Astana, Kazakhstan;

²Astana International University, Astana, Kazakhstan;

³Karaganda National Research University named after Academician E.A. Buketov,
Karaganda, Kazakhstan.

*E-mail: rjalmakhanbetova@gmail.com

TERPENOID COMPOUNDS OF *ARTEMISIA TERRAE-ALBAE* GROWING IN THE TURKESTAN REGION OF THE KAZAKHSTAN

Jalmakhanbetova Roza — Doctor of Chemical Sciences, Associate Professor, L.N. Gumilyov Eurasian National University, Astana, Kazakhstan,

E-mail: rjalmakhanbetova@gmail.com, <https://orcid.org/0000-0001-9937-275X>;

Yelshibayeva Aizhan — PhD student, L.N. Gumilyov Eurasian National University, Astana, Kazakhstan,

E-mail: individ.931@gmail.com, <https://orcid.org/0000-0003-0830-2946>;

Zhumagaliyeva Zharkyn — Candidate of Chemical Sciences, Associate Professor, Astana International University, Astana, Kazakhstan,

E-mail: zharkyn.73@mail.ru, <https://orcid.org/0009-0002-0993-008X>;

Mukusheva Gulim — Candidate of Chemical Sciences, Associate Professor, Karaganda National Research University named after Academician E.A. Buketov, Karaganda, Kazakhstan,

E-mail: mukushevagulim5@gmail.com, <https://orcid.org/0000-0001-6706-4816>.

Abstract. This research work was aimed at a comprehensive assessment of the chemical composition and biological activity of the ethanol extract of *Artemisia terrae-albae* Krasch. The obtained extract was studied using IR and GC–MS analysis methods. IR spectroscopic analysis of the extract confirmed the presence of terpenoid compounds in it. Absorption bands characteristic of terpenoid compounds belonging to hydroxyl (–OH) groups, carbonyl (C=O) groups, and unsaturated C=C bonds were observed. As a result of the analysis by GC-MS method, a total of 46 components were identified in the studied extract. From the identified components, 17 compounds were classified as terpenoids, the total amount of which was 36.96% of the total chemical composition of the extract. In the structure of the terpenoid fraction, 8 compounds were identified as monoterpenes (17.39% of the total composition), and another 8 compounds were identified as sesquiterpenes (17.39%). One triterpenoid - ursolic acid - was identified in the amount of 2.17%. In addition, an analysis of the distribution of compounds in

the group of terpenoids was carried out. It was established that monoterpenes make up 47%, sesquiterpenes - 47%, and triterpenes - 6% in the terpenoid fraction.

The extract showed moderate activity against gram-positive bacteria (*Staphylococcus aureus*, *Bacillus subtilis*), and the effect on gram-negative bacteria was weak. A weak fungistatic effect was recorded against the *Candida albicans* strain. The toxicity level was determined using the *Artemia salina* bioassay, and the LD₅₀ value was 90.6 µg/ml, indicating a relatively low toxicity of the extract.

The results obtained indicate that the studied sample is rich in terpene components and can serve as a basis for further studies of their biological activity and pharmacological potential. The relatively high content of terpenes proves the importance of the studied raw material as a source of natural biologically active substances.

Keywords: *Artemisia terrae-albae*, terpenoid compounds, GC-MC, IR-spectroscopy, antimicrobial activity, cytotoxicity

For citations: Jalmakhanbetova R.I., Yelshibayeva A.M., Zhumagaliyeva Zh.Zh., Mukusheva G.K. *Terpenoid Compounds of Artemisia terrae-albae* Growing in the Turkestan Region of Kazakhstan. *Academic Journal of Physical and Chemical Sciences*. 2026. No.2. Pp. 213–227. DOI: <https://doi.org/10.32014/2026.2518-1483.448>

©Джалмаханбетова Р.И.^{1*}, Елшібаева А.М.¹, Жумагалиева Ж.Ж.²,
Мукушева Г.К.³, 2026.

¹Л.Н. Гумилев атындағы Еуразия ұлттық университеті, Астана, Қазақстан;

²Астана халықаралық университеті, Астана, Қазақстан;

³Академик Е.А. Бөкетов атындағы Қарағанды ұлттық зерттеу университеті,
Қарағанды, Қазақстан.

*E-mail: rjalmakhanbetova@gmail.com

ҚАЗАҚСТАННЫҢ ТҮРКІСТАН Өңірінде өсетін *ARTEMISIA TERRAE-ALBAE* ТЕРПЕНОИДТЫ ҚОСЫЛЫСТАРЫ

Джалмаханбетова Роза — химия ғылымдарының докторы, қауымдастырылған профессор, Л.Н. Гумилев атындағы Еуразия ұлттық университеті, Астана, Қазақстан, E-mail: rjalmakhanbetova@gmail.com, <https://orcid.org/0000-0001-9937-275X>;

Елшібаева Айжан — PhD докторант, Л.Н. Гумилев атындағы Еуразия ұлттық университеті, Астана, Қазақстан,

E-mail: individ.931@gmail.com, <https://orcid.org/0000-0003-0830-2946>;

Жумагалиева Жарқын — химия ғылымдарының кандидаты, Астана халықаралық университеті, Астана, Қазақстан,

E-mail: zharkyn.73@mail.ru, <https://orcid.org/0009-0002-0993-008X>;

Мукушева Гүлим — химия ғылымдарының кандидаты, қауымдастырылған профессор, академик Е.А. Бөкетов атындағы Қарағанды ұлттық зерттеу университеті, Қарағанды, Қазақстан, E-mail: mukushevagulim5@gmail.com, <https://orcid.org/0000-0001-6706-4816>.

Аннотация. Бұл зерттеу жұмысы *Artemisia terrae-albae* Krasch. өсімдігінің этанолды сығындысының химиялық құрамын және биологиялық белсенділігін кешенді бағалауға бағытталды. Алынған сығынды ИҚ-спектроскопия және ГХ–

МС талдау тәсілдері арқылы зерттелді. Сығындының ИҚ-спектроскопиялық талдауы оның құрамында терпеноидты қосылыстардың бар екендігін растады. Терпеноидты қосылыстарға тән гидроксил (–ОН) топтарына, карбонил (C=O) тобына, қанықпаған C=C байланыстарына тиесілі жұтылу жолақтар байқалды. ГХ-МС талдауы нәтижесінде зерттелген сығындының құрамында барлығы 46 компонент анықталды. Анықталған компоненттердің ішінде 17 қосылыс терпеноидтар ретінде жіктелді, олардың жалпы мөлшері сығындының жалпы химиялық құрамының 36,96%-ын құрады. Терпеноид фракциясының құрылымында 8 қосылыс монотерпендер (жалпы құрамның 17,39%-ы), тағы 8 қосылыс сесквитерпендер (17,39%) ретінде анықталды. Бір тритерпеноид - урсол қышқылы - 2,17% мөлшерінде анықталды. Сонымен қатар, терпеноидтар тобындағы қосылыстардың таралуына талдау жүргізілді. Терпеноидтар фракциясында монотерпендер 47%, сесквитерпендер 47% және тритерпендер 6% құрайтыны анықталды.

Сығынды грампон бактерияларға қатысты орташа деңгейде белсенділік көрсетті (*Staphylococcus aureus*, *Bacillus subtilis*), ал грамтеріс бактерияларға әсері әлсіз болды. *Candida albicans* штамына қарсы әлсіз фунгистатикалық әсер тіркелді. Уыттылық деңгейі *Artemia salina* биотесті арқылы анықталып, LD₅₀ мәні 90,6 мкг/мл құрады, бұл сығындының салыстырмалы түрде төмен уыттылығын көрсетеді.

Алынған нәтижелер зерттелген үлгінің терпендік компоненттерге бай екенін көрсетеді және олардың биологиялық белсенділігі мен фармакологиялық әлеуетін әрі қарай зерттеуге негіз бола алады. Терпендердің салыстырмалы жоғары үлесі зерттелетін шикізаттың табиғи биологиялық белсенді заттар көзі ретіндегі маңыздылығын дәлелдейді.

Түйін сөздер: *Artemisia terrae-albae*, терпеноидты қосылыстар, ГХ-МС, ИҚ-спектроскопия, антимикробтық белсенділік, цитоуыттылық

©Джалмаханбетова Р.И.^{1*}, Елшібаева А.М.¹, Жумагалиева Ж.Ж.²,
Мукушева Г.К.³, 2026.

¹Евразийский национальный университет имени Л.Н. Гумилева,
Астана, Казахстан;

²Астанинский международный университет, Астана, Казахстан;

³Карагандинский национальный исследовательский университет имени
академика Е.А. Букетова, Караганда, Казахстан.

*E-mail: rjalmakhanbetova@gmail.com

ТЕРПЕНОИДНЫЕ СОЕДИНЕНИЯ *ARTEMISIA TERRAE-ALBAE*, ПРОИЗРАСТАЮЩЕГО В ТУРКЕСТАНСКОМ РЕГИОНЕ КАЗАХСТАНА

Джалмаханбетова Роза — доктор химических наук, ассоциированный профессор, Евразийский национальный университет имени Л.Н. Гумилёва, Астана, Казахстан,

E-mail: rjalmakhanbetova@gmail.com, <https://orcid.org/0000-0001-9937-275X>;

Елшібаева Айжан — PhD докторант, Евразийский национальный университет имени Л.Н. Гумилева, Астана, Казахстан,

E-mail: individ.931@gmail.com, <https://orcid.org/0000-0003-0830-2946>;

Жумагалиева Жаркын — кандидат химических наук, Международный университет Астана, Астана, Казахстан,

E-mail: zharkyn.73@mail.ru, <https://orcid.org/0009-0002-0993-008X>;

Мукушева Гүлим — кандидат химических наук, ассоциированный профессор, Карагандинский национальный исследовательский университет имени академика Е.А. Букетова, Караганда, Казахстан,

E-mail: mukushevagulim5@gmail.com, <https://orcid.org/0000-0001-6706-4816>.

Аннотация. Настоящая работа посвящена комплексному исследованию химического состава и биологической активности этанольного экстракта *Artemisia terrae-albae* Krasch. Полученный экстракт исследовали с помощью ИК-спектроскопии и ГХ-МС анализа. ИК-спектроскопический анализ экстракта подтвердил наличие в нем терпеноидных соединений. Наблюдались полосы поглощения, характерные для терпеноидных соединений, принадлежащие гидроксильным (–ОН) группам, карбонильным (C=O) группам и ненасыщенным связям C=C. В результате анализа методом ГХ-МС в составе исследуемого экстракта было идентифицировано в общей сложности 46 компонентов. Из идентифицированных компонентов 17 соединений были классифицированы как терпеноиды, общее количество которых составило 36,96% от общего химического состава экстракта. В структуре терпеноидной фракции 8 соединений были идентифицированы как монотерпены (17,39% от общего состава), еще 8 соединений - как сесквитерпены (17,39%). Один тритерпеноид - урсоловая кислота — был идентифицирован в количестве 2,17%. Кроме того, был проведен анализ распределения соединений в группе терпеноидов. Было установлено, что монотерпены составляют 47%, сесквитерпены - 47%, а тритерпены - 6% в терпеноидной фракции.

Экстракт показал умеренную активность против грамположительных бактерий (*Staphylococcus aureus*, *Bacillus subtilis*), а эффект на грамотрицательные бактерии был слабым. Слабый фунгистатический эффект был зафиксирован против штамма *Candida albicans*. Уровень токсичности определяли с помощью биотеста на *Artemia salina*, и значение LD₅₀ составило 90,6 мкг/мл, что указывает на относительно низкую токсичность экстракта.

Полученные результаты свидетельствуют о том, что исследуемый образец богат терпеновыми компонентами и может служить основой для дальнейших исследований его биологической активности и фармакологического потенциала. Относительно высокое содержание терпенов подтверждает важность исследуемого сырья как источника природных биологически активных веществ.

Ключевые слова: *Artemisia terrae-albae*, терпеноидные соединения, ГХ-МС, ИК- спектроскопия, антимикробная активность, цитотоксичность

Introduction. One of the most widespread medicinal plants in Kazakhstan is the genus *Artemisia* L. a species-rich and taxonomically complex genus of dicotyledonous plants belonging to the family *Asteraceae* L. Plants of the genus *Artemisia* are widely

used in various traditional and folk medicine systems and are well known for their medicinal properties in the treatment of fever, malaria, inflammation, ulcers, diabetes, and intestinal parasites. This genus includes more than 500 perennial, biennial, and annual herbaceous plants and small shrubs growing in temperate regions of Europe, Asia, and North America (Nigam et al., 2019). 81 species of this genus grow in Kazakhstan, including 19 described as endemic.

In traditional folk medicine, *Artemisia* species have been used to reduce fever, have antiseptic effects, fight intestinal worms, stimulate the body, induce urination, and relieve abdominal pain (Ksibi et al., 2022). In traditional Central Asian medicine, infusions of *Artemisia* flowers are used to treat various diseases such as ulcerative colitis, appendicitis, hemorrhoids, bad breath, epilepsy, and many others (Koul et al., 2018). The *Artemisia* genus is characterized by a variety of biologically active substances. Studies have shown that the plant species belonging to the *Artemisia* genus contain various biologically active substances, such as lignans, sesquiterpenoids, flavonoids, coumarins, glycosides, acids, and sterols (Jalmakhanbetova et al., 2007, 2021; Trifan et al., 2022). One of the main compounds characteristic of wormwood plants is terpenes, including sesquiterpene lactones, which have a diverse chemical structure and a broad spectrum of pharmacological activities. These compounds have been shown to have anticancer, antimalarial, and anti-inflammatory properties, as well as to accelerate wound healing, and to have antibacterial, antifungal, and antiviral activities (Ivanescu et al., 2015; Wang et al., 2023).

Plants belonging to the genus *Artemisia* are of great economic and medical importance. This is because the terpenoid compound, terpenoid sesquiterpene lactone artemisinin, isolated from *Artemisia annua* L., is recognized as the main active ingredient against malaria. This discovery has increased the interest of scientists around the world in finding new biologically active drugs through the study of traditional medicinal plants (Zaman et al., 2021). In traditional Russian medicine, tinctures from the roots and leaves of the *Artemisia* plant are widely used to treat liver, stomach, and spleen diseases. A solution of fresh wormwood juice mixed with diluted ethanol is used for insomnia and kidney stones, as well as as an anti-inflammatory agent (European Scientific Cooperative on Phytotherapy 2003; Abad et al., 2012). In Kazakhstan, tinctures prepared from the aerial parts of this plant have been used in folk medicine to treat stomach ulcers, appendicitis, hemorrhoids, bad breath, and epilepsy. Wormwood is used in the food industry as a spice to give a special taste to fatty foods. It is also used to add flavor to some alcoholic beverages and wines (Krebs et al., 2010). The aerial parts of the plant are also a valuable source of raw materials in the paint industry (Wu et al, 2020).

A. terrae-albae Krasch. is a poorly studied plant, but is of great interest due to its use in folk medicine. *A. terrae-albae* is a semi-shrub plant that grows in the semi-desert and steppe regions of Kazakhstan. In folk medicine of Central Asia and Eastern Europe, *A. terrae-albae* is widely used in the treatment of skin diseases such as dermatitis, eczema, psoriasis, as well as for inflammation, wounds and burns (Turuspekov et al, 2018; Sagyndykova et al., 2024).

The essential oil of *A. terrae-albae*, a plant distributed in Central Asia, is characterized mainly by oxygenated monoterpenes (Sampietro et al, 2016). The dominant component in its composition is camphor (47.3%). In addition, 1,8-cineole (23.9%), camphene (9.8%) and β -thujone (6.0%) were detected. α -Pinene is also present, but its amount is not specified. The chemical composition of the essential oil is characterized by the predominant content of camphor and 1,8-cineole, which determines its biologically active properties.

A number of studies have investigated the chemical composition, biological activity and ecological significance of the plant *A. terrae-albae*. Dyusebaeva and colleagues (Dyusebaeva et al., 2024) determined the macro- and microelement composition, amino acids and fatty acids of the aboveground part of the plant and showed that it is dominated by calcium, magnesium, sodium elements, as well as oleic, linoleic and palmitic acids. These data prove that the plant has nutritional and physiological activity.

In recent years, extracts of the *A. terrae-albae* plant have been used as biogenic reducing agents in the field of nanotechnology. In the conducted studies, silver nanoparticles were obtained by the green synthesis method using the ethanol extract of the plant and their cytogenic toxicity was evaluated. As a result, it was found that the obtained nanoparticles have a pronounced antiproliferative effect, inhibiting cell division (Zhumanova et al., 2023).

In a similar study (Dyusebaeva et al., 2025), the antimicrobial activity of silver nanoparticles stabilized with a lipophilic extract of the plant *A. terrae-albae* was evaluated. The resulting nanoparticles showed activity against microorganisms such as *S. aureus*, *E. coli*, *P. aeruginosa*, and *C. albicans*.

The aim of this research work is to identify terpene compounds in the ethanol extract of *A. terrae-albae*, which grows in the Khantagy Ridge area of Turkestan region, and to characterize their structural features. Determining the chemical composition of terpene compounds of *A. terrae-albae* and studying their relationship with biological activity is an important scientific task for the modern field of phytochemistry and pharmacognosy.

Materials and methods. Plant material. The above-ground part of *Artemisia terrae-albae* Krasch. was collected in July 2024 from the Khantagy Ridge area of Turkestan region. The collected plant material was air-dried in the shade. The dried plant was crushed and stored. Only the above-ground part of the plant was used for research.

Extraction of raw. An ethanol solvent was used to obtain an extract of the crushed and pre-dried aerial part of *A. terrae-albae*. 20 g of dry raw material was extracted twice with ethyl alcohol (ratio 1:10, w/v). Each extraction was carried out with boiling for 2 hours. The resulting extracts were combined and evaporated in a rotary evaporator. As a result, a dark green extract was obtained. Yield – 4.015 g (20 % relative to air-dried raw material).

GC Conditions. Gas chromatography–mass spectrometry was used to determine the composition of the ethanol extract of *A. terrae-albae*. The analysis was carried out on an Agilent 7890A gas chromatograph system and a 5975C Mass Selective Detector

(Agilent Technologies, USA). The analysis was carried out under the following conditions: column type – Rtx-100DHA, column length – 30 m; column diameter – 0.25 mm; adsorbent layer thickness in the column – 0.5 μm ; evaporator temperature – 280 $^{\circ}\text{C}$; column temperature – 60–300 $^{\circ}\text{C}$; column heating rate – 8 $^{\circ}\text{C}/\text{min}$; ion source temperature – 230 $^{\circ}\text{C}$; quadrupole condenser temperature – 150 $^{\circ}\text{C}$; EI = 70 eV; carrier gas – helium grade A; gas pressure in the column – 2 psi; sample volume – 0.2 μl ; injection mode – flow splitting (split 20:1); mass spectrum recording mode – scan; library – NIST 08; analysis time – 32 minutes.

The percentage of component composition was automatically calculated using the GS-MSD Data Analysis program based on the peak areas of the total ion chromatogram, and identification was performed using the NIST 08 library based on mass spectra and retention times.

IR spectroscopy. Infrared spectroscopic analysis was performed to conduct a primary screening of terpene compounds in the ethanol extract of *A. terrae-albae*. The infrared spectrum was recorded on an IRTracer - 100 spectrometer.

IR spectrum (ν , cm^{-1}): 3600–3200 (broadband), 3075, 3030, 2965, 2925, 2855, 1740, 1650, 1605, 1515, 1460, 1375, 1260, 1215, 1170, 1110, 1050, 1020, 970, 920, 875, 820, 760, 700, 650, 600, 520, 470, 430.

The antimicrobial activity. The antimicrobial activity of the ethanolic extract of *A. terrae-albae* was determined by the serial dilution method. The following microorganisms were used as reference test strains for the analysis: gram-positive bacteria: *S. aureus* ATCC 6538, *B. subtilis* ATCC 6633; gram-negative bacteria: *E. coli* ATCC 25922, *P. aeruginosa* ATCC 27853; yeast-like fungus: *C. albicans* ATCC 10231. All strains were obtained from the American Type Culture Collection (ATCC). Daily cultures of microorganisms were grown on nutrient agar at 37 $^{\circ}\text{C}$ (for fungi – 30 $^{\circ}\text{C}$, 48 h). The antimicrobial activity of the extracts was studied in the concentration range of 1.56–50 $\mu\text{g}/\text{ml}$.

Each sample was incubated with 0.1 ml of microbial suspension (10^6 CFU/ml). The incubation process was carried out in a thermostat at 37 $^{\circ}\text{C}$ for 24–48 hours, depending on the type of microorganism. The minimum inhibitory concentration (MIC) was determined as the lowest concentration at which turbidity was observed. The study was performed in triplicate. Ceftriaxone (antibacterial drug) and nystatin (antifungal drug) were used as controls for comparison.

The cytotoxicity. The cytotoxic activity of ethanolic extract of *A. terrae-albae* was evaluated in vitro by its effect on the larvae of the brine shrimp *A. salina* (Leach). The study was carried out according to the method of B. N. Meyer et al. (Planta Medica, 1982). For the experiment, *A. salina* eggs were placed in artificial seawater and incubated for 48 hours at 37 $^{\circ}\text{C}$. The 2-day-old larvae (nauplii) obtained in this way were used as samples. A 2 mg sample of the extract under study was dissolved in 2 ml of ethanol and subsequently diluted accordingly to obtain concentrations of 100, 10 and 1 $\mu\text{g}/\text{ml}$. Each concentration was prepared in triplicate. Ten *A. salina* larvae were introduced into each vial. After complete evaporation of the ethanol, 5 ml of artificial seawater was added to each vial. All samples were incubated at room temperature in the light for 24 hours.

After incubation, live and dead larvae were counted and the lethal dose (LD_{50} , $\mu\text{g/ml}$) was calculated based on the percentage of death. An equivolume solution of dimethyl sulfoxide (DMSO) was used as a control sample, and dactinomycin (actinomycin D) was used as a reference drug. The results were performed in triplicate and statistically processed using the FIN program.

Results. In the IR spectrum of the dry extract of *A. terrae-albae*, a broad absorption band corresponding to the stretching vibrations of hydroxyl groups ($-\text{OH}$) was observed in the region of 3400 cm^{-1} . The peaks in the range of $2920\text{--}2850\text{ cm}^{-1}$ indicate the vibrations of the C-H bonds of aliphatic groups. The intense band in the region of $1730\text{--}1700\text{ cm}^{-1}$ is characteristic of the C=O bonds of carbonyl compounds (acids, esters). Absorption bands in the range of $1620\text{--}1600\text{ cm}^{-1}$ correspond to C=C bonds. In the range of $1250\text{--}1050\text{ cm}^{-1}$, C-O vibrations characteristic of alcohols, ethers, and esters were observed. These spectral data prove the presence of functional groups characteristic of terpenoid compounds in the extract.

GC-MS analysis revealed a multicomponent chemical composition of the ethanol extract of *A. terrae-albae*. Several distinct peaks were observed in the chromatogram, the highest intensity of which was observed at a retention time of 26.411 min, indicating that this compound was present in the majority. Peaks at early retention times correspond to monoterpenes, while peaks at 15–30 min correspond to sesquiterpenes and triterpenoids. A high concentration of terpene compounds was observed between 25–28 min (Figure 1).

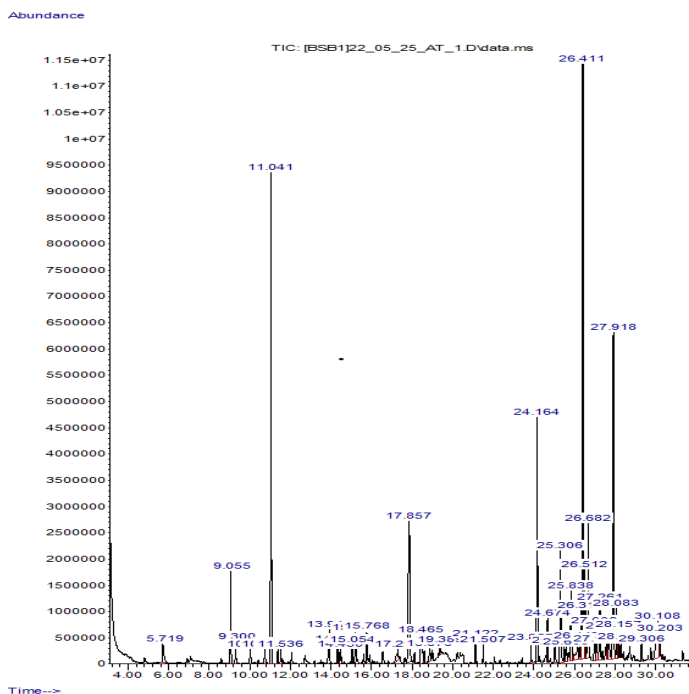
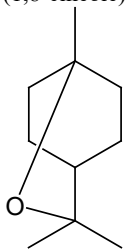
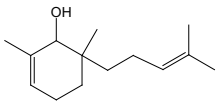
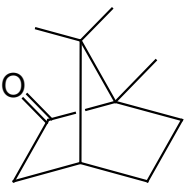
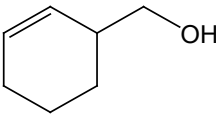
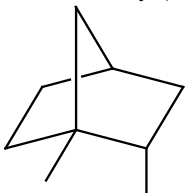
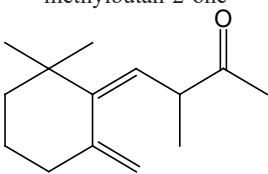
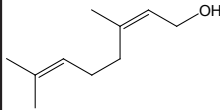
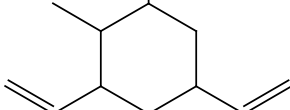
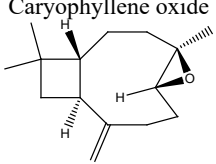
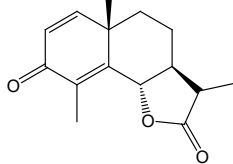
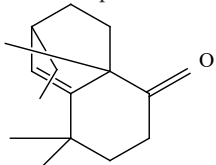
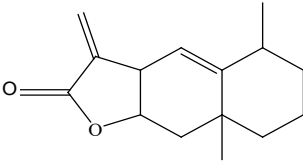
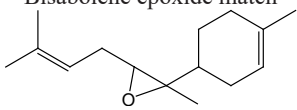
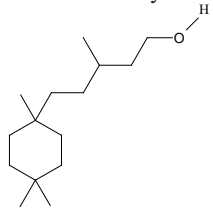
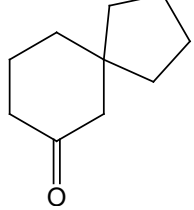
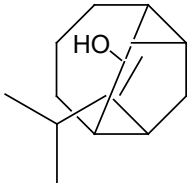
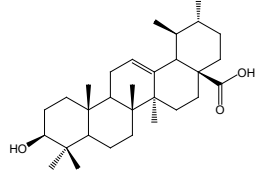


Figure 1. GC/MS chromatogram of *A. terrae-albae* extract collected in the Turkistan region of Kazakhstan.

A total of 46 different organic compounds were identified as a result of gas chromatography–mass spectrometry analysis of the ethanol extract of *A. terrae-albae* (Figure 1). Analysis of the component composition revealed the presence of 17 terpenoid compounds with monoterpene, sesquiterpene and triterpene structures (Table 1).

Table 1. Terpenoids compounds of *A. terrae-albae* extract.

Monoterpenes			
Compound	Structural features	Compound	Structural features
1	2	3	4
Eucalyptol (1,8-cineole) 	Monoterpene oxide -Bicyclic ether, Contains an internal oxygen bridge (ether linkage), Fully saturated carbon skeleton.	2-Cyclohexene-1-methanol, 2,6-dimethyl-6-(4-methyl-3-pentenyl) 	Monoterpene oxide -Composed of two isoprene units Monocyclic hydrocarbon structure Contains two vinyl (ethenyl) groups (C=C)
Camphor-type bicyclic monoterpene 	Monoterpene ketone -Bicyclic bornane skeleton, Contains a ketone group, Rigid, saturated structure.	2-Cyclohexene-1-methanol 	Monoterpene oxide -Monocyclic Structure, One double bond, One hydroxyl group.
Borneol (Bicyclo[2.2.1]heptan-2-ol, 1,7,7-trimethyl-) 	Monoterpene alcohol -Bicyclic bornane skeleton, Saturated carbon framework.	4-(2,2-Dimethyl-6-methylenecyclohexylidene)-3-methylbutan-2-one 	Monoterpene oxide -Built from two isoprene units Monocyclic structure Contains a ketone group
Linalool / Geraniol family (2,6-Octadien-1-ol, 3,7-dimethyl-) 	Monoterpene alcohol -Acyclic monoterpene alcohol, Contains two double bonds, One hydroxyl group, Built from two isoprene units	Cyclohexane, 1,5-diethenyl-2,3-dimethyl 	Monoterpene alcohol -Derived from three isoprene units

1	2	3	4
Sesquiterpenes			
Caryophyllene oxide 	Sesquiterpene oxide -Derived from three isoprene units Bicyclic structure Contains an epoxide ring (three-membered cyclic ether)	α-Santonin 	Sesquiterpene lactone -Bicyclic structure Contains a lactone ring. Multiple double bonds
Neoisolongifolene-8-oxo-type compound 	Sesquiterpene oxide -Tricyclic framework Ketone functionality Longifolene-type sesquiterpene structure.	Eudesma-5,11(13)-dien-8,12-olide 	Sesquiterpene lactone Eudesmane-type skeleton Lactone functional group
Bisabolene epoxide match 	Sesquiterpene oxide -Mono- or acyclic framework, Contains an epoxide ring	3-Methyl-5-(1,4,4-trimethylcyclohex-2-enyl)-pent-2-enoic acid ethyl ester 	Sesquiterpene oxide -Built from three isoprene units Contains a cyclohexene ring
Spiro[4.5]decan-7-one, epoxy-derivative 	Sesquiterpene oxide Spiro structure (two rings sharing one carbon atom).	3-Isopropyl-tricyclo[4.3.1.1(2,5)]undec-3-en-10-one 	Sesquiterpene oxide -It contains a 15-carbon skeleton (C_{15}). Sesquiterpenes are composed of three isoprene units ($C_5 \times 3$).
Triterpenes (C_{30})			
Urs-20-en-3-ol (ursane-type triterpenoid) 	Triterpenes (C_{30}) -Pentacyclic (five-ring) structure Ursane-type triterpenoid skeleton One hydroxyl group at C-3 One double bond at C-20.		

Among them, the main components were 2-Cyclohexene-1-methanol, 2,6-dimethyl-6-(4-methyl-3-pentenyl)- (17.33%), Bicyclo[2.2.1]heptan-2-one, 1,7,7-trimethyl-

(camphor) (13.19%), Cyclohexane, 1,5-diethenyl-2,3-dimethyl- (9.71%) and Butanoic acid, octyl ester (8.29%). Thus, as a result of gas chromatography-mass spectrometry studies, it was determined that the extract contains monoterpene, sesquiterpene, and triterpene compounds belonging to terpenoid compounds.

According to the results of the study, the ethanolic extract of *A. terrae-albae* showed pronounced antimicrobial activity. The inhibitory effect of the extract against *B. subtilis* ATCC 6633, *E. coli* ATCC 25922 and *C. albicans* ATCC 10231 strains was observed at a concentration of 50 mg/ml. In addition, moderate activity was determined against the *S. aureus* ATCC 6538 strain, the effective concentration was 25 mg/ml. However, the antimicrobial activity of the extract against the *P. aeruginosa* ATCC 27853 strain was not recorded (Table 2).

Thus, the results obtained indicate that the *A. terrae-albae* extract has a pronounced antimicrobial potential against gram-positive bacteria and yeast-like fungi, but its effect on the gram-negative *P. aeruginosa* strain is limited. Overall, these results provide evidence for the antimicrobial properties of biologically active compounds in the extract, including potential terpenoid components.

Table 2. Antimicrobial activity of *A. terrae-albae* extract.

Test substances	<i>Staphylococcus aureus</i> ATCC 6538	<i>Bacillus subtilis</i> ATCC 6633	<i>Escherichia coli</i> ATCC 25922	<i>Pseudomonas aeruginosa</i> ATCC 27853	<i>Candida albicans</i> ATCC 10231
Extract of <i>A. terrae-albae</i>	25	50	50	-	50
Control (ceftriaxone)	6.3	12,5	6,3	12,5	-
Control (nystatin)	-	-	-	-	12,5

According to the results of the study, the cytotoxic activity of the extract of the *A. terrae-albae* plant was determined. The half-lethal dose (LD₅₀) of the studied sample was 90.6 µg/ml.

Dactinomycin (actinomycin D), used as a reference drug, showed a significantly higher cytotoxicity, its LD₅₀ value was recorded at the level of 45.8 µg/ml. This indicator is approximately two times lower than that of the studied plant extract, which indicates that the cytotoxic effect of dactinomycin is stronger (Table 3).

Thus, the results obtained indicate that the extract of *A. terrae-albae* has cytotoxic activity, but its effect is weaker than that of a standard antitumor drug. This indicates the prospect of further pharmacological studies of the plant extract.

Table 3. Cytotoxic activity of *A. rtemisia terrae-albae* extract.

Test substances	LD ₅₀ , µg/ml
Extract of <i>A. terrae-albae</i>	90.6
Comparison drug: dactinomycin (actinomycin D)	45.8

Discussions. During the general analysis, 17 terpene compounds (mono-, sesquiterpenes and one triterpenoid) were identified in the extract. The quantitative

ratio and group classification of these terpenes are shown in the diagram presented in the work (Figure 2). Terpenes constitute the majority of the identified compounds and are the main biologically active components of the extract.

Camphor and cyclic monoterpenes are known natural compounds characteristic of the *Artemisia* genus and exhibit antiseptic, anti-inflammatory and antimicrobial activity. In addition, the identified triterpenoid Urs-20-en-3-ol indicates the presence of high molecular weight terpenes in the extract and may be associated with its antioxidant and cytoprotective properties.

Among the 17 terpene compounds identified in the extract of *A. terrae-albae* by GC–MS analysis, monoterpenes (47%) and sesquiterpenes (47%) accounted for the majority, while triterpenes accounted for only 6%. These results indicate a clear dominance of low-molecular, volatile terpenes in the secondary metabolite profile of the studied species (Figure 2).

The presence of equal amounts of monoterpenes and sesquiterpenes indicates a relatively balanced activity of the plant's biosynthetic pathways (mevalonate and methylerythritol phosphate pathways). The high proportion of monoterpenes may be related to their volatility and protective function, as these compounds play an important role in plant defense against phytopathogens, insects, and abiotic stress factors.

The high percentage of sesquiterpenes (47%) is also a chemical marker characteristic of the *Artemisia* genus. Literature data indicate that biologically active sesquiterpenes (especially lactones) are common in *Artemisia* species, which are associated with their anti-inflammatory, antimicrobial and antioxidant properties.

The relatively low content of triterpenes (6%) may indicate that they are mainly structural or late metabolic products. Triterpenes are often described as storage or stabilizing compounds and may be less detectable by GC–MS analysis than volatile terpenes.

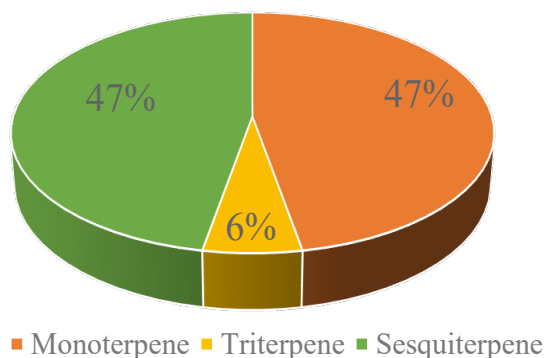


Figure 2. Relative percentage composition of terpenoid compounds identified in *A. terrae-albae* extract by GC–MS analysis.

In general, the terpene profile determined indicates that *A. terrae-albae* has a high pharmacological potential and that its biological activity is likely to be mainly associated with mono- and sesquiterpene components. This ratio of terpenes also provides important information for the chemotaxonomic characterization of the species.

It was observed that the chemical nature of the compounds is diverse: monoterpenes, sesquiterpenes, sesquiterpene lactones, as well as triterpenoids were identified.

GC–MS analysis revealed a high concentration of terpene compounds in the ethanol extract of *A. terrae-albae*. Among them, the highest concentration was 2-Cyclohexene-1-methanol, 2,6-dimethyl-6-(4-methyl-3-pentenyl)- (17.33%). This compound is structurally related to terpene alcohols and is considered a mono- or sesquiterpene derivative. Terpene alcohols are generally characterized by antimicrobial and anti-inflammatory activity.

The second highest-abundant compound is Bicyclo[2.2.1]heptan-2-one, 1,7,7-trimethyl- (13.19%), a camphor-like monoterpene. Camphor-like compounds are characteristic of the *Artemisia* genus and are the main components of the essential oil fraction of the plant. These substances are known for their antimicrobial, fungicidal, and insecticidal properties.

In addition, the compound Cyclohexane, 1,5-diethenyl-2,3-dimethyl- (9.71%) was also detected in significant amounts. Based on its structural features, it also belongs to the terpene hydrocarbons. Terpene hydrocarbons are protective metabolites of plants and play an important role in environmental adaptation.

Among the sesquiterpenes, the pharmacologically important α -santonin (1.04%) and Eudesma-5,11(13)-dien-8,12-olide (1.38%) were identified. These compounds belong to sesquiterpene lactones and are known as chemotaxonomic markers of the *Artemisia* genus. Their anthelmintic, anti-inflammatory and cytotoxic activities have been reported in the literature.

Of particular interest is the ursane-type triterpenoid (Urs-20-en-3-ol, 3.21%). Triterpenes with the ursane structure are characterized in the literature by anti-inflammatory, hepatoprotective and antitumor activity. Its detection confirms the pharmacological potential of the studied plant. In general, terpenes with a high percentage are the main components that determine the biological activity of the plant. Their predominance indicates a high pharmacological potential of the *A. terrae-albae* species.

The results of this work show that the ethanol extract of *A. terrae-albae* is rich in biologically active compounds, with a predominantly terpene nature. The high content of identified mono- and sesquiterpenes confirms the specificity of the essential oil and secondary metabolite profile of the species and allows it to be considered as a promising source of raw materials for pharmacological studies.

Thus, the GC–MS results showed that the composition of *A. terrae-albae* is rich in terpenes, and the 17 terpene compounds identified determine the phytochemical and pharmacological potential of the plant. The relative distribution and structural features of terpenes are presented in a diagram, and the obtained data allow us to consider the plant as a promising source of biologically active natural compounds.

As a result of GC–MS analysis, a total of 46 compounds were identified from the extract. Of these, 17 compounds are of terpene nature, which accounts for 36.96% of the total composition. In particular, 8 monoterpenes (17.39%), 8 sesquiterpenes (17.39%) and 1 triterpenoid – Ursolic acid (2.17%) were identified. The results obtained indicate

that the studied extract is rich in terpenes and its biological activity may be associated with these compounds.

Conclusion. The study conducted comprehensively analyzed the chemical composition and biological activity of the ethanol extract of *A. terrae-albae*. The results showed that this plant is rich in biologically active compounds, including terpene compounds.

Initial IR spectroscopic screening revealed absorption bands characteristic of functional groups commonly found in plant terpenoid compounds, namely hydroxyl (–OH), carbonyl (C=O), as well as C=C and C–O bonds.

As a result of GC–MS analysis, a total of 46 organic compounds were identified, 17 of which were attributed to the terpene nature. In particular, monoterpenes, sesquiterpenes and one triterpenoid were identified.

The main components were 2-cyclohexene-1-methanol derivative (17.33%), camphor (13.19%), cyclohexane derivative (9.71%) and octyl butanoate (8.29%). It was found that the terpene profile consists mainly of oxygenated monoterpenes, which is a chemotaxonomic characteristic of the *Artemisia* genus. In addition, the discovery of the urs-20-en-3-ol triterpenoid, which belongs to the ursane family, indicated the presence of high molecular weight terpenes.

The antimicrobial activity evaluation revealed that the extract exhibited moderate activity against Gram-positive bacteria. The minimum inhibitory concentration (MIC) against *S. aureus* ATCC 6538 and *B. subtilis* ATCC 6633 strains ranged from 12.5–50 µg/ml. A weak effect was observed against the fungus *C. albicans* ATCC 10231 (MIC = 50 µg/ml). Gram-negative bacteria (*E. coli* ATCC 25922 and *P. aeruginosa* ATCC 27853) showed relative resistance. This antimicrobial effect may be due to the combined action of oxygenated monoterpenes, sesquiterpene lactones and phenolic compounds.

The *A. salina* test system was used to determine the toxicity level. As a result, the half-lethal dose (LD₅₀) of the extract was 90.6 µg/ml, which indicates a lower toxicity compared to the standard drug dactinomycin (LD₅₀ = 45.8 µg/ml).

Overall, the results obtained demonstrate that *A. terrae-albae* is rich in terpenes and is a promising source of natural raw materials with antimicrobial activity. In the future, the isolation of individual active components, the study of their mechanisms of action, and testing in in vivo models will allow us to further explore the pharmacological potential of this plant.

References

- Abad M.J., Bedoya L.M., Apaza L., Bermejo P. (2012) The *Artemisia* L. Genus: A Review of Bioactive Essential Oils. *Molecules*, 17. – P. 2542-2566. (in Eng.).
- Dyusebaeva G.M., Kudaibergenova S.K., and Bekmuratova Z.K. (2024). Chemical constituents of liposoluble extract of *Artemisia terrae-albae*. Reports of the National Academy of Sciences of the Republic of Kazakhstan. – No. 2(360). – P. 83-93. <https://journals.nauka-nanrk.kz/reports-science/article/view/5788> (in Eng.).
- Dyusebaeva G.M., Zhumanova G.M., and Kudaibergenova S.K. (2025). Green synthesis and characterization of silver nanoparticles using *Artemisia terrae-albae* extracts and evaluation of their cytogenotoxic effects. *International Journal of Molecular Sciences*. – No. 26(15). – P. 7499. <https://doi.org/10.3390/ijms26157499> (in Eng.).



European Scientific Cooperative on Phytotherapy (2003) E/S/C/O/P Monographs: The Scientific Foundation for Herbal Medicinal Products; European Scientific Cooperative on Phytotherapy: Exeter, UK. – P. 1-147. (in Eng.).

Ivanescu B., Miron A., Corciova A. (2015) Sesquiterpene Lactones from *Artemisia* Genus: Biological Activities and Methods of Analysis. *J. Anal. Methods Chem.* – P. 1–21. (in Eng.).

Jalmakhanbetova R.I., Adekenov S. M. (2007) Chemical study of *Artemisia filatovae* // *Chemistry of Natural Compounds.* – Vol. 43. – No. 3. – P. 347-348. (in Eng.).

Jalmakhanbetova R.I., Suleimen Ye.M., Oyama M., Elkaeed E.B., Eissa I.H., Suleimen R.N., Metwaly A.M., Ishmuratova M.Yu. (2021) Isolation and In Silico Anti-COVID-19 Main Protease (Mpro) Activities of Flavonoids and a Sesquiterpene Lactone from *Artemisia sublessingiana*. *Journal of Chemistry.* ID 5547013. <https://doi.org/10.1155/2021/5547013> (in Eng.).

Koul B., Taak P., Kumar A., Khatri T., Sanyal I. (2018) The *Artemisia* Genus: A Review on Traditional Uses, Phytochemical Constituents, Pharmacological Properties and Germplasm Conservation. *J. Glycom. Lipidom.* – No. 7. – P. 142-149. (in Eng.).

Krebs S., Omer B., Omer T.N., Fliser D. (2010) Wormwood (*Artemisia absinthium*) for Poorly Responsive Early-Stage IgA Nephropathy: A Pilot Uncontrolled Trial. *Am. J. Kidney Dis.* – No. 56. – P. 1095-1099. (in Eng.).

Ksibi N., Saada M., Yeddes W., Limam H., Tammar S., Wannes W.A., Labidi N., Hessini K., Dakhlaoui S., Frouja O. et al., (2022) Phytochemical Profile, Antioxidant and Antibacterial Activities of *Artemisia absinthium* L. Collected from Tunisian Regions. *J. Mex. Chem. Soc.* – No. 66. – P. 312-329. <https://doi.org/10.29356/jmcs.v66i3.1709> (in Eng.).

Meyer B.N., Ferrigni N.R., Putnam J.E., Jacobsen L.B., Nichols D.E., and McLaughlin J.L. (1982). Brine shrimp: A convenient general bioassay for active plant constituents. *Planta Medica.* – No. 45(5). – P. 31-34. <https://doi.org/10.1055/s-2007-971236> (in Eng.).

Nigam M., Atanassova M., Mishra A.P., Pezzani R., Devkota H.P., Plygun S., Salehi B., Setzer W.N., Sharifi-Rad J. (2019) Bioactive compounds and health benefits of *Artemisia* species. *Nat. Prod. Commun.* – No. 14. – P. 1934578–19850354. <https://doi.org/10.1177/1934578X19850354> (in Eng.).

Sagyndykova M., Imanbayeva A., Gassanova G., Ishmuratova M. (2024) Current Status and Resources of *Alhagi pseudalhagi* (Fabaceae) in the Atyrau Region, Western Kazakhstan. *Diversity.* – No. 16. – P. 219. (in Eng.).

Sampietro D.A., Gomez A. de los A., Jimenez C.M., Lizarraga E.F., Ibatayev Z.A., and Suleimen Y.M. (2016). Chemical composition and antifungal activity of essential oils from medicinal plants of Kazakhstan. *Natural Product Research.* – No. 30(13). – P. 1464-1467. <https://doi.org/10.1080/14786419.2016.1258560> (in Eng.).

Trifan A, Zengin G, Sinan KI et al (2022) Unveiling the phytochemical profile and biological potential of five *Artemisia* species. *Antioxidants* 11. – P. 1017. <https://doi.org/10.3390/antiox11051017> (in Eng.).

Turuspekov Y., Genievskaya Y., Baibulatova A., Zatybekov A., Kotuhov Y., Ishmuratova M., Abugalieva S. (2018) Phylogenetic taxonomy of *Artemisia*, L. species from Kazakhstan based on matK analyses. *Proc. Latv. Acad. Sci.* – No. 72. – P. 29. (in Eng.).

Wang Y., Ma Y. B., Huang X. Y., et al. (2023) Artemleucolides A–L: eudesmane-type sesquiterpenoids from *Artemisia leucophylla* and their antihepatoma cytotoxicity. *Fitoterapia.* – No. 165. – P. 105399. <https://doi.org/10.1016/j.fitote.2022.105399> (in Eng.).

Wu C., Yan Y., Wang Y., Sun P., Qi R. (2020) Antibacterial epoxy composites with addition of natural *Artemisia annua* waste. *e-Polymers.* – No. 20. – P. 262-271. (in Eng.).

Zaman W., Ye J., Saqib S., Liu Y., Shan Z., Hao D., Chen Z., Xiao P. (2021) Predicting potential medicinal plants with phylogenetic topology: Inspiration from the research of traditional Chinese medicine. *J. Ethnopharmacol.* – No. 281. – P. 114515. (in Eng.).

Zhumanova G.M., Dyusebaeva G.M., and Kudaibergenova S.K. (2023). Antimicrobial activity of silver nanoparticles stabilized by liposoluble extract of *Artemisia terrae-albae*. *Processes.* – No. 11(10). – P. 3041. <https://doi.org/10.3390/pr11103041> (in Eng.).

Publication Ethics and Publication Malpractice in the journals of the «Central Asian Academic Research Center» LLP (Almaty)

For information on Ethics in publishing and Ethical guidelines for journal publication see <http://www.elsevier.com/publishingethics> and <http://www.elsevier.com/journal-authors/ethics>.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see <http://www.elsevier.com/postingpolicy>), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the originality detection service Cross Check <http://www.elsevier.com/editors/plagdetect>.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Requirements for articles design for publication in the journal are available on the websites:

www.nauka-nanrk.kz

ISSN 2518-1483 (Online), ISSN 2224-5227 (Print)

<http://reports-science.kz/index.php/en/archive>

Managing Editor: T. Apendiev
Editors: D.S. Alenov, A. Shormakova
Computer layout: G.D. Zhadyranova

Signed for print: June 22, 2026
Format: 70×90 1/16. 24.5 printed sheets. Order No. 2.

*«Central Asian Academic Research Center» LLP
Almaty, Shevchenko Street, 28*