ABSTRACT

for the dissertation for Doctor of Philosophy (PhD) degree
in the specialty «6D060700 – Biology»
of **Alimova Sofiakhan Tileshovna** on the theme

Study morphobiological features and medicinal properties of "Frangula alnus" from mountain areas of Tien-Shan

General characteristics of the work. The dissertation is devoted to the study of the biological features, morphological and anatomical structure, phytochemical composition, and pharmacological properties of *Frangula alnus* Mill. growing in the mountainous regions of the Tien Shan.

Relevance of the Research Topic

At present, improper nutrition, obesity, and excessive alcohol consumption are the main risk factors leading to chronic inflammation and liver damage. Obesity causes various pathological changes in the human digestive, circulatory, and immune systems. In this regard, the scientific study of plants possessing natural hepatoprotective and anti-inflammatory properties has become an urgent issue. In this direction, as shown in our previous studies, *Frangula alnus* Mill., belonging to the family Rhamnaceae Juss. and growing in the Tien Shan Mountains, occupies a special place. *Frangula alnus* Mill. (commonly known as alder buckthorn) is a pharmacologically valuable plant whose bark and fruits contain biologically active compounds with anti-inflammatory, hepatoprotective, and immunomodulatory effects. Therefore, the study of the morphobiological and medicinal characteristics of this species is of great significance.

Currently, in Kazakhstan, the demand for plant-based medicinal preparations in healthcare is steadily increasing. The therapeutic effects of medicinal plants on human health have long been known and are widely used in both traditional and official medicine. Moreover, drugs based on medicinal plants are in high demand. While chemical drugs can have both beneficial and adverse effects on health, plant-based medicines generally have only positive effects on the body. Medicinal plants play an important role in human life. Their healing properties are due to the presence of various chemical compounds such as steroids, triterpenes, alkaloids, glycosides, vitamins, essential oils, and tannins.

In Kazakhstan, more than six thousand species of plants grow, about five hundred of which are classified as medicinal. The plants used as raw materials for the preparation of medicines are specially selected, and most are collected from wild species. Medicinal plants are used in various forms, such as dried herbs, infusions, decoctions, teas, or powders. The chemical composition of medicinal plants is highly diverse; they contain numerous biologically and pharmacologically active compounds as well as neutral and ballast substances. In fact, there are virtually no plants in nature that are absolutely neutral for the human body. Medicinal plants are distinguished by their unique chemical composition and the presence of specific biologically active substances that can directly affect the organism.

Only plants are capable of synthesizing organic compounds from inorganic substances, and therefore, humans and animals cannot exist without plants. All elements of nature are thus directly interconnected.

In this regard, since the medicinal properties of many plant species growing in Kazakhstan have not yet been fully studied, the investigation of their botanical, phytochemical, and pharmacological characteristics remains one of the pressing scientific issues. According to the definition of the World Health Organization, human health is not merely the absence of disease or physical defects but a state of complete physical, mental, and social well-being. Improving health, preventing diseases, and using medicinal plants for treatment are long-standing practices of traditional medicine. Therefore, the identification and scientific justification of the therapeutic properties of such plants form the foundation of this research.

Historically, humans have recognized the beneficial effects of various medicinal plants for disease prevention. As a result, medicinal plants are valued for their antimicrobial, antioxidant, nutritional, and therapeutic properties. In recent years, due to the coronavirus pandemic, people around the world have become more conscious about their health, and the use of medicinal plants has expanded considerably.

In this context, *Frangula alnus* Mill., a representative of the family Rhamnaceae Juss., was selected for the study due to the medicinal properties of its bark and fruits, which are also used in traditional medicine. In official medicine, a preparation called "Ramnil", made from the bark of *Frangula alnus* Mill., is used for therapeutic purposes. *Ramnil* is a yellowish-brown powder with no odor or taste and is available in tablets containing 0.05 g of the active ingredient. It is taken as a mild laxative before bedtime in doses of one to two tablets.

Modern pharmacological studies using advanced research methods demonstrate that medicinal plants play a crucial role in disease prevention and treatment. Therefore, studying the morphobiological features and medicinal properties of *Frangula alnus* Mill. growing in the Tien Shan mountain regions is particularly relevant for developing effective and safe hepatoprotective and

Purpose of the Study: To investigate the morphobiological characteristics and medicinal properties of *Frangula alnus* Mill. growing in the mountainous regions of the Tien Shan.

Research Objectives:

1. To study the degree of environmental adaptation reflected in the morphological structure of *Frangula alnus* Mill. in the Tien Shan mountain regions;
2. To determine the anatomical features of the above-ground organs of *Frangula alnus* Mill. (leaves, fruits, stems, and bark);
3. To analyze the phytochemical composition of the above-ground organs of *Frangula alnus* Mill. (leaves, fruits, stems, and bark);
4. To investigate the effects of *Frangula alnus* Mill. on the liver and stomach of rats with induced obesity;
5. To study the influence of *Frangula alnus* Mill. on blood biochemistry and liver condition in mice with alcohol-induced fatty liver dystrophy.

Object of the Study:

The plant *Frangula alnus* Mill. collected along the Talgar River in the Ile Alatau Mountains.

GPS coordinates: 43°47′15″ N, 77°14′15″ E; altitude 475 m above sea level. During the experiment, the plant's leaves, fruits, stems, and bark were examined.

Taxonomic Classification:

- Division: Magnoliophyta — Angiosperms
- Class: Magnoliopsida — Dicotyledons
- Order: Rosales — Rose-like
- Family: Rhamnaceae Juss. — Buckthorn family
- Genus: *Frangula* Mill. — *Frangula*
- Species: *Frangula alnus* Mill. — Alder buckthorn

Thirty-six male, three-month-old, white, outbred rats weighing 170–200 g were obtained from the vivarium of Al-Farabi Kazakh National University. Under a high-fat diet, the effects of *Frangula alnus* Mill. extract on the liver and stomach of these rats were analyzed.

Additionally, sixty-eight male mice (strain SPF C57BL/6), aged three months and weighing 28–30 g, were obtained from the Experimental Animal Center of Xinjiang Medical University. Under a standard Lieber-DeCarli (LDK) liquid diet, the effects of *Frangula alnus* Mill. on the blood and liver of mice were investigated.

Research Methods: Morphological, anatomical, histochemical, phytochemical, biochemical, histological methods, and statistical analysis**.**

Scientific Novelty:

1. For the first time, a comprehensive study of the morphobiological characteristics and medicinal properties of *Frangula alnus* Mill. growing in the Tien Shan mountain regions was conducted;
2. Based on the results of morphological and anatomical studies of *Frangula alnus* Mill., diagnostic criteria for differentiating the bark of this plant were developed;
3. The phytochemical composition of *Frangula alnus* Mill. growing in the Tien Shan mountain regions was identified;
4. The biologically active substances of the pharmacopoeial plant *Frangula alnus* Mill. were determined;
5. The effects of *Frangula alnus* Mill. extract on the liver and stomach of obese rats were evaluated;
6. The influence of *Frangula alnus* Mill. on blood biochemistry and liver condition in mice with alcohol-induced fatty liver dystrophy was assessed.

Scientific and Practical Significance: The findings of this research provide valuable information for assessing the morphobiological characteristics and medicinal properties of *Frangula alnus* Mill. growing in the Tien Shan mountain regions.

The results obtained contribute to expanding scientific knowledge about the morphological and anatomical structure, phytochemical composition, and pharmacological properties of *Frangula alnus* Mill. from this region. The proposed

diagnostic characteristics of *Frangula alnus* Mill. possess significant practical importance for botanical identification and pharmacognostic analysis.

Main Provisions Submitted for Defense:

1. Identification of the morphobiological characteristics of *Frangula alnus* Mill. growing in the mountainous regions of the Tien Shan;
2. Discovery of diagnostic features in the macroscopic and microscopic analyses of the bark of *Frangula alnus* Mill. from the Tien Shan mountain regions;
3. Determination of the phytochemical composition of *Frangula alnus* Mill. growing in the Tien Shan mountain regions;
4. Identification of biologically active substances responsible for the pharmacological properties of *Frangula alnus* Mill.;
5. Determination of the antioxidant and antimicrobial activity of the bark, leaves, and fruits of *Frangula alnus* Mill.;
6. Proposal to reconsider the approaches for using medicinal plants, such as *Frangula alnus* Mill., in the development of effective and safe drugs with hepatoprotective and immunomodulatory effects.

Author's Personal Contribution: The dissertation is a completed scientific work. The author independently carried out the analysis of literature related to the research object, formulated and fulfilled the goals and objectives of the study, selected research methods, conducted field and experimental studies, processed and analyzed the obtained results, prepared practical recommendations, and personally wrote and formatted the dissertation manuscript.

Connection of the Work with the Research Program: The dissertation was performed as an independent study by the author in collaboration with scientific supervisors.

Approbation of the Work: The main provisions and research results of the dissertation were presented and discussed at the following international scientific conferences:

1. Proceedings of the XIII International Scientific and Practical Conference "Modern Technological Aspects of Agricultural Production and Environmental Protection", November 8–11, 2017, Almaty, Kazakhstan;
2. Collection of the International Scientific and Practical Conference "Formation and Prospects of the Development of the Scientific School of Pharmacy: Continuity of Generations", June 16, 2018, Almaty;
3. Proceedings of the International Scientific Conference of Young Scientists, Master's Students, Students, and Schoolchildren "XX Satbayev Readings", Pavlodar: S. Toraighyrov Pavlodar State University, 2020;
4. The main results of the dissertation were regularly reported and discussed at the meetings of the Department of Biodiversity and Bioresources, Faculty of Biology and Biotechnology, Al-Farabi Kazakh National University, every semester.

Publications:

The main content of the dissertation is reflected in nine published works, including:

- Three articles published in scientific journals indexed in the *Scopus* database;
- Three articles published in national scientific journals included in the list of the Committee for Quality Assurance in the Field of Science and Higher Education of the Republic of Kazakhstan;
- Three theses published in collections of international scientific conference proceedings.

Structure of the Dissertation: The dissertation consists of 100 typed pages and includes the following sections: list of symbols and abbreviations, introduction, literature review, materials and methods, results and discussion, conclusion, a list of 120 references, 15 tables, and 35 figures.