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The History and Development of Modern Pharmacognosy in Ukraine: The National University of Pharmacy, Kharkiv

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Abstract: This historical essay presents an analysis of the origins and development of modern pharmacognosy in Ukraine and explores the founding and development of the Department of Pharmacognosy at the National University of Pharmacy (NUPh, Kharkiv), providing an overview of the department`s history, a framework of its educational and methodological processes, primary research directions, and its main achievements. The paper also includes biographical data and outlines the main scientific and pedagogical achievements of prominent individuals who made a significant contribution to the development and formation of pharmacognostic and pharmaceutical science and education in Ukraine. Over the years, the staff of the pharmacognosy department has authored and published 14 monographs, 8 standard training programs, 25 textbooks, practical guides, and training manuals, 47 lecture notes, and 103 educational and methodological developments. Furthermore, 16 doctoral and 77 candidate theses have been defended at the Department of Pharmacognosy. The staff has also secured 63 author's certificates and 171 patents, and published about 1,050 articles, 1,060 abstracts, and 16 monographs. In addition, the department has developed numerous medicinal products and therapeutic as well as preventive items that have been introduced into medical practice. These achievements create a solid background for the department's fruitful development and future success.

Keywords: *history of pharmacy, medicinal plants, National University of Pharmacy, pharmacognosy, Ukraine*

General historical background

Pharmacognosy is a branch of pharmacy concerned with medicinal plants, herbal and animal-derived drugs, and products with pharmacological effects, which are used for medical purposes, as well as for regulating the body's physiological processes (Kovalev *et al.*, 2000; Raal, 2010).

In Eastern-European countries, folk traditions of harvesting and drying medicinal raw materials, and preparing medicines from them have been developed for centuries. In Kyivan Rus, even in pre-Christian times, people were treated by "*magi*, witch doctors, simplest folk healers," who used plants, minerals, and animal products. These healers often used various poisons and plants with intoxicating, emetic, and hypnotic properties. (Gaidai, 2000; Kotlyar, 2010; Tolochko, 2011)

The feudal period (10th–18th centuries)

In the 10th century, Eastern Slavs acquired writing and adopted Christianity, expanding the political ties of the state. Upon the invitation of Volodymyr Monomakh, the Greek physician Ioann Smer (1053–1125) arrived at Kyiv. Around the same time, the first written references to healing with plants, with "potions," emerged. The word stood for herb, herbal infusions, and poison, and is also the word from which "potioner," denoting a healer, was derived. Manuscripts of books on herbal remedies and home cures were also called potioners. The *Izbirnik* of Grand Duke Svyatoslav Yaroslavovich (1073) describes many medicinal plants used at that time (*Collection of Svyatoslav 1073*, 1983). Another significant text, *Shestydniv*, or *Hexaemeron* by John the Exarch (1263) contains brief information on the use of aconite, hemlock, henbane, and details the process for extracting opium from poppy. (Aitzetmüller, 1958; Kotlyar, 2010)

With the spread of Christianity on the territory of Ukraine, Orthodox monasteries became centers for "medical care." Medicinal herbs were cultivated at the Kyiv-Pechersk Lavra in Kyiv. Also, hospitals were established at the monasteries of Kyiv, Mizhhirsk, and Pustelno-Mykolaivkyi, where a combination of prayer and therapy using natural remedies was practiced. The Kyiv-Pechersk Monastery, founded in the 11th century by Venerable Anthony and Theodosius, played a significant role in the history of Ukrainian medicine. From the very first years, the Kyiv-Pechersk Monastery became not only one of the centers of Orthodoxy but also a center of national culture—chronicles, art, and architecture. Prominent

writers and artists lived and worked here. The first monks of the Pechersk Monastery came from Mount Athos and brought with them medical knowledge. During the reign of Emperor Romanos, St. Athanasius founded the "hospital for sick people" at the monastery. The Pechersk Patericon gives us information on several ascetics from Pechersk, such as Venerable Anthony, Damian, Agapit Pecherskyi, and Pymen Posnyk, who became famous for their art of healing. Antipus, also known as Anthony Pecherskyi (982–1073), treated the sick at the Kyiv-Pechersk Lavra (Gaidai, 2000). The Kyiv-Pechersk Patericon describes Agapit's most successful cases of treatment of both ordinary people and boyars, princes, and even Grand Prince Volodymyr Monomakh (Tolochko, 2011). There were also female healers, for example, Evpraksia Mstislavna (in the first half of the 12th century), the granddaughter of Volodymyr Monomakh, treated the sick and became famous for her treatise *Ointments* (Varzos, 1984).

Volyn and Halychyna

During the period of feudal fragmentation and the later Mongol-Tatar invasion in December 1240, Kyiv was captured and burned down, so the development of science and culture stagnated (Kotlyar, 2010). The western regions, Volyn and Halychyna, were less harmed by the invaders, and due to this, the healing traditions of Kyivan Rus flourished in those territories. The history of medical care in the Galicia region dates back to the 13th century. In 1270, Constance, the wife of Grand Prince Lev (Leo I), allocated land and funds to build a monastery with a shelter and a pharmacy for the sick at the Cathedral of John the Baptist. This pharmacy operated until 1480 (Kypyakevich, 1984). Similar places for the sick were established also in other monasteries, including the famous asclepieion at the monastery of St. George in Lviv (Alexandrovych, 2011), and religious centers. Manyava Skete, a women's monastery at Pochayiv Lavra, helped people through prayer and folk remedies. In the 19th century, as a result of a government's regulation of pharmacies in Halychyna, they were classified into the following groups: royal, military, community (which was the most common), district (area), homoeopathic, home, village, and *drogeries* (hygiene stores). Medical reference books for citizens were developed. In 1484, *Herbarius maguntiae impressum* was published in German (Clair, 1969), describing and providing illustrations of numerous local plants. Unfortunately, for citizens of Halychnya, its use was limited due to the language barrier. Later, Stefanus Falimirz (1534) compiled the encyclopedia of traditional medicines *O ziołach i o mocy ich* (On Herbs and their Potency) in Polish, the official language at the time. Divided in two parts, the first part of this book provides an illustrated description of more than 500 medicinal

products, and the second part describes the diagnosis of diseases, their prevention, and methods of treatment (Falimirz, 1534).

Left-bank Ukraine

On the territory of Left-bank Ukraine, phytotherapy and pharmacognosy developed along a different path. In the Zaporozhian Sich, there were hospitals staffed with experienced bone healers, folk surgeons, and barbers. Cossack beekeepers had experience in phytotherapy, they were long-lived and knew the secrets of medicinal plant use, including their harvest periods and the peculiarities of harvest (Gaidai, 2000; Klikovka & Harkavtseva, 2018).

In 1709, the first "apothecary garden" was established in Lubny (Vasilenko, 1986) where, in 1730, the first harvests of domestic rhubarb, mint, belladonna, and digitalis were made. These plants were in demand among doctors at that time. At the end of the 18th century, the cultivation of sugar beet to produce purified alcohol was started in the Lubny Botanical Garden. The first public pharmacy was established in Kyiv in 1709. (Kypyakevich, 1984; Vasilenko, 1986)

In the nineteenth century, the period of Ukrainian national revival, scientific and academic centers, including those dedicated to pharmacognosy, were relocated to universities and educational institutions established across Ukraine (Koshovyi *et al.*, 2018; Prokopenko *et al.*, 2015).

The main stages of the development of pharmaceutical education in Ukraine

Until the nineteenth century, pharmaceutical education was mainly acquired through apprenticeship in pharmacies. The apprenticeships lasted for 2 to 7 years, and after obtaining the title of sub-pharmacist, the sub-pharmacists underwent a further 1.5 to 3 years of practice, after which they were granted the title of a master. In the nineteenth century, the requirements for graduating from a higher educational institution were changed and, from then on, only applied to the owners and managers of pharmacies, who were required to study in Vienna or Krakow. Certain changes also took place in the training of sub-pharmacists, as now the apprenticeship lasted for 3 to 4 years, and the same terms were established for assistant practice. Only after that were sub-pharmacists and assistants allowed to enter university training. (Falimirz, 1534; Gaidai, 2000)

Higher pharmaceutical education began to develop in Lviv only after Emperor Franz Joseph I signed a decree in 1854–1855 on the establishment of a pharmaceutical department at the Faculty of Philosophy of Lviv University. Training was conducted according to a two-year program by professors of the Faculty of Philosophy and the Medical and Surgical Department of the university. In addition to compulsory subjects, pharmacists were advised to attend supplementary classes in the natural sciences. In 1889, pharmaceutical education was reorganized in Austria: assistant practice was discontinued and training at the university began after the exam. From then on, the completion of six grades of the gymnasium was a critical precondition for the admission of the student to the pharmacy. (Alexandrovych, 2011; Vasilyeva *et al.*, 2014)

By 1900, women were allowed to study pharmacy, and in 1905, Sophia Reich became the first woman in Austria to achieve a master's degree in pharmacy in Lviv. In 1913–1914, half of all female pharmacy students in Austria were studying at Lviv University. (Vasilyeva *et al.*, 2014)

Development of pharmacognosy

In Halychyna, the study of pharmacognosy as an academic discipline began at the medical school *Collegium Medicus* and continued at *Studium Farmaceutychne* at the Faculty of Philosophy of Lviv University, established in 1853. The development of a separate department dedicated to pharmacognosy is associated with the scientific and pedagogical activities of Tadeusz Feliksovich Wilczyński, who, in 1920–1923, was invited to teach a course on plant morphology and taxonomy to students of the pharmaceutical department (Vasilyeva *et al.*, 2014). Wilczyński is one of the founders of the Polish Dendrological Society, established in Lviv in 1924. In 1940, after the medical faculty was granted the status of a medical institute, Wilczyński used his own funds to establish a separate department of pharmacognosy with a course of botany, and became the head of the institute (1929–1964). In 1929–1930, Professor Wilczyński founded a garden of medicinal and ornamental plants, as well as an arboretum with plants brought from other continents and countries. The collection of medicinal plants amounted to up to 1,500 species. (Vasilyeva *et al.*, 2014)

Since 1964, the scientific research of Professor Wilczyński was continued by his student, Associate Professor I. P. Karpus, who was head of the department until 1970. At the department, traditions were maintained under the leadership of Professor L. Ya. Ladna-Rogovska (1970–1995), Associate Professor I. M. Bornyak (1995–1999), Associate Professor R. E. Darmograya (1999–2020), and, since

2020, Associate Professor N. V. Shapoval (Prokopenko *et al.*, 2015; Vasilyeva *et al.*, 2014).

As reported in the Ukrainian business weekly *Kontrakty* (2005, no. 11), the main chronological periods in pharmacognosy are briefly as follows: in 1921, pharmacy institutes with four-year programs were founded in Kharkiv and Odesa, alongside pharmacy technical schools offering a three-year course in Kyiv, Vinnytsia, and Kharkiv. In 1923, the training of professionals was started at the chemical and pharmaceutical faculties of Kharkiv and Odesa universities. In 1930, Ukrainian pharmacy educational institutions were transferred from the system of the People's Commissariat for Education to the People's Commissariat for Health. The Odesa Institute was reorganized into the medical and analytical institute, and pharmacy technical schools were reorganized into institutes with five-year programs. In 1937, the academic degrees of candidates and doctors in pharmaceutical sciences were introduced. In 1940, faculties of pharmacy were established at the Lviv Medical Institute and the Kyiv Institute for the Advancement of Pharmacists. In 1945–1950, after the Second World War, pharmacy institutes resumed training. Since 1954, advanced studies courses and specialization courses for pharmacists and part-time training of pharmacists for individuals with secondary pharmaceutical education and more than five years of professional experience were implemented. A part-time faculty was established at the Odesa Pharmaceutical Institute. (Koshovyi *et al.*, 2018; Vasilyeva *et al.*, 2014)

In 1903, a faculty of pharmacy was established at what later became Zaporizhzhya State Medical University as the Higher Courses for Women in Odesa (Klikovka & Harkavtseva, 2018).

In 1959, the Odesa State Pharmaceutical Institute was relocated to Zaporizhzhya, and Zaporizhzhya State Medical University was founded. Later, in 1968, the institute was reorganized into a medical institute and, in 1994, was officially assigned the status of the university (Klikovka & Harkavtseva, 2018). The Department of Pharmacognosy was established at the Zaporizhzhya Pharmaceutical Institute, with Associate Professor V. M. Sheludko as the first head of the department (1959–1968). In 1968–1973, the department was led by Associate Professor K. E. Koreshchuk; in 1973–1992, by Professor N. O. Kaloshina; and in 1992–2012, by Professor V. S. Dolia, doctor of pharmaceutical sciences. Since September 2012, Professor S. D. Trzetsynskyi, doctor of biological sciences, has been the head of the department.

In independent Ukraine, faculties of pharmacy were established at medical universities in regional centers. Pharmacognosy was one of the main academic disciplines in corresponding curricula, and professors of pharmacognosy were the guarantors of educational programs (Klikovka & Harkavtseva, 2018).

In Prykarpattia, Professor Andriy Romanovych Grytsyk established the Faculty of Pharmacy of the Ivano-Frankivsk National Medical University, where he has been the head of the Department of Pharmacy since 2001 and, since 2022, of the Department of Pharmaceutical Management, Drug Technology and Pharmacognosy. Since 2023, Grytsyk has been the first Vice Rector of the University. His scientific research is devoted to the phytochemical study of the Alpine sorrel of the flora of the Carpathians (1998), and the pharmacognostic study of plants of *Gentianaceae* and *Polygonaceae* families as promising sources of therapeutic and prophylactic agents (2008). Grytsyk founded a domestic school of pharmacognostic research in Prykarpattia. Under his supervision, phytochemical studies of the flora of western Ukraine were carried out on the following plant species: willow gentian (N. P. Tsveiuk), broad-leaved sermountain (U. B. Sikoryn), true catnip (T. G. Stasiv), common heather (G. Y. Starchenko), great masterwort (T. I. Kolyadzhin), wood sanicle (N. I. Legin, N. M. Posatska) and *Agrimonia* (N. M. Huzio), as well as species of *Veratrum* (G. I. Melnyk), *Filipendula* (O. A. Struk), *Hypericum* (V. A. Sologub), *Ruta* (M. V. Melnyk), *Pinus* (T. P. Mandziy), *Betonica* (I. A. Sas), *Achillea* (O. V. Neiko), *Anchusa* (S. P. Svirska), and *Verbena* (N. M. Posatska) genera. Fifteen candidate's theses and two PhD theses were defended at the school (*Naukova shkola Grytsyk*, n.d.).

At the forefront of establishing the pharmacognostic school in Kyiv was Nina Pavlivna Maksyutina (19 February 1925 – 17 November 2015), a graduate of the Kharkiv Pharmaceutical Institute (KhPhI), an outstanding academic pharmacognosist and phytochemist, doctor of chemical sciences, a professor, Laureate of the All-Union Society of Inventors and Rationalizers Prize among women, and an Honored Worker of Science and Technology of Ukraine. She held positions at the Kharkiv Scientific Research Chemical and Pharmaceutical Institute (KHNIHFI) and at Bogomolets O. O. National Medical University, where she served as a professor and head of the pharmacognosy and botany section of the Department of Pharmacy. Over her 64 years of scientific and pedagogical activity, Maksyutina established a school of phytochemists and pharmacists, supervising the defense of 5 doctoral theses and 19 candidate theses. Her talented student and colleague Olena Mykolaivna Hrytsenko should be mentioned here too. She was also a graduate of Kharkiv Pharmaceutical

Institute, a doctor of pharmaceutical sciences, a professor, an academician of the International Academy of Informatization at the United Nations, and head of the Department of Pharmacognosy (later, the Department of Pharmaceutical Chemistry and Pharmacognosy) of Shupyk P. L. National Medical Academy of Postgraduate Education. She has supervised three candidate's theses and a doctoral thesis in pharmaceutical sciences.

In addition, it is also important to mention Professor Svitlana Mykhailivna Marchyshyn (from I. Horbachevsky Ternopil National Medical University), who has significantly contributed to the development of pharmacognosy in independent Ukraine.

At the moment, the field of education and science, including pharmacy, face extremely challenging times. However, there is hope that with international support, pharmaceutical education and science will gain a new impetus for sustainable productive development.

Historical essay on the development of the Department of Pharmacognosy at the National University of Pharmacy

The Department of Pharmacognosy has its origins in the Department of Drug Substances, Pharmacy and Medical Art of Imperial Kharkiv University, which was founded in 1805. In Europe, these departments were called *materia medica*. Later, the department was reorganized into the Department of Pharmacy and Pharmacognosy and the Department of Pharmacology (1837), where medicinal products of plant origin were taught since the very beginning. The first professor to teach pharmacognosy was George Koritari, a Hungarian by origin, who graduated from the University of Jena, with expertise in medicine, surgery, pharmacy, and chemistry. Initially, the teaching at *materia medica* was not separated from therapy and pharmacy with pharmacognosy. Koritari used the textbook of Johann Bartholomew (Bartholomäus) Trommsdorff to teach pharmacy. For a brief period, the department was led by the renowned chemist Johann Emanuel Ferdinand Giese before he moved to the University of Dorpat in 1814. In 1813–1816, the theory and practice in pharmacy were taught by M. P. Bolgarevskyi, whose name is associated with the founding of the pharmaceutical laboratory. One of the main research areas of this laboratory was pharmacognosy, that is, the study of medicinal plants and herbal raw materials

(HRM) (Shvalb *et al.*, 2007). In 1839, by the decision of the medical faculty at the Department of Drug Substances, a course of pharmacognosy was established, led by Professor E. S. Hordienko. During Hordienko's internship abroad, lectures and classes on pharmacy and pharmacognosy were taught by H. S. Ryndovskyi. In different years, pharmacognosy was also taught by professors Ludvig Vanotti (Yakiv Osypovych), I. P. Kamenskyi, and Y. M. Gromov. (Shvalb *et al.*, 2007)

In the academic year 1847–1848, pharmacognosy became distinct from pharmacology. Pharmacognosy and pharmacy were taught for two semesters to second-year students for three hours per week. Textbooks used by pharmacists were the main instructional resources, notably the multivolume work *Drug Substances* by Nestor Maksymovych Maksymovych-Ambodik, which was published in 1783–1788. (Koshovyi *et al.*, 2018; Shvalb *et al.*, 2007)

Professor Oleksandr Petrovych Nelyubin compiled the manual *Pharmacography or Chemical and Pharmaceutical and Pharmacodynamic Description of the Preparation and Use of New Drugs* (1827). Considering the need to develop methods for identification of herbal raw materials, establish their quality, and detect foreign matters, Nelyubin's follower, Academician Yuliy Karlovych Trapp (1814–1908) distinguished pharmacognosy as a separate discipline and authored the first textbook in the field. The well-known works of Volodymyr Andriyovich Tikhomirov, professor of pharmacy are *The Course of Pharmacognosy* (1885), *Guide to the Study of Pharmacognosy* (1888–1890), and *Textbook on Pharmacognosy* (1900). (Koshovyi *et al.*, 2018; Shvalb *et al.*, 2007)

Georgiy (Georg) Ludvigovich Dragendorff (1836–1898), professor of the University of Dorpat, authored the work *Qualitative and Quantitative Analysis of Medicinal Plants* (1882) and the handbook *Medicinal Plants of Different Peoples and Times, Their Use, Major Chemical Substances and History* (1890), describing 12,000 species of medicinal plants (Hinrikus *et al.*, 2005; Raal *et al.*, 2020; 2023; Tankler *et al.*, 2002)

Heads of the department of pharmacognosy and outstanding scientists

Yakiv Mykolayovych Gannot, the first head of the Department of Pharmacy and Pharmacognosy (1864–1884), was born in Holland and became one of the first students of pharmaceutical courses taught at Kharkiv University in 1843.

In 1846, he successfully passed the exam for the pharmacist's title. In 1848–1862, he was employed as a laboratory assistant at the university's chemical laboratory. In 1854, he defended his master's thesis on the chemical analysis of cochinilla or Ukrainian *Coccus radicum*. In 1861, he was appointed to the position of pharmacist-scientist with the rights of an adjunct of the Kharkiv Veterinary School. The following year, Gannot began teaching pharmacy and pharmacognosy to second-year students. In 1863–1884, he was associate professor at the Department of Pharmacy and Pharmacognosy, but there is no information on his scientific activities and his students during his leadership in the laboratory. Gannot focused on the practical training of pharmacist trainees, and advocated for a separate department of pharmacy. In 1869, at his request, the number of pharmacy and pharmacognosy hours taught was increased. In 1884, Gannot left the university due to health reasons. (Shvalb *et al.*, 2007)

Mykola Fedorovich Mentin (1848–1893) began his career in pharmacy as a pharmacist apprentice and then as a pharmacist assistant. Through extraordinary perseverance and hard work, Mentin entered the medical and surgical academy in St. Petersburg, becoming a doctor in 1875. He served as a doctor in the active army and received awards and letters of acknowledgement from the emperor. In 1862, he defended his thesis *On Hippuric Acid in the Urine of Syphilitics* for the doctor of medicine degree at Kharkiv University. In 1883, Mentin was appointed to teach the course on pharmacognosy, and in 1884, he started work at the Department of Pharmacy and Pharmacognosy at Kharkiv University. At that time, Mentin was appointed to the University of Warsaw, where he assumed the position of the extraordinary pharmacy professor from 1886 until the end of his life and published the well-known *Course on Pharmacognosy*. His work on the causes of morbidity from chloroform among troops stationed in Turkey is widely known. Mentin never became a head of the department, but for a short period of time, namely, one year, as he worked as a teacher, he made significant contributions to its development. In Kharkiv, among other works, Mentin published an article on the culture of cinchona trees (*Pharmaceutical Journal*, 1884). Thanks to his requests, the department was provided with specialized literature on pharmacognosy for a total amount of 174 rubles (at that time, no literature was provided for more than 25 years). He purchased a Zeiss microscope with a polarizing device, worth 204 rubles, and a hand microscope. The pharmaceutical laboratory held a large number of drugs prepared by Mentin. (Koshovyi *et al.*, 2018; Shvalb *et al.*, 2007)

Figure 1. Andriy Dmytrovych Chirikov (1849–1912).

Andriy Dmytrovych Chirikov (1849–1912) was born in Kharkiv (Fig. 1). After graduating from the 5th grade of the gymnasium, he became a pharmacist apprentice. In 1869, he passed the exam for the title of pharmacist assistant, and in 1871, after completing courses at Kharkiv University, for the title of pharmacist (with honors). In 1877, he became a laboratory technician at the chemical laboratory of Kharkiv University, where, in 1880, he was granted the pharmacist's degree. In 1882, he obtained the title of private associate professor of pharmacy and pharmacognosy at Kharkiv University, and in 1882, a master's degree in pharmacy and became a private associate professor. In 1878–1887, Chirikov was employed as a laboratory assistant at the university's chemical laboratory. In 1883, his master's thesis in pharmacy explored the chemical composition and physical properties of hard coal and anthracites of the Donetsk Basin. Since 1885, Chirikov taught the pharmacy course. In 1885, Chirikov was appointed as head of the separate Department of Pharmacy and Pharmacognosy (according to the new University Charter of 1884). In 1888, he was appointed an extraordinary professor of the Department of Pharmacy and Pharmacognosy, and in 1901, an acting extraordinary professor. Chirikov significantly expanded the content of practical classes for students of pharmaceutical courses at the university. His *Guide to Practical Classes in General Pharmacy* was published thrice, and he authored several textbooks on pharmacy and pharmacognosy: *Course of Pharmacognosy* (3 editions, Kharkiv, 1871–1890) (Chirikov, 1871); *Guide to Practical Classes in Pharmacy with Medical Students* (3 editions, Kharkiv, 1890); *Guide to Qualitative Chemical Analysis* (Kharkiv, 1886), and a number of articles in specialized journals. Since 1891, Chirikov was head of the Pharmacy Association in Kharkiv. His activities were not limited to the walls of Kharkiv University, as he also taught a course of pharmacognosy and pharmacy at the Veterinary Institute, the Kharkiv Medical Society, as well as at the Red Cross Society. As a representative of the Medical Society, Chirikov and Professor V. Ya. Danylevsky petitioned the Minister of National Education to

open the Women's Medical Institute in Kharkiv. In 1910, with the founding of this educational institution, Chirikov was elected as a professor of the Department of Pharmacy and Pharmacognosy, as well as a comrade (assistant) of the director of the Institute. At the end of 1909, the Medical Faculty of Kharkiv University elected the Master of Pharmacy and Chemistry, Private Associate Professor M. A. Valyashko as an extraordinary professor of the Department of Pharmacy and Pharmacognosy. After handing over the leadership of the department to Valyashko, Chirikov remained a part-time honored professor with the right to teach. (Koshovyi *et al.*, 2018; Prokopenko *et al.*, 2015)

Leonid Grigorovych Spassky (1868–1929) was a distinguished specialist in the field of chemistry and pharmacognosy. He obtained the title of pharmacist assistant at Kazan University, and the title of pharmacist and a master's degree in pharmacy from Kharkiv University. Spassky was a part-time employee, as from 1889 to 1898 he performed the duties of a full-time laboratory assistant at the pharmaceutical laboratory. In 1896–1901, he worked as a private associate professor at Kharkiv University, and then as an associate professor at Tartu Veterinary Institute. He published numerous publications in journals and publications of various societies, including 'On Methods of Preparation of *Extr. Aconiti*,' 'Critical Notes on the Comments to the IV Edition of the Pharmacopoeia,' 'Results of Chemical and Microscopic Research of Persian Tea,' 'On Liquid Alkaloid and Essential Oil from Sunflower Flowers,' and 'On Methods of Quantification of Alkaloids in Narcotic Extracts.' (Koshovyi *et al.*, 2018; Shvalb *et al.*, 2007)

Mykola Ovksentiiovych Valyashko's (1871–1955) life and career played a significant role in the history of the Department of Pharmacognosy of the National University. Having become a scientist at Kharkiv University, in 1906–1908, he lectured on organic chemistry and carried out research into biologically active substances of medicinal plants and stereochemistry. At the same time, he successfully conducted phytochemical research. In 1903, he defended his thesis for the master's degree in pharmacy on the chemical study of glycoside rutin from rue, and in 1909, he was elected professor of the Department of Pharmacy and Pharmacognosy. In 1921, on his initiative and hard work, Kharkiv Pharmaceutical Institute (KhPhI) was founded. Kharkiv University appointed professors, handed over educational and scientific literature, devices, equipment, and provided KhPhI with a collection of herbal raw materials, which is kept at the Department of Pharmacognosy of the NUPh, and is a museum rarity. At the newly founded institute, the Department of Pharmaceutical Chemistry, Pharmacognosy and

Forensic Chemistry was headed by Professor M. O. Valyashko, who for a limited time took parallelly the position of rector of the Institute. After reorganizations in 1937, the department was divided into the Department of Pharmaceutical Chemistry (with Valyashko as its head) and the Department of Pharmacognosy and Forensic Chemistry (with Associate Professor P. K. Virup as its head). (Chernykh, 2005a, 2005b; Koshovyi *et al.*, 2018)

At the end of 1938, the Department of Pharmacognosy became a separate department, and in 1938–1966, it was headed by Associate Professor, later Professor and Rector of the KhPhI Yulian Halaktionovych Borysyuk (Fig. 2). (Chernykh, 2005a; Solodovnichenko & Kovalev, 2001)

Figure 2. Yulian Halaktionovych Borysyuk (1901–1970). Research supervisor Borysyuk with his students—future assistant professors-pharmacognostists H. V. Makarova and M. I. Borisov (1960).

Yulian Halaktionovych Borysyuk's (1901–1970) personality developed under the influence of his supervisor professor Valyashko, who recognized a leader in the graduate student and supported him. The young scientist was offered to perform an analysis of the quality of essential oils produced at the Prylutsky Essential Oil Plant. With Borysyuk's participation, 12 samples of essential oils were obtained under industrial production conditions. A comparison with commercial samples revealed the variability of the chemical composition of essential oils, which changed significantly during storage. To standardize the products, the physical and chemical properties of the studied oils were determined, and quality indices of industrially produced mint oil were proposed. In 1937, Borysyuk defended his candidate's thesis in pharmaceutical sciences on the topic of Ukrainian samples of essential oils. (Solodovnichenko & Kovalev, 2001)

During the Second World War, the institute was evacuated to the city of Semipalatinsk, and the department's equipment was evacuated as well, including microscopes, the collection of herbal raw materials, and other valuable materials. In Semipalatinsk, Kharkiv, and Dnipropetrovsk, the pharmaceutical institutes were merged. At the time, the Department of Pharmacognosy was headed by Borysyuk. When the institute was re-evacuated to Kharkiv in February 1944, Borysyuk was reappointed as the director of the Kharkiv Pharmaceutical Institute and at the same time held the position of the head of the Department of Pharmacognosy. The department was located at 12 Melnikova Street, now 12 Kulikivska Street (Fig. 3). Within a short period of time, the teaching staff were hired, classrooms and laboratory premises were restored, and the educational process at the institute was started. In 1946, as director of the KhPhI, Borysyuk obtained from the local authorities a land plot of 3 ha in the area of Dalnya Zhuravlivka to create an experimental field for cultivating medicinal plants for scientific research and to support the educational process. The collection of medicinal plants was spread over 148 plots of an area of 6 sq. m. This collection included plants studied in the pharmacognosy course and vegetated in the Central European climate zone. Furthermore, plots with possible impurities and poisonous plants provided for in the curriculum were created. In the early days, 110 species of medicinal plants were grown, and later the composition reached more than 300 species. The diversity of plant species was constantly maintained through seed exchange with 16 botanical gardens (Chernykh, 2005b). The cultivation area was 1.5 ha. In 1977, according to the Kharkiv reconstruction plan, the experimental field was destroyed. While in the post-evacuation period, classes were held only on microscopic analysis of medicinal raw materials, later the laboratory was established to conduct chemical research on medicinal raw materials. (Chernykh, 2005b; Koshovyi *et al.*, 2018)

Figure 3. The educational building at 12 Melnikova Street in the 1930s and today.

In 1946, a postgraduate program was initiated at the department, and the first graduate student was Raisa Kalinivna Chagovets, a participant in the Second World War. She researched the topic of essential oil of water and wild mint and defended her research work in 1952. From 1952 to 1960, there was no postgraduate program at the department and the scientific staff was trained mainly through assistantships. During this period, seven dissertations were defended. (Koshovyi *et al.*, 2018)

In 1960–1972, a botany course was conducted at the Department of Pharmacognosy, and the department was renamed the Department of Pharmacognosy with Basics of Medicinal Plant Biochemistry and Botany Course. In 1961, Borysyuk defended his thesis *Study of Essential Oils and Their Use in Medical Practice* for the doctoral degree in pharmaceutical sciences, and in 1962, he was awarded the title of professor of the Department of Pharmacognosy. Hundreds of highly qualified pharmacists graduated from the institute under Borysyuk's lead. (Koshovyi *et al.*, 2018; Solodovnichenko & Kovalev, 2001)

The scientific school, established by Borysyuk, was for decades involved in the study of the chemical composition of essential and fatty oils of species of Ukrainian flora, peppermint oil and by-products, as well as the morphological and anatomical features of herbal raw materials. Borysyuk and his students made a significant contribution to the study of biologically active substances of medicinal plants. In 1960, the postgraduate program was restored, and the scientific and research topics of the department changed. The study of phenolic compounds of species of the *Rubiaceae*, *Rosaceae*, and *Lamiaceae* families was given preference (Chernykh, 2005a).

Mykhailo Ivanovich Borysov (1928–1979) (Fig. 4). In 1960–1963, Borysov was a postgraduate student at the Department of Pharmacognosy. After the postgraduate program and defense of his candidate's thesis on the topic *Phytochemical Study of* Galium ruthenicum*,* salicifolium *and* cruciata (1964), he worked as an assistant and, in 1966–1979, as an associate professor and head of the Department of Pharmacognosy (Chernykh, 2005a). Borysov paid considerable attention to the training of highly qualified scientific staff. He established his own scientific school, and supervised the defense of six candidate's theses (Chernykh, 2005a; Koshovyi *et al.*, 2018).

Figure 4. Mykhailo Ivanovich Borysov (1928–1979).

a. At festive demonstrations with students and employees of the institute (1970).

b. Borysov with students during the practical training in Kobuletti (1976).

In 1974, the monograph *Medicinal Properties of Agricultural Plants* was published (Borisov *et al.*, 1974). The monograph was and still is very popular, and was republished in 1985. The department's scientific and pedagogical team

participated in the writing of the monograph, with Borysov coordinating the activities and editing the monograph. This work is of great importance in teaching the course on nutritive science, which studies the chemical composition of food products, their interaction with drugs, and the effect on a body's physiological processes. On public grounds, scientific expeditions were held to identify HRM resources in the Kharkiv region. As a result of the research, recommendations on how to optimize the herbal raw materials procurement were substantiated and forwarded to the Regional Pharmacy Department, which coordinated these activities.

After the untimely death of Borisov in 1979, Associate Professor **Nina Makarivna Solodovnichenko** (1929–2012) became the head of the Department of Pharmacognosy. At the department, Solodovnichenko worked her way up from assistant (1952) to the department's head (1979–1985). She defended her candidate's thesis on the chemical study of the essential oil from *Libanotis intermedia* and peppermint oil (1964) (Chernykh, 2005a; 2005b). Under her supervision, scientific research expanded in searching for biologically active substances with anti-inflammatory, choleretic, and hypoglycemic properties. Studies on cardiotonic glycosides, capsaicinoids, iridoids, and carotenoids were initiated. (Koshovyi *et al.*, 2018)

Collaborating with the State Scientific Center for Drugs, standard samples of rutin, myricetin, capsaicin, and the technology of capsaicinoid and carotenoid concentrates, as well as the improved production technology of the drug *Lanatozid* were developed under a new scientific direction 'Complex processing of herbal raw materials.' A new research topic, 'Resource science of medicinal plants,' was also established. The resources of HRM of Ukrainian flora were being studied, and distribution maps of multi-tonnage plant species of Kharkiv, Sumy, and Chernihiv regions were compiled for the pharmaceutical industry (Koshovyi *et al.*, 2018).

In February 1985, the department moved from 12 Melnykova Street to the new chemistry building at 4 Blyukhera Street (now 4 Valentynivska Street, see Fig. 5), where it is located on the fourth floor (Chernykh, 2005b).

From 1985 to 2012, the Department of Pharmacognosy was led by Professor **Volodymyr Mykolayovych Kovalev** (born in 1941), who is an honored figure in science and technology of Ukraine (1996) (Chernykh, 2005a). Kovalev defended his candidate's thesis *Pharmacognostic Study of Some Restharrow Species* in 1979 and his doctoral thesis *Research of Plants of the* Legume *Family as Sources*

Figure 5. The building at 4 Valentinovska street and the main building at 53 H. Skovorody Street today (photo by Prof. Viacheslav Lebedynets).

of Biologically Active Substances and Synthesis of Their Analogs in 1985. He has trained 6 doctors and 25 candidates of sciences. The department expanded its range of research topics and postgraduate and doctoral degree programs. The training of scientific staff for neighboring and more distant foreign countries was successfully carried out. At the department, students from thirty countries have studied, academic staff from Ukrainian medical universities have improved their qualifications, and scientific staff from Mongolia, Egypt, Vietnam, Afghanistan, and Lebanon have undergone internships. When the department moved to the new chemistry building, Rector Professor V. P. Chernykh raised a question regarding the establishment of the Botanical Garden at the National University of Pharmacy. A great deal of work was carried out by Prof. V. M. Kovalev, head of the Department of Botany, Professor A. G. Serbin, and senior researcher A. T. Volodarska. The year 1992 can be considered as the year of its establishment, and the botanical garden currently occupies an area of 7.16 ha. The collection includes 1,600 specimens of trees, 1,900 shrubs, and 200 species of herbaceous plants belonging to 30 families. (Chernykh, 2005a; Koshovyi *et al.*, 2018)

Systematic and pharmacopoeial plots of an area of 0.50 ha were established on the territory of the Botanical Garden, where medicinal plants are planted based on their dominant biologically active substances. The collection of plants in the pharmacopoeial plot supports the educational process with samples of herbal raw materials and herbariums and enables to carry out educational pharmacognosy practice at the NUPh Botanical Garden. (Chernykh, 2005b; Koshovyi *et al.*, 2018)

In 2004–2005, the Department of Pharmacognosy was divided into two departments: the Department of Pharmacognosy and the Department of Chemistry of Natural Compounds. These departments merged on September 1, 2023. (Chernykh, 2005b)

In 2006, with support from the administration and Rector of the NUPh, Academician of the National Academy of Sciences of Ukraine Professor V. P. Chernykh, employees of the Department of Pharmacognosy, Botany, Chemistry of Natural Compounds and of the NUPh Botanical Garden created 123 plots, each measuring 1 sq. m., next to the chemistry building to cultivate about 200 species of medicinal plants and morphologically similar species (Chernykh, 2005b).

In 2013–2022, the head of the department was **Oleh Mykolayovych Koshovyi** (born in 1981), doctor of pharmaceutical sciences and professor since 2017. Koshovyi defended his candidate's dissertation for the degree in pharmaceutical sciences on *Creating a New Drug Based on Complex Processing of Eucalyptus Leaves* in 2007, and a doctoral dissertation for the degree in pharmaceutical sciences on *Contemporary Approaches to the Development of New Remedies on the Basis of the Plants from* Eucalyptus *and* Salvia *Genera* in 2013. He has supervised ten candidates of science and doctors of philosophy. Koshovyi is an academician of the Academy of Sciences of High Education of Ukraine. Under his leadership, the material and technical base of the department improved significantly (Fig. 6). A new learning laboratory and a classroom-museum with exhibits of herbal raw materials, samples of medicinal preparations of plant origin, and some devices from the early 20th century were established. A computer-based learning and training class on pharmacognosy was created for students' self-training. The department's staff has also been involved in the promotion and digitization of the educational process: the department's website, audio and video lectures, distance-learning courses on pharmacognosy, and resources on medicinal plants have been developed. Drawing attention to the active integration of Ukraine into the European community, international cooperation of the department has been actively developed. Cooperation agreements with the Institute of Pharmacy of the University of Tartu, the Medical University of Warsaw, the University of Florence, the Jagiellonian University, and other foreign institutions have been signed. Educational and scientific cooperation is being developed, with students and the academic staff undergoing internships in these universities, including within the framework of the Erasmus+ program, conducting joint scientific research, with findings published in the world's leading academic journals. (Koshovyi *et al.*, 2018)

Figure 6. The Department of Pharmacognosy today.

On September 1, 2023, the new Department of Pharmacognosy and Nutricology was created by merging the Department of Pharmacognosy and the Department of Chemistry of Natural Compounds and Nutricology, and will undoubtedly continue the successful long-standing traditions of pharmacognostic education and science at the National University of Pharmacy.

Educational and methodological work at the Department of Pharmacognosy

Until 1930, pharmacognosy at Kharkiv Pharmaceutical Institute, as well as at other universities, was taught according to the commodity classification system of herbal raw materials (HRM). With this approach, herbal raw materials were classified both by morphology (roots, bark, herb, leaves, flowers, etc.) and plant materials (gums, fatty oils, resins, essential oils, etc.). In late nineteenth- and early twentieth-century pharmacognosy textbooks, all objects were classified according to this approach. As a result of this intensive development of knowledge on plant material phytochemicals and their properties, phytochemical analysis was introduced in laboratory classes since 1927, and the practice is continued

in all pharmacognosy departments. In 1939, with the adoption of the new curriculum, the theoretical course of pharmacognosy was revised, and the objects became classified based on herbal raw material phytochemicals, which was progressive for that time. Laboratory classes were improved: in addition to the HRM identification by microscopic features, students conducted commodity analyses of the HRM. The first scientific articles on the microscopic analysis of crushed raw materials with histochemistry and microchemistry were published. (Koshovyi *et al.*, 2018; Prokopenko *et al.*, 2015)

The number of teaching hours in pharmacognosy changed over the years. With the introduction of the four-year study period in 1930, pharmacognosy was taught for three semesters (on the fourth, fifth, and sixth semester) in the 2nd and 3rd years. The practical training lasted for 21 days. After the 3rd year, students were expected to pass the exam on pharmacognosy and cultivation of medicinal plants. By 1953, the training period extended to five years, and pharmacognosy was taught for three semesters in the 3rd and 4th years. (Koshovyi *et al.*, 2018)

Lectures on pharmacognosy were given by Professor Borysyuk. Methodologically, the laboratory classes were based on the 8th edition of the textbook by A. F. Hammerman, *The State Pharmacopoeia of the USSR*, and since 1962, on the 9th edition, making use of the methodological developments of the department, medicinal plant figures and figures showing anatomical features of raw materials, herbariums and samples of HRMs collected during educational practice. Laboratory classes lasted for six academic hours, were conducted according to the unified methodology, and were aimed at the morphological and anatomical analysis of HRMs. During phytochemistry laboratory classes, essential oils were quantified using steam distillation, and the quality of essential and fatty oils was studied. To carry out qualitative reactions, students were provided with guides to prepare extracts from HRMs; then the students performed chemical reactions, recorded the progress of work and observations in laboratory notebooks, and drew conclusions. An "anonymized" collection of HRMs was always on the lecturer's desk and was expanded from class to class. Students were rated on a 4-point scale: excellent, good, satisfactory, and unsatisfactory. An unsatisfactory grade was required to be balanced with a positive grade. (Koshovyi *et al.*, 2018; Solodovnichenko & Kovalev, 2001)

Students completed their internship on the experimental field and in the pharmacies of the Kharkiv region. Since 1952, the Ministry of Health of the USSR allocated the following bases for internships in pharmacognosy: the Crimean Zonal Research Station of the Union-Wide Scientific and Research Institute of

Medicinal and Aromatic Plants (ZRS of VILAR) (in the city of Simferopol), the North Caucasus ZRS of VILAR (the Vasyurynska station), Przhevalsk, district pharmacies of the Kharkiv, Poltava, Sumy, and Voronezh regions, and later also VILAR in Moscow, the Transcaucasian RS of VILAR (in Kobuleti), the Ukrainian ZRS of VILAR (in the village of Berezotocha, Poltava region), Hyagin state-owned farm of medicinal plants named after Ordzhonikidze (in the village of Stara Ushytsiav, Khmelnytskyi region), as well as the collective farm "Peremoha" (in Kaushany, Moldavian SSR). Expeditions were held to the Czech Republic, Bulgaria, and Mongolia. (Koshovyi *et al.*, 2018)

In 1966, the 4.5-year study period was introduced, and pharmacognosy was taught in the fifth and sixth semesters. With a new syllabus implemented in 1973, the study period changed from 4.5 years to 5. Since then, pharmacognosy has been taught in the fifth and sixth semesters of the 3rd year, and the ninth and tenth semesters of the 5th year. Specialization in phytotherapy was introduced in 1975. (Koshovyi *et al.*, 2018)

In 1960, the Department of Evening Studies and the Part-Time Department were established at the KhPhI for the first time for persons with secondary vocational pharmaceutical education who had relevant experience in their specialty. The Department of Evening Studies operated until 1992, while the Part-Time Department continues to operate. (Chernykh, 2005b)

The syllabus of 1981–1982 introduced a new academic course, 'Resource science of medicinal plants,' as part of the implementation of the state program to map thickets and discover HRM resources on the territory of the USSR. In parallel with the development of the working program and plans for laboratory classes, scientific expeditions were carried out on a voluntary basis to identify HRM resources in the Kharkiv region. (Chernykh, 2005b)

The department's herbarium collection, which is periodically updated and annually replenished, includes more than 1,000 samples, with over 300 species of medicinal plants and possible impurities. The HRM collection consists of five sets of 110 samples. (Koshovyi *et al.*, 2018)

When Ukraine gained independence in 1991, Kharkiv Pharmaceutical Institute became the first higher educational institution in the former USSR to be certified and accredited under the higher category of educational institutions. In 1992, it was reorganized into the Ukrainian Pharmaceutical Academy, later into the National Pharmaceutical Academy of Ukraine, and in 2002 into the National

University of Pharmacy. That same year, the Faculty of Industrial Pharmacy was established to meet the needs of the newly independent state. This period saw the creation of programs and the development of methodological support for new specialties and specializations. (Chernykh, 2005b; Prokopenko *et al.*, 2015)

In 1994, admissions to the master's degree program were initiated for graduates of full-time and part-time departments. A curriculum of the course 'Pharmacognostic analysis of new types of HRM' was created for master's students. By 1995–1996, a specialization in 'Fundamentals of practical phytotherapy' was introduced in the 5th year, with the curriculum developed and approved, new lectures compiled, and methodological developments for practical classes created. Along with that, an alternative course, 'Folk medicinal plants,' was also provided for educational and production internships. The title of the specialization was later changed to 'Medicinal plants in naturopathy (Basics of practical herbalism)' and 'Medicinal plants and phytotherapy.' (Koshovyi *et al.*, 2018; Prokopenko *et al.*, 2015)

In parallel, the department has introduced computer technologies in the educational process: processing lectures in a digital format, tickets of all types of control, and has initiated the development of data banks on medicinal plants, HRM, original photos of plants and raw materials, and a computer library of educational and scientific literature (Koshovyi *et al.*, 2018).

In 1998–2004, the Department of Pharmacognosy offered courses for students of various faculties and specialties. New specialties such as 'Technology of perfumery and cosmetic products' and 'Clinical pharmacy' were introduced in 1998, followed by 'Biotechnology'. A great amount of work was done for the licensing of these specialties. A comprehensive educational and methodological complex of pharmacognosy was developed for students of these specialties. (Chernykh, 2005b)

In 1998, the department's academic staff started the development of a bank of pharmacognosy tests for the licensing examination KROK-2: Pharmacy. Every year, new tests are created in Ukrainian, Russian, and English. (Chernykh, 2005b) In 1999–2000, the development of national standards of education, educational qualification characteristics (EQC) and educational and professional program (EPP) was started (Chernykh, 2005b).

In 2003–2004, the department began teaching English-speaking students of the Faculty for Foreign Citizens' Education. A course of lectures on pharmacognosy was created in English and guides to conducting laboratory classes for English-

speaking students were developed (Chernykh, 2005b). In 2004–2005, the course 'Pharmacognostic methods of analysis' was taught to students specializing in 'Laboratory diagnostics.'

In independent Ukraine, the creation of the national textbook *Pharmacognosy and the Principles of Plant Biochemistry* (Kovalev *et al.*, 2000) was among the department's most important projects. This first Ukrainian-language textbook on the professional discipline in pharmaceutical education, published in 2000, is used by students in all pharmaceutical universities and faculties in Ukraine. The department's staff has also created a number of manuals: *Prospects of the Use of Wormwood Species in Medicine* (Kovalyova *et al.*, 2021), *Fundamentals of Practical Phytotherapy* (Kovalev *et al.*, 1999), *A Practical Course on Pharmacognosy* (Kovalev *et al.*, 2003), *Herbal Raw Materials and Phytopreparations* in 2001 and 2003 (Solodovnichenko *et al.*, 2001), *Pharmacognosy* in 2007 and 2009 (Kovalev *et al.*, 2007), and *A Practical Course on the Identification of Herbal Raw Materials* (Kovalev *et al.*, 2014).

The number of bases for educational internships in pharmacognosy also expanded. Starting in 2005 and for years later, students underwent internships to learn about mountain flora in the city of Yaremche in the Ukrainian Carpathians. Student exchange with foreign educational institutions also progressed, with pharmacognosy internships taking place in Varna, Bulgaria (2008 and 2013), Warsaw, Poland (2016–2018), and at the Institute of Pharmacy of the University of Tartu in Estonia (2018).

The transition to the credit-module system in 2008–2009 increased hours of independent student learning and significantly reduced lecture hours in pharmacognosy. Independent learning is supported by educational literature, methodological recommendations, tests and cases to monitor learning success, but also by structural and logical schemes for studying medicinal plants and HRM, the herbarium collection, and the collection of herbal raw materials and phytopreparations.

Since 2014, distance learning has been implemented at the NUPh, with video lectures and laboratory classes, and distance learning courses provided by the department's staff (Koshovyi *et al.*, 2018).

Over the years, the department's staff has prepared and published 14 monographs, 8 standard training programs, 25 textbooks, practical course and training manuals, 47 lecture notes, and 103 educational and methodological developments (Koshovyi *et al.*, 2018).

The department's scientific school of pharmacognosy

This article only presents data on the department's scientific activities starting from the early twentieth century. Professor Valyashko was the first to isolate rutin from *Ruta graveolens* L. and determine its structure. His main research areas were the chemistry of medicinal substances and the study of their structure using ultraviolet spectroscopy. Valyashko studied the chemical properties of adonin, rutin, robinin, kaempferol, phytochemicals from buckthorn fruits (*Rhamnus cathartica*), essential oils from plants of Ukrainian flora, castor oil from Ukrainian varieties, etc. He established absorption spectra regularities for aromatic and heterocyclic compounds and made some interesting conclusions on the subtle molecular structure of various compounds. (Chernykh, 2005a)

In 1930–1960, the department's scientific activities included the standardization of HRM and derived products, such as implementation of HRM's morphological and anatomical analysis results, in particular of *Apiaceae* fruits, during pharmacopoeial monographs (PhM) development; standardization of industrially produced mint oil; establishment of quality parameters crucial for the quality of raw materials and domestically produced derived products (Yu. H. Borysyuk, R. K. Chagovets); development of phytopreparations based on individual compounds isolated from the essential oils from the fruits of *Coriandrum sativum* and *Carum ajowan* (Yu. H. Borysyuk) (see Solodovnichenko & Kovalev, 2001); complex processing of medicinal plants and HRM: the new source of menthol from mint oil production by-products; regulation on choleretic drug Flavomentin from mint leaves; mint oil production by-products were proposed as the cheap source to obtain *S*-guaiazulene, an imported medicinal substance with anti-inflammatory properties; obtaining the lipid substance from some *Apiaceae* fruits after essential oil extraction (N. M. Solodovnichenko, K. N. Zarayska); search for domestic substitutes for imported pharmaceutical products and herbal raw materials, expanding the range of domestic HRM: justifying the use of the lipid substance from celery, carrot, coriander, and fennel fatty oils as the suppository base and cocoa butter substitute in pharmaceutical and confectionery production (V. M. Pogorelova, Z. A. Nepomnyashcha); development of production regulation on hypotensive phytopreparation Vimin from periwinkle, an analogue of Vinblastin (P. M. Lyapunova); proposing *Galium ruthenicum* as the additional source for rutin (vitamin P) production (M. I. Borysov); obtaining antibacterial substance geraniol; obtaining carvone, thymol, especially bromothymol with antiseptic properties; obtaining linalool

from coriander oil with anthelmintic properties for use in medicine, and obtaining limonene for perfumery needs (Yu. H. Borysyuk, G. V. Makarova); and use of chromatographic methods in phytochemistry, in particular for the isolation of native compounds and substances (M. I. Borisov).

Since 1960, the department's research areas changed and the emphasis shifted to the study of phenolic compounds, especially hydroxycinnamic acids, flavonoids (M. I. Borysov) (Borisov *et al.*, 1971), iridoids (M. I. Borysov, M. M. Lytvynenko), and anthraquinones (M. S. Zhuravlyov, A. K. Bogaevsky) (Bogaevskii, 1972; Zhuravlev *et al.*, 1987) in *Rubiaceae* plants.

In research articles on the chemosystematic studies of *Asperula* L. and *Galium* L., the first effort to confirm the classification system of these genera based on external (morphological) features using chemical profile (M. I. Borisov) was made. Unlike most researchers in this field, Borisov used four classes of compounds (flavonoids, phenolic acids, coumarins, and iridoids) as chemomarkers (Borisov & Zoz, 1975a; 1975b). Phenolic compounds, terpenoids, and polysaccharides from *Fabaceae* species (V. M. Kovalev) (Borisov *et al.*, 1975c) and *Bidens* genus (A. G. Serbin, T. I. Isakova) (Serbin *et al.*, 1977), and the complex processing of herbal raw materials was studied, the latter in depth.

Yearly scientific expeditions to identify new species of medicinal plants and HRM were carried out in the Ukrainian Carpathians and the Caucasus (Koshovyi *et al.*, 2018).

Professor V. P. Chernykh proposed a new strategic direction for further scientific research, the objects of which were fruit, berry, leguminous agricultural plants, and their by-products (Koshovyi *et al.*, 2018).

In the 1980s, research in essential oils and phenolic compounds was continued. The composition of essential oils from *Lavandula* species, the phytochemicals of 30 *Vicia* species, *Pisum sativum* (14 varieties), *Bidens radiata* and *Aronia melanocarpa* were studied; methods were developed for the analysis of tropane alkaloids and *Thermopsis* alkaloids (N. M. Solodovnichenko). Studies into *Salvia* species (S. O. Prokopenko) (Litvinenko *et al.*, 1980); *Capsicum annuum* (N. V. Popova) (Bovtenko *et al.*, 2010), flavonoids and cardenolides in HRM (V. S. Kyslychenko) (Makarevich *et al.*, 1987), and anthracene derivatives (T. V. Ilyina, T. M. Kryuchkova, Mohammad Abu-Darvish, Khaled Taha Moh'd Abu Zaher) (Dykiy *et al.*, 2006; Zhuravlev *et al.*, 1987) were conducted. Serhiy Oleksiyovych Prokopenko used chemotaxonomy methods to study *Salvia* species

(in his thesis *A Chemical Study of* Salvia *Genus Species* for the academic degree of the candidate of pharmaceutical sciences in 1982) and *Lamiaceae* species (in his doctoral thesis *Research in Biologically Active Substances of Lamiaceae Plants of the Flora of Ukraine, and Production of Medicines on Their Basis* in 1988).

Between 1980 and 2010, the department's research focused prominently on the study of *Fabaceae* genera: *Ononis* L. (V. M. Kovalev) (Kovalev *et al.*, 1975), *Phaseolus* L. (V. I. Dikhtyaryov, A. B. Sedova) (Kovalev *et al.*, 1988), *Glycine* Willd. (L. M. Sira), *Vicia* L. and *Pisum* L. (A. M. Kovaleva) (Kovaleva & Kovalev, 1986), *Caragana* Lam. (V. V. Boynik, S. I. Uskova) (Boinik & Kovalev, 1987), *Coronilla* L., *Securinega* DC. and *Psoralea* L. (A. M. Komisarenko) (Komissarenko & Kovalev, 1987), *Lathyrus* L. (I. E. Shmaraieva) (Shmaraeva, 1993), *Robinia* L. (O. V. Demeshko) (Demeshko *et al.*, 2004), and *Cicer* L. (A. V. Cherkashyna) (Cherkashyna & Kovalev, 2009). Other agricultural crops extensively studied at the department were *Fagopyrum sagittatum* Gilib. (I. O. Zhuravel) (Zhuravel *et al.*, 2002), *Beta vulgaris* L. (L. V. Lienchyk) (Upyr *et al.*, 1996), *Ribes nigrum* L. (O. V. Kryvoruchko) (Komissarenko *et al.*, 1997), and *Rubus caesius* L. (O. A. Histseva) (Histseva *et al.*, 2004).

The department also conducted extensive research on *Populus* species (N. V. Borodina, A. M. Rudnyk) (Borodina *et al.*, 2008), *Crataegus* species (A. M. Kovaleva, N. V. Sydora, S. V. Kovalev) (Kovaleva *et al.*, 2009) and others. Technologies for obtaining standard compounds of ononin (V. M. Kovalev) (Kovalev *et al.*, 1980), capsaicin (N. V. Popova) (Popova *et al.*, 1996), and alizarin (T. V. Ilina, M. S. Zhuravlyov) were developed at the department (Zhuravlev *et al.*, 1988).

It is also worth emphasizing the invaluable contribution of Prof. Mykola Fedotovych Komisarenko to scientific activities carried out at the department. Komisarenko was an outstanding, internationally recognized phytochemist, head of the unit of natural and synthetic heterocyclic compounds (1977) and head of the laboratory of natural and synthetic heterocyclic compounds (1980–1997) at the State Scientific Center of Drugs in Kharkiv. For many years, Komisarenko managed phytochemical research, and advised and supported the department's young researchers in every way. (Koshovyi *et al.*, 2018)

Next to herbal raw material studies, a number of works at the department were devoted to the synthesis of analogs or derivatives of natural compounds. Cooperation with the Department of Organic Chemistry at Taras Shevchenko National University of Kyiv in the field of synthesis of natural compounds under

the supervision of Academician Professor Khilya Volodymyr Petrovych, doctor of chemical sciences, yielded promising findings. Synthesis of flavonoids and isoflavonoids was pursued to expand the range of sugar-lowering drugs based on natural raw materials (V. M. Kovalev) (Kovalev *et al.*, 1984).

Various hypoglycemic, anabolic, hepatoprotective, anti-inflammatory, and antiviral properties of natural and synthesized derivatives of 2(3)-phenyl(hetaryl)-γ-chromones were established, and the potential for creating antidiabetic agents based on 2(3)-phenyl(hetaryl)-γ-chromones was justified (Koshovyi *et al.*, 2018). The semi-synthesis of compounds using amino sugars, namely derivatives of dicarboxylic acids and glucosamine, resulted in synthesis of the drug substance Oxaglucamine with a wide spectrum of properties, including anti-inflammatory, analgesic, wound-healing, and anti-allergic ones (O. I. Pavlii) (Pavliy *et al.*, 1987).

Under the supervision of the world-renowned Prof. Ivan Khomych Makarevych, the directed semi-synthesis of cardiac glycosides was achieved through the condensation of strophanthidin with nitrogen-containing compounds—amines and hydroxylamines. New derivatives of benzo-α-pyrone and its acyl derivatives (S. V. Kovalev) were synthesized (Kovalev & Makarevich, 2009). The semi-synthesis based on aminoanthracenes and dicarboxylic acids was considered a promising research direction (M. S. Zhuravlyov, T. V. Ilina, L. M. Shtefan, and T. M. Kryuchkova) (Salnikova *et al.*, 1990).

Many research articles were devoted to plant chemosystematics (A. M. Kovaleva) (Kovaleva, 2011; Kovaleva *et al.*, 1997). The chemotaxonomic and chemoresource studies on 15 *Pisum sativum* L. varieties were carried out and the chemical profiles and characteristic features of *Pisum* varieties were established. Based on the relationships between *Pisum* varieties, the algorithm for a targeted search for flavonoids was developed, flavonoid sources among numerous varieties were identified, and the hepatoprotective drug Piflamin was developed (and launched in industrial production on September 2, 2005). Since 1991, new approaches to the targeted search for phytochemicals among plants of Ukrainian flora and its neighboring countries were developed, and the chemotaxonomy method was selected as the main method for comprehensive flora research (Kovaleva, 2011; Kovaleva *et al.*, 1997).

Professor Vasyl Ivanovych Lytvynenko emphasized the need to revise plant systematics by integrating chemical, morphological and ecological features—the set of phenetic (chemical and morphological) ecological features were first

implemented in plant systematics, and the numerical taxonomy method was developed using modern information technologies suitable for processing large data sets (A. M. Kovaleva) (Litvinenko *et al.*, 1980).

Numerical methods were first applied to process numerous genera of domestic flora and flora of the neighboring countries. As chemical features were identified, secondary metabolites were selected. At Komisarenko's suggestion, the research focused on the large *Astragalus* L. genus accounting for more than 2,000 species in the world flora. As a result of the chemotaxonomic research, correlation between the morphological and chemical features of *Astragalus* species was established—the quantitative phenetic-ecological-taxonomic and resource research study of 81 *Astragalus* species was carried out via an analysis of 31,356 states of 468 morphological features and ecotopes using flavonoids, as well as 1,320 states of 60 features based on cycloartanes. On the basis of the principles of graph theory, dendrograms were built and disputed issues regarding the genus hierarchy of *Astragalus* L. were resolved (Kovaleva *et al.*, 1997). A correlation was identified between phenetic features and the presence of such valuable pharmacological substances as quercetin, rutin, robinin, narcissin, hyperoside, as well as cycloartanes—cyclosiversigenin, and dasiantosides. The findings of these studies are presented in articles and in the monograph *Contemporary Approaches to the Search for Plant Sources of Biological Active Substances on the Basis of Multidimensional Taxonomy Analysis Technique* (Kovaleva, 2011).

In cooperation with Professor Kovaleva, phytochemical and chemotaxonomic studies of the following genera of Ukrainian flora were carried out: *Potentilla* L. (E. R. Abdulkafarova) (Abdulkafarova *et al.*, 2012), *Melilotus* Mill. (I. V. Grudko) (Kovaleva *et al.*, 2012), *Artemisia* L. (O. V. Ochkur) (Kovaleva *et al.*, 2019), *Galium* L. and *Cruciata* Mill. (T. V. Ilina) (Ilyina, 2013), *Asperula* L. (N. S. Shemchuk) (Shemchuk *et al.*, 2017), *Crataegus* L. (N. V. Sydora) (Sydora, 2018) and *Salvia* L. (O. M. Koshovy) (Koshovyi *et al.*, 2020); pharmacognostic studies of species of genera *Veronica* L. (A. P. Osmachko) (Kovaleva *et al.*, 2022), *Lamium* L. (O. V. Honcharov) (Ochkur *et al.*, 2015), and *Ballota nigra* L. (Ya. S. Kolisnyk) (Kolisnyk *et al.*, 2014). Under the supervision and consultation of Professor Kovaleva, eight candidate's theses and two doctoral theses were defended.

Professor T. V. Ilina and her students continued the phytochemical and chemotaxonomic studies of *Rubiaceae* species: *Sherardia arvensis* L., *Gardenia* J. Ellis, *Pentas lanceolata* (Forssk.) Deflers, *Galium* L. (O. V. Goryacha, I. L. Shinkovenko) (Ilina *et al.*, 2019; Shinkovenko *et al.*, 2018), *Asperula* L. (N.

S. Shemchuk) (Yurchenko *et al.*, 2013), *Cruciata* Mill. (O. V. Goryacha) (Ilina *et al.*, 2013). Ilina was the first to carry out the morphological and taxonomic studies of 131 representatives of *Rubiaceae* Juss. family: 69 *Galium* species, 10 *Cruciata* species and 52 *Asperula* species, and the chemotaxonomic studies of 79 representatives of *Rubiaceae* Juss. family: 54 *Galium* species, 19 *Asperula* species, and 6 *Cruciata* Mill. of Ukrainian flora and flora of other countries. The chemical profiles of genera were established and correlations between the species' morphological features and the presence of individual compounds were identified; some provisions in genera's taxonomy were clarified; and a theoretical basis developed for the targeted search for promising sources of phytochemicals among the species of *Rubiaceae* Juss.

Since 2010, under the supervision of Professor Koshovyi, research activities have focused on the development of new medicinal products via complex processing of herbal raw materials and modification of galena extracts from HRM, the concept of manufacturing of water-soluble nanosomal forms of lipophilic extracts, and import-substituting herbal medicinal products.

Koshovyi was the first to carry out the comprehensive morphological and taxonomic study of 78 *Salvia* species and the chemotaxonomic study of 17 *Salvia* species of Ukrainian flora (Koshovyi *et al.*, 2020). The modification of plant extracts using amino acids and inorganic compounds was considered an attractive direction of scientific research (Komisarenko *et al.*, 2016; Koshevoi, 2011; Koshovyi *et al.*, 2015; 2021; 2023b; 2023c; 2016; Upyr *et al.*, 2016). The replacement of the central ion in the porphyrin, for example, Mg by Zn or by Cu or Ag, increases the phytochemical's bioavailability, expands the spectrum of their pharmacological activities and increases the efficacy of treatment.

Another fascinating direction of Koshovyi's research is the implementation of 3D-printing technology for the development of dosage forms of products of plant origin (Koshovyi *et al.*, 2023a; 2023b). These studies are conducted within the framework of the scientific grant of the MSCA4Ukraine project 'Design and development of 3D-printed medicines for bioactive materials of Ukrainian and Estonian medicinal plants origin' (ID number 1232466) under the supervision of Professor Ain Raal and Professor Jyrki Heinämäki at the Institute of Pharmacy of the University of Tartu, Estonia.

The scientific school of Prof. Koshovyi conducts research in phytochemicals from the *Eucalyptus* L'Hér. and *Salvia* L. genera (O. M. Koshovyi, Yu. N. Avidzba, G. V. Vovk) (Koshevoi, 2011; Koshovyi *et al.*, 2023b; 2015), *Ericaceae* DC.

family—*Vaccinium myrtillus* L. (I. O. Kolychev) (Koshovyi *et al.*, 2016), *Vaccinium vitis-idaea* L. (M. A. Komisarenko) (Komisarenko *et al.*, 2016), *Arctostaphylos uva-ursi* (L.) Sprend (N. B. Chaika) (Kravchenko *et al.*, 2022), *Ledum palustre* L. (T. V. Upyr) (Upyr *et al.*, 2016), *Vaccinium uliginosum* L. (O. O. Stremoukhov) (Koshovyi *et al.*, 2021), and *Vaccinium oxycoccos* L. (I. K. Vlasova) (Koshovyi *et al.*, 2023c; Vlasova *et al.*, 2022).

Conclusion

In conclusion, the contributions of the scientists of the Department of Pharmacognosy at the National University of Pharmacy to the development of the Ukrainian school of pharmacognosy have been profound. Over the years, 16 doctoral theses and 77 candidate theses have been defended at the Department of Pharmacognosy. The work carried out has resulted in 63 author's certificates, 171 patents, about 1,050 articles, 1,060 abstracts, and 16 monographs, and a number of medicinal products and therapeutic and preventive products have been developed and introduced into medical practice. The department's achievements provide a strong foundation for future advancements in the field of pharmacognosy. Studying the history of pharmacognosy is important in the formation of students as pharmacists and contributes to the stable development of pharmacy in Ukraine.

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References

Abdulkafarova, E. R.; Kovaleva, A. M. & Ilyina, T. V. (2012), 'Comparative Characteristics of the Species of the Subgenus *Dynamidium* of *Potentilla* L. Genus Based on the Component Composition of Essential Oils and Morphological Structure' [in Ukrainian], *Collection of Scientific Works of Staff Member of Shupyk NHU*, vol. 21, no. 4, pp. 284–289.

Aitzetmüller, R. (1958), *Das Hexaemeron des Exarchen Johannes*, Graz: Akademische Druck-u.Vlgs.

Alexandrovych, V. S. (2011), 'St. George's Cathedral in Lviv' [in Ukrainian], in V. A. Smoliy *et al.* (eds.) *Encyclopedia of the History of Ukraine*, vol. 10, Kyiv: Tekhnika, p. 701.

Bogaevskii, A. K. (1972), *Phenolic Compounds of Galium fagetorum and Galium pseudomollugo* [in Russian], *Candidate's thesis abstract*, Moscow.

Boinik, V. V. & Kovalev, V. N. (1988), 'Flavonoids of *Caragana frutex*,' *Chemistry of Natural Compounds*, vol. 23, no. 4, p. 504. https://doi.org/10.1007/BF00597817

Borisov, M. I.; Korshikov, B. M.; Makarova, G. V. *et al.* (1974), *Medicinal Properties of Agricultural Plants* [in Russian], Minsk: Uradzaj.

Borisov, M. I.; Kovalev, V. N. & Zaitsev, V. G. (1971), 'The Chemical Composition of *Galium verum*,' *Chemistry of Natural Compounds*, vol. 7, p. 511. https://doi.org/10.1007/BF00564764

Borisov, M. I.; Serbin, A. G.; Chernobay, V. T.; Obolontseva, G. V.; Khadzhay, Ya. I. & Vifokova, A. I. (1975c), *A. C. 475152 USSR, IPC A61K 27/14. Method for Obtaining the Sum of Polyphenolic Compounds with Choleretic Activity* [in Russian], no. 185764, application of 09.20.74; publ. 20.10.75. Bull. no. 24., p. 10.

Borisov, M. I. & Zoz, I. G. (1975a), 'On the Chemotaxonomy of *Asperula* L.' [in Russian], *Plant Resources*, vol. 11, no. 1, pp. 52–59.

Borisov, M. I. & Zoz, I. G. (1975b), 'Chemosystematic Study of the Genus *Galium* L.' [in Russian], *Plant Resources*, vol. 10, no. 2, pp. 175–183.

Borodina, N. V.; Rudnyk, A. M.; Kovalev, V. M. & Yemelianova, I. V. (2008), 'Pharmacognostic Study of *Populus alba* L. Leaves' [in Ukrainian], *Zaporizhzhya Medical Journal*, vol. 2, no. 47, pp. 170–172.

Bovtenko, V. A.; Popova, N. V. & Litvinenko, V. I. (2010), 'On the Issue of Standardization of Capsicum Fruits' [in Russian], *Pharmacom*, vol. 2, pp. 21–29.

Cherkashyna, A. V. & Kovalev, S. V. (2009), 'Amino Acid and Mineral Composition of *Cicer arietinum*' [in Ukrainian], *Pharmacom*, vol. 2, pp. 50–53.

Chernykh, V. P., ed. (2005a), *The Glorious Names of the National University of Pharmacy* [in Ukrainian], Kharkiv: Prapor.

Chernykh, V. P., ed. (2005b), *History of the National University of Pharmacy: People, Ideas, Facts* [in Ukrainian], Kharkiv: Vyd-vo NFaU "Zoloti storinky."

Chirikov, A. D. (1871), *Pharmacognosy, Compiled by Andrei Chirikov and Reviewed by Ya. Gannot, Associate Professor at Kharkov University* [in Russian], Kharkov, vol. 18, no. 2, p. 268, II.

Clair, C. (1969), *A Chronology of Printing*, New York: Frederick A. Praeger.

Collection of Svyatoslav 1073 (1983), [in Russian], A facsimile edition in 2 volumes, Moscow.

Demeshko, O. V.; Kovalev, S. V. & Komisarenko, S. M. (2004), 'Study of the Amino Acid Composition of the Leaves of *Robinia pseudoacacia* L.' [in Ukrainian], *Pharmacom*, vol. 4, pp. 61–64.

Dykiy, I. L.; Zhuravlev, M. S.; Kriuchkova, T. M. & Filimonova, N. I. (2006), 'Antimicrobial Activity of Natural and Synthetic Anthraquinone Derivatives' [in Ukrainian], *Bulletin of Pharmacy*, vol. 4, pp. 23–26.

Falimirz, S. (1534), *O ziołach i o mocy ich*, Kraków: F. Ungler.

Gaidai, L. (2000), *History of Ukraine in Personalities, Terms, Names and Concepts* [in Ukrainian], Lutsk: Vezha.

Grytsyk, A. (2023), 'Farmatsevtychna Shkola: Naukovyi napryamok shkoly' [in Ukrainian]. Retrieved from https://www.ifnmu.edu.ua/wp-content/uploads/2024/07/%D0%A4%D0%B0%D1%80%D0%BC%D0%B0%D1%86%D0%B5%D0%B2%D1%82%D0%B8%D1%87%D0%BD%D0%B0-%D0%BD%D0%B0%D1%83%D0%BA%D0%BE%D0%B2%D0%B0-%D1%88%D0%BA%D0%BE%D0%BB%D0%B0.pdf [accessed 29 May 2024]

Hinrikus, T.; Tankler, H. & Raal, A. (2005), 'Unter der Leitung des Pharmazie Professors Georg Dragendorff in den Jahren 1864–1894 an der Universität Tartu/Dorpat Verfasste Medizinische Doktorarbeiten,' *Pharmazie*, vol. 60, pp. 388–395.

Histseva, O. A.; Kotelevets, N. V. & Yakovleva, L. V. (2004), 'Pharmacological Study of the Infusion from Blackberry Shoots' [in Ukrainian], *Current Issues of Pharmaceutical and Medical Science and Practice*, vol. 12, no. 111, pp. 147–153.

Il'ina, T. V.; Kovaleva, A. M.; Goryachaya, O. V. & Vinogradov, B. A. (2013), 'Terpenoids and Aromatic Compounds from Essential Oils of *Cruciata laevipes* and *C. glabra*' [in Ukrainian], *Chemistry of Natural Compounds*, vol. 48, no. 6, pp. 1106–1108. https://doi.org/10.1007/s10600-013-0482-7

Ilina, T.; Kashpur, N.; Granica, S.; Bazylko, A.; Shinkovenko, I.; Kovalyova, A.; Goryacha, O. & Koshovyi, O. (2019), 'Phytochemical Profiles and in Vitro Immunomodulatory Activity of Ethanolic Extracts from *Galium aparine* L.' [in Ukrainian], *Plants*, vol. 8, no. 12, art. 541. https://doi.org/10.3390/plants8120541

Ilyina, T. V. (2013), 'To Chemotaxonomy of *Galium* Genus Species (Sections of *Depauperata* Pobed., *Hyalea* (Griseb.) Ehrend., *Cymogalia* Pobed., *Brachyantha* (Boiss.) Pobed.). Report 1' [in Ukrainian], *News of Pharmacy*, vol. 1, no. 73, pp. 47–50.

Klikovka, G. & Harkavtseva, I. (2018), *Zaporizhzhya State Medical University (ZSMU): Ahead of Time* [in Ukrainian], Zaporizhzhya: ZSMU.

Kolisnyk, Ya.; Ochkur, O.; Kovalyova, A. & Koshoviy, O. (2014), 'Organic Acid of Vegetative and Generative Organs of Black Horehound' [in Ukrainian], *The Pharma Innovation Journal*, vol. 3, no. 10, pp. 33–37.

Komisarenko, M. A.; Koshovyi, O. M. & Avidzba, Yu. N. (2016), 'Studies of Compound of Derivatives of Hydroxycinnamic Acids and Coumarins in Cranberry Leaves by HPLC' [in Ukrainian], *Ukrainian Biopharmaceutical Journal*, vol. 6, pp. 68–70.

Komissarenko, A. N. & Kovalev, V. N. (1987), 'Hydroxycoumarins and Flavones of *Securigera securidaca*,' *Chemistry of Natural Compounds*, vol. 23, p. 252. https://doi.org/10.1007/BF00598775

Komissarenko, N. F.; Krivoruchko, E. V.; Kislichenko, V. S. & Kovalev, V. N. (1997), 'Tyrosol from *Ribes nigrum*,' *Chemistry of Natural Compounds*, vol. 33, no. 1, p. 97. https://doi.org/10.1007/BF02273935

Koshevoi, O. N. (2011), 'Amino-Acid and Monosaccharide Compositions of *Salvia officinalis* Leaves,' *Chemistry of Natural Compounds*, vol. 47, no. 3, pp. 492–493. https://doi.org/10.1007/s10600-011-9976-3

Koshovyi, O.; Granica, S.; Piwowarski, J. P.; Stremoukhov, O.; Kostenko, Y.; Kravchenko, G.; Krasilnikova, O. & Zagayko, A. (2021), 'Highbush Blueberry (*Vaccinium corymbosum* L.) Leaves Extract and Its Modified Arginine Preparation for the Management of Metabolic Syndrome—Chemical Analysis and Bioactivity in Rat Model' [in Ukrainian], *Nutrients*, vol. 13, art. 2870. https://doi.org/10.3390/nu13082870

Koshovyi, O.; Heinämäki, J.; Laidmäe, I.; Topelius, S. N.; Grytsyk, A. & Raal, A. (2023a), 'Semi-Solid Extrusion 3D-Printing of Eucalypt Extract-Loaded Polyethylene Oxide Gels Intended for Pharmaceutical Applications,' *Annals of 3D Printed Medicine*, vol. 12, art. 100123. https://doi.org/10.1016/j.stlm.2023.100123

Koshovyi, O.; Heinämäki, J.; Raal, A.; Laidmäe, I.; Topelius, N. S.; Komisarenko, M. & Komissarenko, A. (2023b), 'Pharmaceutical 3D-Printing of Nanoemulsified Eucalypt Extracts and Their Antimicrobial Activity,' *European Journal of Pharmaceutical Sciences*, vol. 187, art. 106487. https://doi.org/10.1016/j.ejps.2023.106487

Koshovyi, O.; Raal, A.; Kovaleva, A.; Myha, M.; Ilina, T.; Borodina, N. & Komissarenko, A. (2020), 'The Phytochemical and Chemotaxonomic Study of *Salvia* spp. Growing in Ukraine,' *Journal of Applied Biology and Biotechnology*, vol. 8, no. 3, pp. 29–36. https://doi.org/10.7324/JABB.2020.80306

Koshovyi, O.; Vlasova, I.; Laur, H.; Kravchenko, G.; Krasilnikova, O.; Granica, S.; Piwowarski, J. P.; Heinämäki, J. & Raal, A. (2023c), 'Chemical Composition and Insulin-Resistance Activity of Arginine-Loaded American Cranberry (*Vaccinium macrocarpon* Aiton, Ericaceae) Leaf Extracts,' *Pharmaceutics*, vol. 15, no. 11, art. 2528. https://doi.org/10.3390/pharmaceutics15112528

Koshovyi, O. M.; Kovalev, V. M.; Ilyina, T. V.; Isakova, T. I.; Kovalova, A. M.; Boynik, V. V.; Stremoukhov, O. O.; Borodina, N. V.; Goryacha, O. V. & Ochkur, O. V. (2018), *History of the Department of Pharmacognosy of the National University of Pharmacy* [in Ukrainian], Kharkiv.

Koshovyi, O. M.; Zagayko, A. L.; Kolychev, I. O.; Akhmedov, E. Yu. & Komissarenko, A. N. (2016), 'Phytochemical Study of the Dry Extract from Bilberry Leaves' [in Russian], *Azerbaijan Pharmaceutical and Pharmacotherapy Journal*, vol. 16, no. 1, pp. 18–23.

Koshovyi, O. N.; Vovk, G. V.; Akhmedov, E. Yu. & Komissarenko, A. N. (2015), 'The Study of the Chemical Composition and Pharmacological Activity of *Salvia officinalis* Leaves Extracts Getting by Complex Processing' [in Russian], *Azerbaijan Pharmaceutical and Pharmacotherapy Journal*, vol. 15, no. 1, pp. 30–34.

Kotlyar, M. F. (2010), 'Mongol-Tatar Invasion' [in Ukrainian], in V. A. Smoliy *et al.* (eds.) *Encyclopedia of the History of Ukraine*, vol. 7, Kyiv: Naukova dumka, pp. 51–54.

Kovalev, S. V. & Makarevich, I. Kh. (2009), *Patent 89045, Ukraine, IPC A 61 K 36/00. The Method of Obtaining 3'-4'-Isopropylidenerizimine* [in Ukrainian], no. a200613225; application dated 14.12.2006; published 25.12.2009. Bull. no. 24.

Kovalev, V. M.; Marchyshyn, S. M.; Hvorost, O. P. *et al.* (2014), *A Practical Course on the Identification of Herbal Raw Materials: Manual* [in Ukrainian], Ternopil: Ukrmedknyga.

Kovalev, V. M.; Pavliy, O. I.; Isakova, T. I. *et al.* (2000), *Pharmacognosy with the Principles of Plant Biochemistry* [in Ukrainian], Kharkiv: Prapor.

Kovalev, V. N.; Kyslychenko, V. S.; Zhuravel, I. A. & Isakova, T. I. (2007), *Pharmacognosy: Manual for Students of Higher Educational Institutions* [in Russian], Kharkov: NUPh "Zolotie Stranici."

Kovalev, V. N.; Pivovarenko, V. G.; Khilya, V. P.; Timasheva, I. N. & Vasiliev, S. A. (1984), *A. C. 1218653 USSR, IPC A 61 K 31/35. Fluorine-Containing Isoflavones with Hypoglycemic Activity* [in Russian], no. 3803403/23-04; application dated 17.10.84 (not subject to publication).

Kovalev, V. N.; Popova, N. V.; Kislichenko, V. S. *et al.* (2003), *A Practical Course on Pharmacognosy: Manual* [in Russian], Kharkov: NUPh "Zolotie Stranici."

Kovalev, V. N.; Sedova, A. B.; Dykhtyarev, V. I. & Sytnyk, A. G. (1988), *A. C. 1098114 USSR, IPC A 65 K 35/78. The Method of Obtaining an Agent with Hypoglycemic Activity* [in Russian], Application of 03.03.88 (not subject to publication).

Kovalev, V. N.; Spiridonov, V. N.; Borisov, M. I.; Kovalev, I. P.; Gordienko, V. G. & Kolesnikov, D. D. (1975d), 'Phenolic Compounds of *Ononis arvensis*: The Structure of Onogenin' [in Russian], *Chemistry of Natural Compounds*, vol. 11, pp. 367–369. https://doi.org/10.1007/BF00571209

Kovalev, V. N.; Spiridonov, V. N.; Borisov, M. I.; Prokopenko, A. P.; Vikhtinskaya, I. L. & Drogovoz, S. M. (1980), *A. C. 727199 USSR, IPC 2 A61K 35/78. Method*

for Obtaining Ononine Standard [in Russian], no. 2638802/28-13; Application of 03.05.78; publ. 04/25/80. Bull. no. 14.

Kovalev, V. N.; Zupanets, I. A.; Kislichenko, V. S. *et al.* (1999), *Fundamentals of Practical Phytotherapy: Manual* [in Russian], Kharkov: UKRPhA.

Kovaleva, A.; Raal, A.; Ilina, T.; Osmachko, A.; Goryacha, O.; Omelyanchik, L. & Koshovyi, O. (2022), 'Carboxylic Acids in the Flowers of *Veronica spicata* L. and *Veronica incana* L.,' *ScienceRise: Pharmaceutical Science*, vol. 1, no. 35, pp. 37–43. https://doi.org/10.15587/2519-4852.2022.253541

Kovaleva, A. M. (2011), *Contemporary Approaches to the Search for Plant Sources of Biological Active Substances on the Basis of Multidimensional Taxonomy Analysis Technique* [in Russian], Moscow: Iris Group.

Kovaleva, A. M.; Goncharov, N. F.; Komissarenko, A. N.; Sidora, N. V. & Kovalev, S. V. (2009), 'GC/MS Study of Essential Oil Components from Flowers of *Crataegus jackii*, *C. robesoniana*, and *C. flabellate*,' *Chemistry of Natural Compounds*, vol. 45, no. 4, pp. 592–593. https://doi.org/10.1007/s10600-009-9373-3

Kovaleva, A. M.; Grudko, I. V. & Ilyina, T. V. (2012), 'Comparative Characteristics of Species of the Subgenera *Micromelilotus* and *Macromelilotus* of *Melilotus* Mill. Based on the Component Composition of Essential Oils and Morphological Structure' [in Ukrainian], *Collection of Scientific Works of Staff Member of Shupyk NHU*, vol. 21, no. 4, pp. 289–296.

Kovaleva, A. M.; Ilyina, T. V.; Hrytsyk, R. A. & Ochkur, O. V. (2019), 'Identification of Promising Species Among *Artemisia* L. Genus Based on Chemotaxonomic Analysis' [in Ukrainian], in *Chemistry of Natural Compounds: Proceedings of Vth All-Ukrainian Scientific and Practical Conference with International Participation*, Ternopil, pp. 36–38.

Kovaleva, A. M.; Komisarenko, A. M. & Komisarenko, M. F. (1997), 'Cycloartanes of *Astragalus* L. Plants of the CIS Countries. Report 1' [in Ukrainian], *News of Pharmacy*, vol. 1, pp. 62–70.

Kovaleva, A. M. & Kovalev, V. N. (1986), 'Coumarins of *Vicia sativa*,' *Chemistry of Natural Compounds*, vol. 22, p. 723. https://doi.org/10.1007/BF00598366

Kovalyova, A. M.; Hrytsyk, R. A.; Kireiev, I. V. & Ochkur, O. V. (2021), *Prospects for the Use of Wormwood Species in Medicine* [in Ukrainian], Ivano-Frankivsk: Suprun VP.

Kravchenko, G.; Krasilnikova, O.; Raal, A.; Mazen, M.; Chaika, N.; Kireyev, I.; Grytsyk, A. & Koshovyi, O. (2022), '*Arctostaphylos uva-ursi* L. Leaves Extract and Its Modified Cysteine Preparation for the Management of Insulin Resistance: Chemical Analysis and Bioactivity,', *Natural Products and Bioprospecting*, vol. 12, no. 1, art. 30. https://doi.org/10.1007/s13659-022-00352-1

Kypyakevich, I. (1984), *Galicia-Volyn Principality* [in Ukrainian], Kyiv: Naukova dumka.

Litvinenko, M. M.; Prokopenko, S. A.; Protsenko, R. A. *et al.* (1980), 'Search for Biologically Active Substances Among Plants of the Genera *Woodruff*, *Caragana*, *Sage*, *Lavender* and *Vetch*' [in Russian], in *Materials of the 3rd All-Union Congress of Pharmacists*, Chisinau, p. 195.

Makarevich, I. F.; Pavliy, A. I.; Kislichenko, V. S. *et al.* (1987), *A. C. 1311066 USSR, IPC A61K 35/78. Method for Producing Cardiac Glycosides "Lanatoside"* [in Russian], Application of 15.01.87 (not subject to publication).

Ochkur, O.; Kovaleva, A.; Goncharov, O. & Komisarenko, A. (2015), 'Amino Acids and Monosaccharides Composition of White Dead-Nettle (*Lamium album* L.) Extract' [in Ukrainian], *The Pharma Innovation Journal*, vol. 4, no. 3, pp. 45–48.

Pavliy, A. I.; Petiunin, P. A.; Bukharina, E. V.; Drogovoz, S. M.; Zupanets, I. A. & Yakovleva, L. V. (1987), *A. C. 1307810 USSR, IPC A61K 31/70. N-(1-adamantiloxamoyl)-D-(+)-Glucosamine with Analgesic and Antihypoxic Activities* [in Russian], no. 3868133; application dated 03.01.87 (not subject to publication).

Popova, N. V.; Litvinenko, V. I.; Popova, T. P. & Amosov, A. S. (1996), *A. C. 1622983 USSR, IPC A 61 K 35/78 Method for Obtaining Natural Capsaicinoids* [in Russian], Applicant: All-Union Scientific Research Institute of Chemistry and Technology of Medicines, no. 466758/30–14; Application dated 27.03.89; publ. 20.12.96. Bull. RF no. 35.

Prokopenko, T. S.; Kotvitska, A. A. & Gorbanyov, V. V. (2015), 'The Study of the Historical Aspects of Pharmaceutical Education Development in Ukraine in the Second Half of the 19th—Early 20th Century' [in Ukrainian], *Management, Economics and Quality Assurance in Pharmacy*, vol. 5, no. 43, pp. 56–61.

Raal, A. (2010), *Farmakognoosia* [Pharmacognosy: The Textbook for Higher Schools, in Estonian], Tartu: Tartu Ülikooli Kirjastus.

Raal, A.; Gudienė, V. & Koshovyi, O. (2023), 'Professor Georg Dragendorff (1836–1898) as a Toxicologist,' *Pharmazie*, vol. 78, no. 8, pp. 170–175. https://doi.org/10.1691/ph.2023.3008

Raal, A.; Meos, A.; Hinrikus, T.; Heinämäki, J.; Romāne, E.; Gudienė, V.; Jakštas, V.; Koshovyi, O.; Kovaleva, A.; Fursenco, C.; Chiru, T. & Nguyen, H. T. (2020), 'Dragendorff's Reagent: Historical Perspectives and Current Status of a Versatile Reagent Introduced Over 150 Years Ago at the University of Dorpat, Tartu, Estonia,' *Pharmazie*, vol. 75, no. 7, pp. 299–306. https://doi.org/10.1691/ph.2020.0438

Salnikova, S. I.; Ilyina, T. V.; Zhuravlev, N. S. & Verdyan, A. I. (1990), 'Synthesis and Study of the Pharmacological Activity of Substituted Amides of 2-Anthraquinone Succinic Acid' [in Russian], *Chemical-Pharmaceutical Journal*, vol. 24, no. 5, pp. 25–27.

Serbin, A. G.; Borisov, M. I.; Chernobay, V. T. & Goncharov, A. I. (1977), *A. C. 555637 USSR, IPC A61K 31/75. Method for Obtaining Biologically Active Polysaccharides* [in Russian], no. 2147925/05; Application of 06.23.96; publ. 25.04.77. Bull. no. 15, p. 179.

Shemchuk, N. S.; Ilyina, T. V.; Kovaleva, A. M. & Komissarenko, A. N. (2017), 'Search for Pharmaceutically Promising Species of *Asperula* L. Genus Using the Method of Numeric Taxonomy' [in Russian], in *III Hammerman Readings*, St. Petersburg, pp. 141–143.

Shinkovenko, I. L.; Kashpur, N. V.; Ilyina, T. V.; Kovalyova, A. M.; Goryacha, O. V.; Koshovyi, O. M.; Toryanyk, E. L. & Kryvoruchko, O. V. (2018), 'The Immunomodulatory Activity of the Extracts and Complexes of Biologically Active Compounds of *Galium verum* L. Herb,' *Ceska a Slovenska Farmacie*, vol. 67, no. 1, pp. 25–29.

Shmaraeva, I. E. (1993), *Phytochemical Study of Plants of the Genus Lathyrus* [in Russian], Candidate's thesis abstract, Kharkov.

Shvalb, M. G.; Krasikov, M. M. & Glibitskaya, S. B. (2007), *History of Kharkiv University (1804–2006)* [in Ukrainian], Kharkiv: V. N. Karazin KhNU.

Solodovnichenko, N. M. & Kovalev, V. M. (2001), *Yu. G. Borysyuk: To the 100th Anniversary of the Birth: Bibliography* [in Ukrainian], Kharkiv: NuPh.

Solodovnichenko, N. M.; Zhuravlyov, M. S. & Kovalev, V. M. (2001), *Herbal Raw Materials and Phytopreparations* [in Ukrainian], Kharkiv: Vyd-vo NFaU "Zoloti storinky."

Sydora, N. (2018), 'Morphological and Taxonomic Study of *Oxyacanthae* Zbl. Section of *Crataegus* L. Genus by Vegetative Characteristics,' *ScienceRise: Pharmaceutical Science*, vol. 1, pp. 36–41. https://doi.org/10.15587/2519-4852.2018.124432

Tankler, H.; Hinrikus, T. & Raal, A. (2002), 'Georg Dragendorff and His Students: The M.Sc. Dissertations in Pharmacy at Tartu University (1864–1894)' [in German], *Pharmazie*, vol. 57, pp. 763–771.

Tolochko, O. P. (2011), 'The Kyiv-Pechersky Paterikon' [in Ukrainian], in V. A. Smoliy *et al.* (eds.) *Encyclopedia of the History of Ukraine*, vol. 8, Kyiv: Naukova dumka, p. 87.

Upyr, L. V.; Voronina, L. M.; Kovalev, V. M.; Sakharova, T. S. & Senyuk, I. V. (1996), 'Research of Chemical Composition and Biological Activity of *Beta vulgaris*' [in Ukrainian], *Bulletin of Pharmacy*, vol. 3-4, pp. 72–75.

Upyr, T. V.; Tolmachova, K. S.; Koshovyi, O. M.; Komisarenko, A. M. & Kireev, I. V. (2016), 'The Study of the Chemical Composition and the Pharmacological Activity of the Polysaccharide Complex Obtained from *Ledum palustre*' [in Ukrainian], *News of Pharmacy*, vol. 3, pp. 32–35.

Varzos, K. (1984), 'Η Γενεαλογία Των Κομνηνών,' *Μακεδονικά*, vol. 25, no. 1, p. 393.

Vasilenko, V. I. (1896), 'Lubny' [in Russian], in *Brockhaus and Efron Encyclopaedic Dictionary: In 86 Volumes*, vol. 18, St. Petersburg: Brokgauz i Efron, pp. 55–56.

Vasilyeva, S. V.; Kril, O. M. & Nadraga, M. S. (2014), *Tadeusz Vilchynskyi: The Founder of the Department of Pharmacognosy and Botany and the Botanical Garden of the Danylo Halytsky Lviv National Medical University (To the 125th Anniversary of the Birth): Bibliographic Index* [in Ukrainian], Lviv: *Halytsky Lviv National Medical University*.

Vlasova, I.; Gontova, T.; Grytsyk, L.; Zhumashova, G.; Sayakova, G.; Boshkayeva, A.; Shanaida, M. & Koshovyi, O. (2022), 'Determination of Standardization Parameters of *Oxycoccus macrocarpus* (Ait.) Pursh and *Oxycoccus palustris* Pers. Leaves' [in Ukrainian], *ScienceRise: Pharmaceutical Science*, vol. 3, no. 37, pp. 48–57. https://doi.org/10.15587/2519-4852.2022.260352

Yurchenko, N. S.; Ilina, T. V. & Kovaleva, A. M. (2013), 'Amino-Acid Composition of *Asperula odorata* Herb,' *Chemistry of Natural Compounds*, vol. 49, pp. 401–402. https://doi.org/10.1007/s10600-013-0622-0

Zhuravel, I. O.; Misiurova, S. V. & Kovalev, V. M. (2002), 'Study of the Hepatoprotective Activity of Complexes of Biologically Active Substances from the Pericarp of *Fagopyrum sagittatum* in Acute Liver Damage by Tetrachloromethane' [in Ukrainian], *Clinical Pharmacy*, vol. 6, no. 4, pp. 49–51.

Zhuravlev, N. S.; Ilyina, T. V.; Georgievsky, V. P. & Kovalev, V. N. (1988), *A. C. 1612525 USSR, IPC 4 S 07 S 50/18, 46/10. Method of Alizarin Purification* [in Russian], no. 4493082/31-04; Application dated 20.07.88 (not subject to publication).

Zhuravlev, N. S.; Shtefan, L. M. & Luchkina, T. V. (1987), 'Anthraquinones of *Galium fagetorum* II,' *Chemistry of Natural Compounds*, vol. 23, p. 761. https://doi.org/10.1007/BF00596662

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