

ANNOTATION

of dissertation work on the topic

“Development of a Technology for the Preparation of an Antifungal Gel Incorporating *Ferula songarica* Essential Oil”, for the degree of Doctor of Philosophy (PhD) in the educational program 8D07201 – “Technology of Pharmaceutical Production”

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Relevance of the research topic

According to the Ministry of Health of the Republic of Kazakhstan, in the first ten months of 2025 the volume of pharmaceutical production increased by 11.7% and reached 156.6 billion tenge (approximately 305 million US dollars). This is 16.4 billion tenge more compared to the same period in 2024. The increase in production volume is associated with the launch of new technological lines for the production of pharmaceutical products and medical devices.

Despite the positive development dynamics of the pharmaceutical industry, the pharmaceutical market of the Republic of Kazakhstan still largely depends on imported medicines. In this regard, the development of domestic medicinal products and the creation and implementation of effective technologies for their production is one of the priority and relevant areas of modern pharmaceutical science and industry.

The creation of new medicines is one of the key tasks of modern pharmaceutical science and industry. The rapid development of medicine, the emergence of new diseases, and the increasing resistance of microorganisms to existing antibiotics require the search for effective, safe, and innovative therapeutic solutions.

According to the World Health Organization, dozens of new strains of pathogenic microorganisms are identified worldwide every year. Under these conditions, the search for and implementation of new medicinal products becomes particularly important for protecting public health and combating infectious diseases.

On the global pharmaceutical market, there is a growing interest in plant-based medicines, due both to their therapeutic effectiveness and the increasing demand for safe and environmentally friendly products. In addition, natural-origin preparations usually have a milder effect on the body and fewer side effects compared to synthetic analogues.

Ferula songarica is known in traditional medicine as a source of valuable essential oils used in the treatment of various diseases. These oils contain biologically active components with antimicrobial, anti-inflammatory, antioxidant, and immunomodulatory properties, making them promising for the development of modern medicines. However, *Ferula songarica* remains insufficiently studied, especially regarding the development of standardized medicinal products based on it and their pharmaceutical substantiation.

A comprehensive study of the essential oil of *Ferula songarica* will make it possible to develop medicinal products whose effectiveness and safety are scientifically justified in accordance with modern healthcare requirements.

The purpose of scientific research: To develop a domestic antifungal medicinal product based on the essential oil of the underground part of *Ferula songarica* and to study its safety and biological activity.

Objects of study: Plant raw material: *Ferula songarica* collected in Central

Kazakhstan; Samples of essential oil obtained from the underground part of *Ferula songarica* and Gel based on this essential oil.

Subject of study: Resource-based data, biomorphological characteristics, diagnostic features, quantitative parameters of the raw material, and chemical composition of the essential oil from the underground parts of *Ferula songarica*; essential oil from the underground parts of *Ferula songarica* and a gel formulated based on it; safety assessment of the essential oil; evaluation of the biological activity of the essential oil and the gel prepared from it; development of regulatory documents; compilation of final materials determining the theoretical and practical significance of the dissertation.

Research Methods: Pharmacopoeial, pharmacognostic, pharmacological, and biological, physicochemical methods

Objectives of study:

1. Pharmacognostic study of the plant raw material *Ferula songarica*.
2. Isolation of essential oil from the underground part of *Ferula songarica* and study of its chemical composition; development of quality specifications and determination of shelf life..
3. Development of the composition and technology for obtaining a gel based on the essential oil of the underground part of *Ferula songarica*..
4. Study of the antifungal activity of the essential oil obtained from the underground part of *Ferula songarica* and the gel based on it, as well as investigation of the acute toxicity of the essential oil.

Scientific novelty of the research:

As a result of the scientific research, for the first time:

- For the first time, a pharmacognostic study of the plant *Ferula songarica* growing in the territory of Kazakhstan has been carried out;
- For the first time, essential oil has been isolated from the underground part of the plant raw material *Ferula songarica* by hydrodistillation, and its chemical composition, safety and efficacy in vitro have been studied;
- For the first time, the composition of a new medicinal product in the form of an antifungal gel based on the essential oil of the underground part of *Ferula songarica* has been developed;
- For the first time, quality indicators of the antifungal gel based on the essential oil of the underground part of *Ferula songarica* have been developed, and the shelf life and storage conditions have been determined.

The scientific novelty of the dissertation research is confirmed by the patent of the Republic of Kazakhstan for a utility model ‘Application of *Ferula songarica* Essential Oil as an Antifungal Agent’ dated 02.12.2024, №10302

The main provisions for defense:

- The results of the assessment of raw material reserves of *Ferula songarica* growing in the territory of Central Kazakhstan, pharmacognostic analysis, as well as draft regulatory documentation;
- The results of obtaining essential oil from the underground part of *Ferula songarica* plant raw material by hydrodistillation and the analysis of its component composition;
- The development of the composition of a medicinal product in the form of a gel based on the essential oil obtained from the underground part of *Ferula songarica* plant raw material;

- The results of the study of the pharmacological activity of the essential oil obtained from the underground part of *Ferula songarica* plant raw material and the gel based on it.

Practical significance of the obtain results

As a result of the conducted research, the raw material reserves of *Ferula songarica* herb in the territory of Central Kazakhstan were determined.

The technology for harvesting medicinal plant raw material *Ferula songarica*, quality specifications, and draft regulatory documentation were developed.

Based on the results obtained during the dissertation research, the medicinal plant raw material *Ferula songarica* herb was recommended.

Essential oil from the underground part of *Ferula songarica* was obtained by hydrodistillation, and its chemical composition was determined using the GC–MS method.

Based on the essential oil of the underground part of *Ferula songarica*, a medicinal product in the form of an antifungal gel was developed. According to the results of non-clinical studies, the medicinal product does not exhibit toxic properties and is recommended as an antifungal agent. A laboratory regulation was developed and draft regulatory documents for the production of the antifungal gel were prepared.

The results of the research work on the pharmacognostic study of *Ferula songarica* were implemented in the educational process of the School of Pharmacy of the Non-profit Joint Stock Company “Karaganda Medical University”, the Faculty of Biology and Geography of the Non-profit Joint Stock Company “Karaganda Buketov University”, as well as the Department of Pharmacognosy and Botany of Bashkir State Medical University.

Personal contribution of the doctoral student:

The author of the dissertation conducted an extensive review and analysis of domestic and foreign scientific literature and independently performed experimental studies in accordance with the research objectives. This is confirmed by the fact that the research results were obtained using modern equipment and scientific literature in laboratory and production conditions.

The scientific validity and reliability of the obtained results are confirmed by their focus on solving current problems of pharmaceutical science and practice, in particular the development of new domestically produced medicinal products, the conduct of research in a modern scientific research center, as well as the preparation of draft regulatory documentation.

Approbation of the results of the dissertation

The results and main provisions of the scientific research were presented at the following scientific events:

1. IX International Scientific Conference of Young Scientists and Students "Prospects for the Development of Biology, Medicine, and Pharmacy" (Shymkent, December 8–9, 2022);

2. Student Scientific and Practical Conference "The Flourishing of Pharmacy!" (Karaganda, 2023);

3. X International Scientific and Practical Conference of Young Scientists "Modern Trends in Health Preservation Technologies" (Moscow, Russia, December 5–6, 2023);

4. Materials of the Republican Scientific and Practical Conference with

International Participation, dedicated to the 80th anniversary of Professor A.I. Akhmetzhanova, Department of Botany, "Topical Problems of Biology and Ecology" (Karaganda, January 15, 2025).

Publications:

Based on the materials of the dissertation, 9 printed works have been published, including:

- 2 articles in an international scientific journal indexed in the Scopus database (Q2, 50%);
- 2 national journals,
- abstracts of 4 reports in the materials of international conferences.
- A patent for a utility model has been obtained -1

Scope and structure of the dissertation

The dissertation is presented in 153 pages of computer text, including 171 literary sources. The dissertation is illustrated with 37 tables and 30 figures and includes 17 appendices.

CONCLUSIONS:

As a result of the conducted dissertation research, the following conclusions were drawn:

1.1 The distribution area and resources of *Ferula songarica* were studied. As a result of studying the distribution area, it was concluded that *Ferula songarica* herb is widely distributed in the territory of Kazakhstan, including the Karaganda region. According to the results of the resource study, the exploitable reserves of the underground part of *Ferula songarica* amount to 564.7 centners, while the reserves of the aboveground part amount to 1238.3 centners. The possible annual harvesting volume of raw materials is 56.4 and 613.2 centners, respectively.

1.2 The pharmacognostic characteristics of the plant raw material *Ferula songarica* were determined. Macroscopic and microscopic analyses of the raw material were carried out, and the histochemical composition was determined.

For the first time, the aboveground and underground organs of *Ferula songarica* were studied using light microscopy in combination with histochemical tests. As a result of histochemical tests on cross-sections of leaves, stems, fruits, roots and surface sections of the flowers of *Ferula songarica*, essential oils, phenolic compounds, sesquiterpene lactones and flavonoids were detected, and their localization was established:

- Essential oils – epidermis, mesophyll and vascular bundles of the leaf; epidermis, xylem and pith parenchyma of the stem; veins of the flower corolla; exocarp and secretory cavities of the fruit and root; cortical parenchyma of the root;
- Phenolic compounds – leaf mesophyll, xylem elements of the vascular bundle, parenchyma and conducting zone of the stem and root, epidermal cells of the flower corolla, walls of secretory cavities and exocarp of the fruit;
- Flavonoids – mesophyll and vascular bundles of the leaf; epidermal cells, chlorenchyma, cortical and pith parenchyma of the stem and root; sclerenchyma of the stem; xylem of the stem and root; mesocarp of the fruit; veins of the flower corolla;
- Sesquiterpene lactones – secretory cavities along the veins of the flower epidermis and in the fruit.;
- Polysaccharides – exocarp of the fruit and the conducting zone of the root.

A technology for harvesting and processing *Ferula songarica* was developed.

2.1 2.1 Quality standards for *Ferula songarica* were developed and shelf life was determined. During 24 months of stability testing of *Ferula songarica* plant raw material in primary packaging, the quality stability indicators remained within the regulated limits, and the obtained data were included in the draft regulatory documentation for the raw material.

3.1 Essential oil from the underground part of *Ferula songarica* was obtained by hydrodistillation, with a yield of 0.9%

3.2 The chemical composition of *Ferula songarica* essential oil was studied. The main components were α -pinene – 32%, (E)- β -farnesene – 3.65%.

3.3 A quality specification for *Ferula songarica* essential oil was developed and its shelf life was determined.

4. The optimal composition and technology for obtaining an antifungal gel based on *Ferula songarica* essential oil were developed.

5. The study of antimicrobial and antifungal activity showed that the essential oil of the underground part of *Ferula songarica* and the gel based on it exhibit pronounced antimicrobial activity against Gram-positive bacteria *Staphylococcus aureus* and *Bacillus subtilis*, as well as against Gram-negative bacteria *Escherichia coli*, moderate activity against *Pseudomonas aeruginosa*, pronounced activity against yeast fungi *Candida albicans*, and strong antifungal activity against clinical strains of *Candida albicans*, *Candida glabrata*, and *Candida dubliniensis*.

6. During the analysis of observation results of experimental mice for 7 and 14 days after acute administration of essential oil at doses of 1000, 3000 and 5000 mg/kg, no negative effects on appearance, general condition, body weight or behavior of the animals were observed, and no adverse effects on biochemical blood parameters or major physiological functions of the organism were detected. It was established that the essential oil of *Ferula songarica* belongs to the group “Practically non-toxic” (Class 4 – low toxicity).

Relation of the present work to research projects.

The dissertation was carried out within the framework of the grant project of the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan, No. AP26103521, ‘Kazakh *Ferula* Species: Pharmacognostic and Genetic Studies for the Development of New Effective Phytopharmaceuticals’ (2025–2027).”