REVIEW

of the official reviewer for dissertation work

Amanzholkyzy Arailym on the theme «Hydrogel forms of hydroxypropylmethylcellulose and bentonite clay based on plant extract *Tamarix Hispida*» presented for the degree of Doctor of Philosophy (PhD) in the educational program «8D05301 - Chemistry».

№	Criteria	Eligibility (one of the options must be checked)	Justification of the position of the official reviewer
1.	The topic of the thesis (as of the date of its approval) corresponds to the directions of development of science and/or state programs	1.1 Compliance with priority areas of science development or government programs: 1) The thesis was completed within the framework of a project or target program financed from the state budget (indicate the name and number of the project or program) 2) The thesis was completed within the framework of another state program (indicate the name of the program) 3) The dissertation corresponds to the priority direction of the development of science, approved by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan (indicate the direction)	The dissertation work was carried out in the priority area of "Life and Health Science" at the Department of Chemistry and Technology of Organic Substances, Natural Compounds and Polymers within the framework of the grant funding program of the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan "Zhas Galym" on the topic AP22684531 "Development of hydrogel forms of plant extracts based on HPMC", 2024-2026.
2.	Importance for science	The work makes/does not make a significant contribution to science, and its importance is **well disclosed**/not disclosed	Biodegradable natural carriers of biologically active substances are of great interest for the creation of soft medicinal forms based on them. The results obtained in the work on the extraction of a water-ethanol plant extract with antioxidant, anti-inflammatory activities by ultrasonic treatment, the establishment of compounds responsible for the manifestation of activities, the introduction into the polymer and composite matrix of HPMC, the production of gels and the establishment of rheological characteristics, undoubtedly contribute to science in the direction of creating prolonged forms. The work clearly

			demonstrates the importance of creating composite systems based on local plant and mineral raw materials, which can subsequently be successfully used to develop medicinal extracts and polymer forms.
3.	The principle of independence	Self-reliance level: 1) **High;** 2) Medium; 3) Low; 4) No independence	In the work, the dissertation candidate independently selected the conditions for extracting the extract from the Tamarix Hispida plant, and conducted the experimental part of the work to study the composition and activity of the extract using modern, effective and standard methods. The establishment of the physicochemical properties, rheological characteristics, sorption-desorption capacities of gels and compositions, the chromatographic analysis carried out by the dissertation candidate, the interpretation of the obtained results in comparison with scientific achievements in this field, presented in the published review, where she is the first author, demonstrate a fairly high level of independence of the applicant in the implementation of the dissertation work.
4.	The principle of inner unity	4.1 Justification of the relevance of the thesis: **1) Justified;** 2) Partially justified; 3) Not justified.	In the dissertation, all chapters are subject to the principle of internal unity, starting from the choice of the topic, its relevance and the results obtained, and are aimed at achieving a solution to the main issue, the creation of hydrogel forms of water-ethanol extract from the *Tamarix Hispida* plant with antioxidant and anti-inflammatory action, in particular, a hydrogel based on HPMC and establishing patterns of interaction of 10% ethanol biologically active complex from the *Tamarix Hispida* plant with the base, starting from the stage of obtaining the extract, establishing the composition

			and obtaining gels based on the polymer. The conducted research is undoubtedly relevant, the dissertation clearly substantiates and presents the relevance, which follows from the literature search and analysis of scientific works and achievements on hydrogel systems of cellulose derivatives.
		4.2 The content of the thesis reflects the topic of the thesis: **1) Reflects;** 2) Partially reflects; 3) Does not reflect	The content fully reflects the topic of the dissertation "Hydrogel forms of hydroxypropylmethylcellulose and bentonite clay based on plant extract *Tamarix Hispida*" and is disclosed in the following sections, such as a review of scientific papers on hydrogel systems, methods of extract isolation and immobilization on hydrogel bases, the experimental part, including objects, materials, methods of chemical biological analysis, discussion of the results on the intensification of the isolation of plant extract from *Tamarix Hispida* plant raw materials, establishing the activity of the extract, determining the properties of hydrogels based on hypromellose with a biologically active extract, obtaining a polymer base with bentonite clay.
		4.3. The purpose and objectives correspond to the topic of the thesis: **1) correspond;** 2) partially correspond; 3) do not correspond	The aim and objectives of the dissertation are fully consistent with the research topic dedicated to solving the current problem of creating phytoextracts with anti-inflammatory and antioxidant activities based on plant raw materials from Kazakhstan and a polymer gel form of a biologically active complex with improved physicochemical characteristics.
		4.4 All sections and provisions of the thesis are logically interconnected: **1) completely interconnected;** 2) the interconnection is partial; 3) there is no interconnection	In the dissertation, all sections and provisions are logically and clearly interconnected, and the main results of the conducted research are fully reflected in the conclusions. The key findings of the dissertation logically follow from the practical work and analyses

			carried out and are consistent with the goals and objectives set in the dissertation.
		4.5 The new solutions (principles, methods) proposed by the author are reasoned and evaluated in comparison with the known solutions: **1) there is a critical analysis;** 2) partial analysis; 3) the analysis does not represent one's own opinions, but quotes from other authors	New solutions to the main goal and conclusions of the dissertation work proposed by the author are fully substantiated on the basis of critical analysis and evaluated in comparison with publications in well-known scientific journals in the field of dissertation research. Thus, the methods used in the work for synthesizing HPMC gels, developing a composite carrier, identifying and detecting plant secondary metabolites exhibiting corresponding biological activities in extracts, and establishing the optimal composition of polymer and composite gels were carried out on the basis of the advanced achievements of scientists in the direction of creating medical biodegradable gels presented in the scientific literature.
5.	Scientific novelty principle	5.1 Are the scientific results and provisions new? **1) completely new;** 2) partially new (25-75% are new); 3) not new (less than 25% are new)	The results obtained in the dissertation are entirely novel and have not been previously described in the literature. In particular, the doctoral candidate presents findings on the intensification and isolation of aqueous-ethanol extracts from *Tamarix Hispida*, their fractional separation with determination of activities; for the first time, hydrogels based on the cellulose derivative HPMC with compositionally immobilized aqueous-ethanol extract were obtained. Based on the rheological behavior of polymeric and composite hydrogels, optimal formulations were proposed. The influence of external and internal factors on the desorption properties of the obtained compositions was established. Furthermore, the antioxidant activity was demonstrated, and, for the first time, the anti-inflammatory activity of the THU-

			10 extract was identified. The novelty of the obtained results of the work and the provisions submitted for defense is also confirmed by publications in journals of the WoS and Scopus databases, a patent of the Republic of Kazakhstan for a utility model for obtaining an extract.
		5.2 Are the dissertation findings new? **1) completely new;** 2) partially new (25-75% are new); 3) not new (less than 25% are new)	The results of the work obtained as a result of a series of experiments and the conclusions drawn from them are new. By using the method of intensifying extraction through ultrasonic treatment, a multiple increase in the yield of extractive substances was achieved, establishing that as a result of exposure to ultrasound, the extraction of the main active components, tannins and flavonoids increases compared to the maceration method. For the first time, a 10% aqueous ethanol extract of *Tamarix hispida* has been shown to exhibit anti-inflammatory and antioxidant activity. For the first time, polymer hydrogel forms were obtained using composite immobilization of an aqueous-ethanol extract with HPMC and HPMC-BC, demonstrating the influence of clay on the properties of the substrate. The results were published in a Scopus-listed journal (Chemistry of Plant Raw Materials) and protected by a patent of the Republic of Kazakhstan for utility model.
		5.3 Technical, technological, economic or management decisions are new and reasonable: **1) completely new;** 2) partially new (25-75% are new); 3) not new (less than 25% are new)	The solutions used in the work for intensifying the extraction of biologically active substances from plant raw materials using a modern and effective method of ultrasonic processing, reducing the extraction time due to this and increasing the quantitative yield of biologically active substances, are new and justified. The fractional composition of the extract was studied for the first time, and their

			antioxidant and anti-inflammatory activity was investigated. Based on the conducted research, a polymer and composite composition with a plant complex with anti-inflammatory and antioxidant action was proposed, which can be the basis for the creation of a medicinal form.
6.	The validity of the main findings	All main conclusions are based on scientifically significant evidence or well-grounded (for qualitative research and areas of training in the arts and humanities)	In the dissertation, the main conclusions are substantiated and interpreted from a scientific point of view in comparison and on the basis of the achievements presented in the works of international scientific journals and are supported by the use of reliable data obtained in the experimental part by spectrophotometric, rheological methods of analysis, as well as biomedical analysis of activities.
7.	The main provisions for the defense	It is necessary to answer the following questions for each provision separately: 7.1 Is the provition proven? **1) proven;** 2) rather proven; 3) rather not proven; 4) not proven 7.2 Is it trivial? 1) yes; **2) no** 7.3 Is it new? **1) yes;** 2) no 7.4 Application level: **1) narrow;** 2) medium; 3) wide 7.5 Is it proven in the article? **1) yes;** 2) no	The provisions put forward in the dissertation are not trivial and have been proven on the basis of experiments and analyses. The propositions are consistent, logically structured, and interconnected. The novelty is proven by the applicant's publications and does not raise any doubts. **Provision 1** has been proven, it is not trivial, the novelty is proven by establishing the optimal time, raw material-extractant ratio, temperature and frequency of ultrasonic treatment, which allow intensifying the isolation of water-ethanol extract and reducing the time to 25 minutes with an increase in the content of extractive substances in a single cycle, at a temperature not exceeding 40°C and at a ratio of 1:6 raw material to extractant. It is characterized by a narrow level of application due to the fact that the established conditions are not common to all plant species and are optimal for the studied raw materials. **Provition 2** has been proven and is not trivial; anti-

			inflammatory and antioxidant activities in inhibiting the DPPH radical of the aqueous-ethanol extract have been established. Radical inhibition, compared to gallic acid and quercetin, showed greater than 98%. The application level of the analysis results is narrow; extracts with anti-inflammatory and antioxidant activities can serve as active ingredients in hydrogel systems for wound dressings. **Provition 3** is not trivial, the results are new, proven by methods of analysis of rheological parameters, quantitative values of the release of the main components of the plant extract from the gel base, optimal compositions for use as wound dressings are proposed. The proposed hydrogels with a plant water-ethanol extract based on HPMC can serve as a basis for the creation of biodegradable medical products, the level of application is narrow.
8.	The principle of reliability Reliability of sources and information provided	8.1 Choice of methodology - is justified or the methodology is described in sufficient detail **1) yes;** 2) no	The reliability of the sources and information presented is beyond doubt, the information and materials used have original data and are presented in the work with appropriate links. In the dissertation, the applicant describes in detail the methodology for conducting experiments and analyses, similar to those presented in articles published in indexed journals of scientific databases. The choice of approaches to conducting analyses and experiments is justified and carried out in accordance with the requirements.
		8.2 The results of the thesis were obtained using modern methods of scientific research and methods of processing and interpreting data using computer technologies:	The obtained experimental data and results were interpreted using modern methods, such as establishing rheological characteristics using a modern rheometer, conducting biomedical analyses

		1) yes; 2) no	using a DPPH test, widely used and recognized for determining activity, separation and determination of the predominant components of the extract.
		8.3 Theoretical conclusions, models, identified relationships and patterns have been proven and confirmed by experimental research (for areas of training in pedagogical sciences, the results have been proven on the basis of a pedagogical experiment): **1) yes;** 2) no	The theoretical conclusions, models, identified relationships and patterns have been proven, fractionation and instrumental studies of the obtained extracts have been carried out, the physicochemical properties of the gels have been established, the activity of the extracts has been established using biomedical analyses and the main patterns of inclusion of the biologically active plant complex in the gel base have been established.
		8.4 Important statements are **confirmed** / partially confirmed / not confirmed by references to current and reliable scientific literature	To interpret and substantiate the main conclusions and results in the dissertation, scientific articles from the scientometric database and peer-reviewed scientific journals were used. During the discussion of the results, advances in the field of plant extracts, chemistry of natural compounds and polymer chemistry, medical and biological materials over the past decades, described in the scientific literature, were used and all references are given.
		8.5 Used literature sources **are sufficient**/not sufficient for a literature review	The dissertation work uses a sufficient list of sources, including 193 titles, which was successfully used in the work to compile a complete and informative review of the literature in the field of the doctoral student's research. This review covers topics such as extraction methods for plant extracts, biodegradable hydrogels, as well as analytical and separation techniquesThis review covers topics such as extraction methods for plant extracts, biodegradable hydrogels, as well as analytical and separation techniques.
9	Practical value principle	9.1 The thesis has theoretical value:	The dissertation work undoubtedly has theoretical

		1) yes; 2) no	significance, which consists in expanding and supplementing the data on the creation of hydrogel medicinal systems, which will further have practical application. The results obtained on the patterns of immobilization and the establishment of the main parameters of gels surely contribute to the theoretical knowledge base of composite materials, on the influence of natural organic molecules and plant components on the physicochemical characteristics of the polymer and clay components of the hydrogel composite base. Data on the biological activity of the obtained extracts can serve as a basis for the creation of therapeutic agents with prolonged anti-inflammatory action.
		9.2 The thesis is of practical importance and there is a high probability of applying the results obtained in practice: **1) yes;** 2) no	The results obtained in the work are of practical significance for use in medical practice, in particular as anti-inflammatory agents, and can serve as a basis for the creation of polymer hydrogels based on a biodegradable polymer and their compositions with a slow release of the active plant complex.
		9.3 Are the practice suggestions new? **1) completely new;** 2) partially new (25-75% are new); 3) not new (less than 25% are new)	The polymer–clay gel formulations proposed in the dissertation are novel. The combination of natural components, their capacity for sustained release, and the demonstrated antioxidant and anti-inflammatory activities of the aqueous-ethanol extracts may serve as an effective basis for the development of gel forms.
10.	The quality of writing and design	Academic writing quality: **1) high;** 2) average; 3) below average; 4) low.	The dissertation is formatted in accordance with the requirements and includes all structural elements. The quality of academic writing is high. The material is presented in a well-structured manner, in a scientific style, with the text logically and coherently organized.
11.	Notes on a thesis	1. Figure 10 on page 36, which shows the UV spectra of aqueous solutions of the extract *Tamarix Hispida* plant, is	

		very unclear. It is difficult to see at which wavelengths the maxima are observed. 2. The methodology for studying the drug release from the gel is based on incubating the sample in an aqueous medium followed by determining the concentration of the active substance using UV spectrophotometry. This approach is acceptable for a preliminary evaluation of the release kinetics. However, the work lacks interpretation of the obtained data using kinetic models, which does not allow conclusions to be drawn about the mechanism of drug release.
12.	Scientific level of the doctoral student's articles on the topic of research (in case of defense of the dissertation in the form of a series of articles, the official reviewers comment on the scientific level of each article of the doctoral student on the topic of research)	Articles on the topic of doctoral students' research have been published in journals indexed in the Scopus database with percentiles of 23 and 80, which is an indicator of the novelty, relevance of scientific results and a sufficiently high level of preparation of the doctoral student. The results were also tested at scientific conferences, and a patent of the Republic of Kazakhstan for a utility model was received. The main scientific results of the dissertation are presented by the author in the following publications: 1. Article «Ultrasonic Extraction of Biologically Active Substances from *Tamarix Hispida* Willd» in the journal "Chemistry of Plant Raw Material": 2021. №3. p.283–289. Percentile - 23 (in the Scopus database), https://doi.org/10.14258/jcprm.2021038695 2. Article in the journal *Molecules* (Switzerland), which in 2024 was ranked in Q1 in the field of "Chemistry (miscellaneous)" with an SJR of 0.865 and a percentile of 80 (according to the Scopus database): "Hydrogel Delivery Systems for Biological Active Substances: Properties and the Role of HPMC as a Carrier". *Molecules* 2025, *30*(6), 1354, https://doi.org/10.3390/molecules30061354). 3. Utility model patent, published by RSE "National Institute of Intellectual Property", 2022, No. 28: "Method for obtaining extract from plant raw material".
13.	Decision of the official reviewer (pursuant to paragraph 28 of the present Model Regulations)	The dissertation work of Amanzholkyzy Araylym on the topic "Hydrogel forms of hydroxypropylmethylcellulose and bentonite clay based on plant extract *Tamarix Hispida*", submitted for the degree of Doctor of Philosophy (PhD) in the educational program 8D05301-"Chemistry" in terms of relevance, scientific novelty, significance for theory and practice, the volume of experimental research fully meets the requirements for dissertations for the degree of Doctor of Philosophy (PhD) in the educational program 8D05301-"Chemistry". Official Reviewer's Decision: 1. to award the degree of Doctor of Philosophy (PhD) in the educational program 8D05301-"Chemistry".

Official Reviewer:
Doctor of Chemical Sciences, professor,
Vice-Rector for Research of the NAO "Academician
Ye.A. Buketov Karaganda National Researcher University" _____ Tazhbayev Yerkeblan Muratovich
(Signature)