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QUALIFICATION WORK

on the topic: **«DEVELOPMENT OF THE COMPOSITION AND TECHNOLOGY OF AN EXTEMPORANEOUS DRUG BASED ON MEDICINAL PLANT RAW MATERIALS»**

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ANNOTATION

Theoretical studies have confirmed the feasibility and relevance of developing extemporaneous vaginal medicinal products based on medicinal plant raw materials. For our own research, a vaginal gel system with anti-inflammatory, antimicrobial, moisturizing, and reparative effects was selected.

During practical studies, the composition and technology of an extemporaneous vaginal gel. The selection of active pharmaceutical ingredients and excipients was substantiated, and the expected pharmaco-technological characteristics of the developed dosage form were determined.

The work is presented on 47 pages, contains 4 tables, 4 figures, and 30 references.

Key words: vaginal gel, medicinal plant raw materials, extemporaneous technology, semi-solid dosage forms.

CONTENT

LIST OF ABBREVIATIONS

API – active pharmaceutical ingredient;

ATC – anatomical and therapeutic chemical classification;

BP – British Pharmacopoeia;

CAS – Chemical Abstracts Service;

CFU – colony forming units;

COX-2 – cyclooxygenase-2;

CPP – critical process parameters;

HEC – hydroxyethyl cellulose;

MIC – minimum inhibitory concentration;

SPU – State Pharmacopoeia of Ukraine;

TAMC – total aerobic microbial count;

TYMC – total yeast and mold count;

PhEur – European Pharmacopoeia.

INTRODUCTION

Actuality of the topic. The use of medicinal plant raw materials in the development of topical dosage forms is one of the most actively developing areas of modern pharmaceutical technology. Of particular interest are vaginal drug delivery systems, as they provide localized therapeutic action, reduce systemic exposure to active substances, and improve patient adherence to treatment.

Inflammatory and dysbiotic conditions of the vaginal mucosa are among the most common gynecological disorders. They are accompanied by disturbances of the normal microbiocenosis, impaired epithelial integrity, and weakened local immune defense. Conventional therapy is often based on synthetic antimicrobial agents; however, their prolonged use may lead to adverse reactions, development of microbial resistance, and disease recurrence.

Medicinal plant raw materials are considered a promising alternative due to their multicomponent composition and broad pharmacological activity, including anti-inflammatory, antimicrobial, antioxidant, and reparative effects. Literature data indicate that plant-derived biologically active compounds, such as flavonoids, terpenoids, phenolic acids, and essential oils, exhibit pronounced biological activity and are widely used in topical dosage forms [7, 14, 19, 20].

Among local vaginal dosage forms, hydrogels are considered one of the most optimal systems due to their high-water content, mucoadhesive properties, and ability to provide sustained release of active substances. Hydrophilic polymer systems, particularly carbomer-based gels, ensure stable rheological properties and uniform distribution of active components on the mucosal surface.

The combination of plant extracts with biopolymers and physiologically active substances such as hyaluronic and lactic acids enables the development of multifunctional formulations with combined anti-inflammatory, moisturizing, and microbiota-regulating effects. Such systems are especially relevant for the treatment of inflammatory processes of vaginal localization and restoration of mucosal homeostasis.

Thus, the development of an extemporaneous vaginal gel based on medicinal plant raw materials represents a relevant scientific and practical task of modern pharmacy.

The purpose of the study. To develop the composition and technology of an extemporaneous vaginal gel based on medicinal plant raw materials with anti-inflammatory, antimicrobial, moisturizing, and reparative effects.

Tasks of the study:

- to review, analyze, and summarize literature data on the use of medicinal plant raw materials in dosage forms;
- to conduct a market analysis of products containing medicinal plants;
- to justify the selection of plant-derived active pharmaceutical ingredients and other excipients for the developed formulation;
- to develop technological approaches for the preparation of the dosage form;
- to describe the expected quality indicators and pharmaco-technological characteristics of the developed composition.

Research objects: medicinal plant raw materials (*Salvia officinalis* L., *Matricaria chamomilla* L.), hyaluronic acid, lactic acid, carbomer-based gel systems, and excipients for topical dosage forms.

The subject of research: development of composition, technological principles, and pharmaco-technological evaluation of an extemporaneous vaginal gel based on medicinal plant raw materials.

Research methods. The study employed general scientific methods of analysis and synthesis, as well as pharmaco-technological, physicochemical, and biopharmaceutical methods used in the development of semi-solid dosage forms.

Practical significance of the results. The proposed composition of a vaginal gel based on medicinal plant raw materials represents a scientifically substantiated approach to the development of extemporaneous topical dosage forms. The obtained results may be used for further optimization and implementation in pharmaceutical

practice as a safe and effective local therapeutic agent with multifunctional pharmacological activity.

Approval of research and publications. The results of the study were presented at the XXXII International Scientific and Practical Conference of Young Scientists and Students «Topical Issues of New Drug Development» in the format of an oral report (Appendix A, B).

Structure and scope of qualification work. The work is presented on 47 pages, contains 4 tables, 4 figures and 30 references.

CHAPTER 1. THE RELEVANCE OF DEVELOPING MEDICINAL PRODUCTS BASED ON HERBAL RAW MATERIALS
(Literature review)

1.1 Current state and prospects of the use of medicinal plant raw materials in pharmacy

Medicinal plant raw materials have remained one of the most important sources of biologically active substances for the development of medicinal products for many centuries. Since ancient times, plants have been used to treat inflammatory processes, infectious diseases, digestive disorders, and pathologies of the skin and mucous membranes. In modern pharmaceutical practice, interest in herbal medicines has significantly increased due to the tendency toward the use of natural components, the search for safer therapeutic agents, the development of personalized medicine, and the need to create drugs with minimal side effects. According to modern studies, a significant proportion of active pharmaceutical ingredients of natural origin were either directly isolated from plants or developed on the basis of natural molecules through semisynthetic modifications [7, 19, 26].

Today, medicinal plants are considered not only as a source of individual pharmacologically active compounds but also as a complex biological system containing a wide range of secondary metabolites capable of potentiating each other’s activity. The multicomponent nature of herbal preparations provides their polyvalent pharmacological effect and allows simultaneous influence on several stages of the pathological process. This is particularly important in the treatment of chronic inflammatory and infectious diseases, where a combination of anti-inflammatory, antiseptic, reparative, and immunomodulatory effects is required [14, 19].

Balunas and Kinghorn [7] note that medicinal plants are among the most promising sources of new pharmacologically active compounds for the development of anti-inflammatory, antimicrobial, antitumor, and antioxidant drugs. The authors emphasize that plant secondary metabolites exhibit a wide spectrum of biological

activity and may serve as the basis for the development of innovative dosage forms. The researchers also point out that nearly half of modern medicinal products are of natural origin or developed based on natural molecules, highlighting the extremely important role of plant raw materials in pharmaceutical science.

An important advantage of medicinal plant raw materials is their high biological compatibility with the human body. Unlike many synthetic drugs, phytocomponents are often characterized by milder pharmacological effects, lower toxicity, and a reduced risk of adverse reactions. In this regard, herbal preparations are widely used in products intended for local application, particularly in gynecology, proctology, dermatology, and dentistry [19, 26].

Modern studies indicate that the most pharmacologically significant groups of biologically active substances of plant origin include flavonoids, alkaloids, terpenoids, saponins, polyphenols, essential oils, and tannins [14, 20, 28]. These compounds provide anti-inflammatory, antiseptic, regenerative, antioxidant, and immunomodulatory activity of herbal medicines. For example, flavonoids demonstrate pronounced antioxidant activity and the ability to stabilize cell membranes, terpenoids and essential oils exhibit antimicrobial properties, while tannins provide astringent and anti-inflammatory effects.

Agarwal et al. [20] emphasize that alkaloids of plant origin occupy a special place among natural compounds due to their high biological activity and wide use in drug development. Many modern medicinal products with antispasmodic, analgesic, and antitumor effects have been developed on the basis of plant alkaloids.

Halder and Jha [14] stress that the biodiversity of medicinal plants is a strategic resource for modern pharmacy because natural metabolites are characterized by high biocompatibility and relatively low toxicity. The authors note that a large number of insufficiently studied medicinal plants exist worldwide and may become sources of new pharmacologically active substances. At the same time, they emphasize the necessity of standardization of plant raw materials and improvement of quality control methods, since the content of active compounds may

significantly depend on cultivation conditions, climate, soil, harvesting time, and storage methods of plant materials.

In this regard, studies related to the improvement of cultivation technologies for medicinal plants and biotechnological production of secondary metabolites are of particular importance. Alamgir [5] and Ramawat and Arora [25] report that modern biotechnological methods make it possible to increase the content of valuable biologically active substances in plant raw materials, ensure the stability of their chemical composition, and reduce dependence on natural resources. Among the promising areas, special attention is paid to in vitro cultivation of plant cells, the use of bioreactors, and genetic modification of plants aimed at enhancing the production of secondary metabolites.

Kwiecień et al. [18] demonstrated that the application of biotechnological approaches in the cultivation of *Hypericum perforatum* significantly improves the quality of medicinal plant raw materials and standardizes the content of active compounds. The authors emphasize that controlling cultivation conditions allows minimizing fluctuations in the chemical composition of plant materials and ensuring stable therapeutic efficacy of herbal preparations. Similar trends are observed for other medicinal plants widely used in the production of herbal medicines.

An important aspect of modern pharmaceutical science is also the improvement of methods for analysis and standardization of medicinal plant raw materials. Ahmad et al. [4] state that quality control of herbal preparations is one of the key factors ensuring their efficacy and safety. The authors emphasize the necessity of using modern analytical methods for determining the qualitative and quantitative composition of biologically active substances, as well as controlling possible impurities and contaminants.

Under current conditions, computer technologies and artificial intelligence are becoming increasingly widespread in the field of medicinal plant research. Javid et al. [15] report that computer-aided drug discovery methods significantly accelerate the search for promising natural compounds and help predict their pharmacological activity. Similarly, Prabhu et al. [6] describe the prospects of applying artificial

intelligence for phytochemical analysis of plants and the development of nanoparticle-based drug delivery systems.

The use of medicinal plants in combating infectious diseases and antibiotic resistance is particularly relevant. Ogbuagu et al. [22] note that traditional medicinal plants are considered a promising source of new antimicrobial agents due to the increasing resistance of microorganisms to antibiotics. Plant extracts and essential oils are capable of exhibiting antibacterial, antifungal, and antiviral activity, as well as potentiating the effects of synthetic antimicrobial drugs.

Shathan et al. [10] confirmed in their studies that medicinal plants contain a wide range of compounds with pronounced antifungal and antibiofilm activity. This is especially important in the treatment of mucosal infections, where biofilm formation significantly complicates therapy.

In addition, herbal preparations are actively studied as potential antiviral agents. Ojah [23] and Msobo et al. [21] report on the prospects of using medicinal plants for the development of antiviral drugs, particularly against SARS-CoV-2. Modern methods of metabolomics, molecular modeling, and machine learning make it possible to accelerate the search for biologically active molecules among natural compounds and predict their interaction with viral targets.

Special attention is also paid by modern researchers to the prospects of using plant raw materials in the development of preparations for local application. Plant extracts are widely used in suppositories, ointments, creams, and gels due to the combination of antiseptic, regenerative, and anti-inflammatory activity. Particularly valuable are multicomponent phytocompositions that provide a synergistic therapeutic effect and allow reducing the concentration of individual active substances without loss of efficacy [11, 16].

1.2. Technological aspects of developing medicinal products based on plant raw materials

One of the key directions of modern pharmaceutical technology is the development of effective dosage forms using medicinal plant raw materials. In

recent years, particular attention has been paid to the creation of combined herbal preparations capable of providing a complex therapeutic effect due to the synergistic combination of several biologically active components [11, 19]. Such preparations are especially promising for the treatment of inflammatory and infectious diseases, as they can simultaneously exhibit anti-inflammatory, antimicrobial, antioxidant, regenerative, and immunomodulatory properties.

The growing interest in herbal medicinal products is associated not only with the demand for natural medicines but also with advances in pharmaceutical technology, which make it possible to improve the stability, bioavailability, and therapeutic efficacy of plant-derived compounds. Modern phytopharmaceutical development involves a comprehensive scientific approach that includes the selection of plant raw materials, extraction and purification of biologically active compounds, formulation optimization, and quality control of the finished dosage form [11, 19].

Djordjevic [11] notes that the process of developing herbal medicinal products includes several important stages: selection of medicinal plant raw materials, standardization of active compounds, optimization of extraction methods, selection of excipients, and development of dosage form technology. The author emphasizes that one of the major challenges in phytopharmaceutical development is ensuring the stability of biologically active substances during manufacturing and storage. Plant-derived compounds are often sensitive to temperature, light, oxidation, and moisture, which may lead to degradation and reduction of therapeutic activity.

An equally important issue is the standardization of medicinal plant raw materials. Due to differences in cultivation conditions, climate, harvesting time, and storage, the concentration of active compounds in plant materials may vary significantly. Therefore, modern pharmaceutical technologies require strict control of the qualitative and quantitative composition of herbal substances to ensure reproducibility and consistent pharmacological activity of medicinal products [4, 11].

Singh et al. [28] emphasize that the extraction method significantly affects the qualitative and quantitative composition of phytocomponents. Water, ethanol, oil-based, and supercritical CO_2 extraction methods are commonly used for obtaining plant extracts. The choice of extraction solvent depends on the chemical nature of biologically active substances and the intended therapeutic application of the medicinal product.

Water extraction is widely used for obtaining hydrophilic compounds such as polysaccharides, tannins, and certain flavonoids, while alcohol extraction is more effective for isolating polyphenols, alkaloids, and glycosides. Oil extraction is commonly applied for obtaining lipophilic compounds, including carotenoids, essential oils, and fat-soluble vitamins. Supercritical CO_2 extraction is considered one of the most advanced technologies because it allows efficient extraction of thermolabile compounds without the use of toxic organic solvents [24, 28].

According to Ojong et al. [24], modern extraction technologies enable the effective recovery of polyphenolic compounds, flavonoids, and terpenoids characterized by pronounced antioxidant and anti-inflammatory activity. The authors emphasize that optimization of extraction processes is an essential stage in the development of high-quality herbal medicinal products. Extraction parameters such as temperature, pressure, extraction time, solvent polarity, and particle size of plant material significantly influence the yield and stability of biologically active compounds.

Special importance is currently attached to the use of nanotechnology and advanced drug delivery systems in phytopharmaceutical development. Chowdhury et al. [9] describe the prospects of using nanoparticles synthesized with the participation of plant-derived compounds to improve the bioavailability and stability of active substances. Nanotechnology-based systems can protect phytocomponents from degradation, enhance penetration into biological tissues, and provide prolonged release of active ingredients.

Such approaches are particularly relevant for topical dosage forms, including suppositories, ointments, creams, and gels, where sustained local action and

improved mucosal penetration are required. The use of nanocarriers may significantly enhance the therapeutic efficacy of herbal medicinal products and reduce the required concentration of active substances [9].

In the work of Prabhu et al. [6], the possibilities of applying artificial intelligence for phytochemical profiling of medicinal plants and prediction of their pharmacological activity were demonstrated. Artificial intelligence technologies allow rapid analysis of large amounts of phytochemical data, identification of potentially active compounds, and prediction of interactions between plant metabolites and biological targets.

Similarly, Javid et al. [15] note that computer-aided drug discovery technologies significantly accelerate the development of plant-based medicinal products. Modern computational methods are increasingly used for molecular docking studies, pharmacokinetic prediction, toxicity assessment, and optimization of herbal formulations. Such technologies reduce the time and cost required for pharmaceutical development and facilitate the discovery of new biologically active substances from medicinal plants.

An important direction in pharmaceutical technology is also the improvement of drug delivery systems. Kolte and Jain [17] report that the choice of dosage form base significantly affects the release rate of active compounds and the therapeutic efficacy of the medicinal product. Lipophilic bases, semisynthetic triglycerides, polyethylene glycols, and combined emulsion systems are widely used in soft and suppository dosage forms.

Lipophilic suppository bases, such as cocoa butter and semisynthetic triglycerides, are especially valuable because they melt at body temperature and provide effective release of active ingredients at the site of application. Polyethylene glycol bases, on the other hand, dissolve in biological fluids and can improve the release of hydrophilic compounds. Combined emulsion systems allow incorporation of both hydrophilic and lipophilic active substances into a single dosage form, thereby enhancing the therapeutic potential of multicomponent herbal preparations [17].

The development of suppository dosage forms based on medicinal plant raw materials requires careful selection of excipients capable of ensuring homogeneity, stability, optimal melting characteristics, and appropriate release of active ingredients. In addition, the compatibility of plant extracts with the suppository base must be considered to prevent phase separation, degradation, or instability during storage.

Another important aspect of phytopharmaceutical technology is the preservation of biological activity of plant-derived compounds during manufacturing. Many biologically active substances, particularly essential oils, flavonoids, and vitamins, are thermolabile and susceptible to oxidation. Therefore, manufacturing conditions such as temperature, mixing rate, and cooling regime must be carefully controlled [11, 24].

Modern pharmaceutical development also focuses on creating multifunctional herbal medicinal products with combined pharmacological activity. The use of multicomponent phytocompositions allows achieving synergistic therapeutic effects and improving treatment outcomes. Such combinations are particularly effective in local therapy, where anti-inflammatory, antimicrobial, reparative, moisturizing, and antioxidant effects are simultaneously required [16, 19].

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1.3. Prospects for the development of extemporaneous medicines based on medicinal plant raw materials

The extemporaneous compounding of medicinal products remains an important and relevant area of modern pharmaceutical practice, as it enables the preparation of individualized medicines tailored to the specific clinical condition, age-related characteristics, physiological status, and therapeutic needs of patients. In recent years, interest in extemporaneous formulations has increased significantly due to the growing demand for personalized medicine, optimization of pharmacotherapy, and the search for safer and more biocompatible therapeutic agents. Particularly promising is the use of medicinal plant raw materials in the

composition of extemporaneous preparations intended for local application, including suppositories, ointments, creams, gels, and vaginal dosage forms.

The growing scientific interest in phytopharmaceuticals is associated with the wide spectrum of pharmacological activity of plant-derived compounds, their relatively low toxicity, favorable tolerability, and the possibility of combining several biologically active substances within a single formulation. Medicinal plant raw materials contain numerous groups of secondary metabolites, including flavonoids, polyphenols, alkaloids, terpenoids, tannins, essential oils, and saponins, which provide anti-inflammatory, antimicrobial, antioxidant, reparative, immunomodulatory, and wound-healing effects. Due to these properties, herbal medicines are increasingly considered promising components of modern local pharmaceutical formulations.

According to Ahmad et al. [4], one of the most important aspects of the preparation of herbal medicinal products is ensuring their quality, safety, and reproducibility. The authors emphasize that medicinal plant raw materials are characterized by considerable variability in chemical composition depending on cultivation conditions, harvesting time, storage, and processing methods. Therefore, the standardization of herbal raw materials and strict quality control of finished dosage forms are essential prerequisites for obtaining effective and safe phytopharmaceuticals. Modern analytical methods, including chromatographic and spectrophotometric techniques, play a key role in identifying active compounds and assessing the stability of herbal preparations [4].

An important advantage of extemporaneous herbal medicines is the possibility of creating multicomponent phytocompositions with complex pharmacological action. Popovic et al. [12] note that the use of medicinal plants in pharmacy is economically justified due to the availability of plant raw materials, relatively low production costs, and high therapeutic potential. Combined herbal formulations may simultaneously provide anti-inflammatory, antimicrobial, reparative, analgesic, antioxidant, and moisturizing effects, which is especially important in the treatment of inflammatory and infectious diseases of mucous membranes and skin.

In addition, the use of medicinal plants in extemporaneous compounding allows pharmacists to vary the concentration of active substances, select optimal combinations of herbal extracts, and choose appropriate pharmaceutical bases depending on the therapeutic objective. Such flexibility significantly expands the possibilities of pharmaceutical care and individualized treatment.

The development of extemporaneous herbal preparations is closely connected with advances in pharmaceutical technology. Nagarajan et al. [16] emphasize that the future of medicinal plant-derived drug development will involve the integration of traditional herbal knowledge with innovative pharmaceutical technologies. According to the authors, the most promising directions include the development of personalized dosage forms, controlled-release systems, multifunctional phytocompositions, and novel delivery systems capable of improving the bioavailability and stability of plant-derived active compounds.

Particular attention is currently being paid to the development of local dosage forms based on medicinal plant raw materials. Vaginal and rectal suppositories, ointments, and gels containing herbal extracts are considered highly promising due to their ability to provide prolonged local therapeutic action while minimizing systemic side effects. Such dosage forms allow direct delivery of active substances to the site of inflammation or infection, ensuring rapid onset of pharmacological activity and improved therapeutic efficacy.

Sharifi-Rad [27] also highlights that plant-derived natural compounds may serve as a promising basis for the development of highly effective medicines with selective pharmacological action. The author emphasizes that numerous non-edible medicinal plants contain bioactive compounds capable of influencing various molecular targets involved in inflammatory, infectious, and oncological processes. This creates significant opportunities for the development of innovative phytopharmaceuticals with multifunctional therapeutic effects.

The growing problem of antimicrobial resistance further increases the relevance of herbal medicines. Many medicinal plants demonstrate broad-spectrum antimicrobial activity against bacteria, fungi, and viruses due to the presence of

essential oils, phenolic compounds, and terpenoids. Therefore, herbal components are increasingly considered as promising alternatives or complementary agents to conventional antimicrobial drugs. This is particularly important for local pharmaceutical forms intended for the treatment of gynecological, dermatological, and proctological diseases.

Another important advantage of extemporaneous herbal medicines is the possibility of combining plant-derived active substances with modern pharmaceutical excipients. Lipophilic bases, semi-synthetic triglycerides, polyethylene glycols, phospholipids, and bioadhesive polymers can improve the release profile, stability, penetration, and therapeutic efficacy of herbal components. Such technological approaches contribute to the creation of stable and highly effective pharmaceutical formulations suitable for individualized therapy.

Modern scientific research also demonstrates the growing role of innovative technologies in the development of phytopharmaceuticals. Artificial intelligence, computational modeling, metabolomics, and molecular docking are increasingly used to identify promising biologically active compounds from medicinal plants and predict their pharmacological activity. These approaches significantly accelerate the development of new herbal medicinal products and optimize the selection of active phytocomponents for multicomponent formulations.

Furthermore, the increasing demand for natural medicines among patients contributes to the expansion of herbal pharmaceutical preparations in both industrial and extemporaneous pharmacy. Many patients prefer herbal medicines because they are perceived as safer, more natural, and better tolerated compared to synthetic drugs. Consequently, the pharmaceutical industry and pharmacy practice continue to focus on the development of effective herbal-based dosage forms.

Thus, the analysis of scientific literature indicates that the development of composition and technology of extemporaneous medicines based on medicinal plant raw materials represents a highly promising direction in contemporary pharmaceutical science. The use of standardized medicinal plant raw materials, multicomponent phytocompositions, modern pharmaceutical technologies, and

innovative delivery systems enables the creation of effective, safe, and personalized medicinal products for local application. The combination of traditional phytotherapeutic knowledge with advanced technological approaches opens broad prospects for the further development of herbal medicines and optimization of pharmaceutical care [4, 12, 16, 27].

CONCLUSIONS TO CHAPTER 1

1. Medicinal plant raw materials remain one of the most important and promising sources of biologically active compounds for the development of modern pharmaceutical products, including those intended for topical application.

2. Plant-derived substances are characterized by a wide spectrum of pharmacological activity, including anti-inflammatory, antimicrobial, antioxidant, immunomodulatory, and reparative effects, which makes them highly suitable for the treatment of inflammatory and infectious diseases.

3. The multicomponent nature of herbal preparations provides a synergistic therapeutic effect, allowing simultaneous influence on different stages of pathological processes and improving overall treatment efficacy.

4. The use of medicinal plant raw materials in pharmaceutical technology is associated with several challenges, including variability of chemical composition, the need for standardization, and ensuring stability and reproducibility of active compounds in finished dosage forms.

5. Modern technological approaches, including advanced extraction methods, nanotechnology, and computational tools such as artificial intelligence and molecular modeling, significantly enhance the development, optimization, and evaluation of phytopharmaceuticals.

6. Topical dosage forms based on medicinal plant raw materials are of particular interest due to their ability to provide localized therapeutic action, reduced systemic exposure, and improved patient compliance, especially in gynecological, dermatological, and proctological practice.

7. The integration of medicinal plant raw materials with modern pharmaceutical excipients and drug delivery systems creates new opportunities for the development of safe, effective, and multifunctional extemporaneous medicinal products.

CHAPTER 2. MATERIALS AND METHODS

2.1 Materials of the research

Characteristics of active substances and excipients used in the formulation of the vaginal gel.

Salvia officinalis L. extract (SPU, PhEur – herbal substance/extract; CAS: 84082-79-1)

Dry or soft extract obtained from the leaves of Salvia officinalis L. (sage). It represents a complex multicomponent phytochemical system containing essential oils (thujone, cineole, camphor), flavonoids (luteolin, apigenin derivatives), phenolic acids (notably rosmarinic acid), and condensed tannins [2, 13, 30].

The extract is typically a brownish-green to dark brown powder or viscous mass with a characteristic aromatic odor. It demonstrates moderate hygroscopicity and is partially soluble in water, while showing good solubility in hydroalcoholic mixtures. From a technological perspective, sage extract is compatible with hydrophilic gel bases; however, its stability is influenced by pH, light exposure, and oxidation processes.

Pharmacologically, Salvia officinalis extract exhibits pronounced antimicrobial, anti-inflammatory, antioxidant, and astringent effects. The mechanism of action is associated with inhibition of pro-inflammatory mediators (COX-2, cytokines such as IL-1β and TNF-α), stabilization of cellular membranes, and direct antimicrobial activity against both Gram-positive and Gram-negative microorganisms. The presence of tannins contributes to protein precipitation and formation of a protective layer on mucosal surfaces, which is particularly important for topical gynecological applications.

From a formulation standpoint, sage extract improves the overall therapeutic profile of the gel by providing a rapid anti-inflammatory response and reducing exudation processes in inflamed mucosal tissues.

Matricaria chamomilla L. extract (SPU, PhEur – herbal substance/extract; CAS: 84649-86-5)

Extract obtained from chamomile flowers (Matricaria chamomilla L.), standardized for content of apigenin derivatives, bisabolol, chamazulene, and other flavonoid glycosides [2, 13, 30].

It is a yellowish-brown to dark brown extract, freely soluble in ethanol-water mixtures and partially soluble in water depending on extraction conditions and phytochemical composition. Chamomile extract demonstrates good compatibility with hydrophilic polymer systems such as carbomer and hydroxyethyl cellulose, without causing significant destabilization of gel structure.

Pharmacologically, chamomile extract is characterized by anti-inflammatory, spasmolytic, antimicrobial, and epithelial-regenerating properties. Its anti-inflammatory activity is mainly attributed to inhibition of cyclooxygenase and lipoxygenase pathways, leading to reduced prostaglandin and leukotriene synthesis. Additionally, apigenin exhibits antioxidant activity and modulation of inflammatory signaling cascades.

From a technological perspective, chamomile extract contributes to tissue regeneration and mucosal soothing effects, making it especially valuable in vaginal formulations intended for irritated or damaged epithelium. It also enhances patient comfort by reducing burning sensations and local irritation.

Sodium hyaluronate (PhEur, USP; CAS №: 9067-32-7). White to off-white hygroscopic powder or fibrous material with high molecular weight variability depending on polymer chain length. It is freely soluble in water, forming highly viscous, transparent, pseudoplastic solutions, while being insoluble in most organic solvents [13, 29, 30].

Structurally, sodium hyaluronate is a linear glycosaminoglycan composed of repeating disaccharide units of D-glucuronic acid and N-acetyl-D-glucosamine. Its physicochemical behavior is strongly dependent on molecular weight, which determines viscosity, mucoadhesion, and residence time on mucosal surfaces.

Sodium hyaluronate plays a key role in extracellular matrix homeostasis. In topical pharmaceutical systems, it acts as a powerful hydrating, film-forming, and

bioadhesive agent. It enhances epithelial regeneration by promoting cell migration and proliferation, while also improving tissue hydration and elasticity.

In vaginal gel formulations, sodium hyaluronate significantly increases mucosal hydration, supports repair of microlesions, and reduces dryness-related discomfort. Its synergistic effect with plant extracts enhances overall regenerative and protective activity of the formulation.

Lactic acid (PhEur, USP; CAS №: 50-21-5). Colorless to slightly yellowish viscous liquid with hygroscopic properties, fully miscible with water, ethanol, and glycerol. It exists in L- and D-isomeric forms, with L-lactic acid being biologically relevant in human physiology.

Chemical formula: $C_3H_6O_3$ [13, 30].

Lactic acid is a natural metabolite of vaginal microbiota, primarily produced by Lactobacillus species, and plays a critical role in maintaining acidic vaginal pH (3.5–4.5), which is essential for protection against pathogenic microorganisms.

From a pharmacological perspective, lactic acid exhibits mild antimicrobial activity and supports restoration of normal microbiocenosis. It also enhances barrier function of the mucosa by maintaining optimal hydration and ionic balance.

Technologically, lactic acid functions as a pH regulator in gel systems, ensuring stability of carbomer-based networks and compatibility with physiological vaginal environment. It also improves preservative efficiency and contributes to overall microbiological stability of the formulation.

Carbomer (PhEur; CAS №: 9003-01-4). White, fluffy, highly hygroscopic powder consisting of crosslinked poly(acrylic acid). It is practically insoluble in water but capable of significant swelling and gel formation upon neutralization with bases such as triethanolamine [13, 29].

Carbomer is widely used as a gelling, suspending, and viscosity-enhancing agent in topical pharmaceutical systems. It forms clear, highly viscous gels with excellent pseudoplastic flow behavior, which is particularly advantageous for mucosal application.

In vaginal formulations, carbomer ensures strong mucoadhesion, prolonged retention time, and uniform distribution of active substances over the mucosal surface. Its rheological properties can be finely adjusted by pH modification, ionic strength, and concentration.

Additionally, carbomer provides structural stability to the gel system, preventing phase separation and sedimentation of dispersed phytocomponents.

Triethanolamine (PhEur, USP; CAS №: 102-71-6). Colorless to pale yellow viscous liquid with mild ammoniacal odor, completely miscible with water and ethanol.

Chemical formula: $C_6H_{15}NO_3$ [13, 30].

Triethanolamine acts as a neutralizing agent for carbomer, enabling transformation of acidic polymer dispersion into a three-dimensional gel network. Optimal gel formation occurs within a pH range of 5.5–6.5, which is compatible with vaginal physiology.

From a technological point of view, triethanolamine also contributes to viscosity adjustment and stabilization of the final gel system. Its concentration must be carefully controlled to avoid excessive alkalinity, which may affect mucosal tolerance.

Hydroxyethyl cellulose (HEC) (PhEur; CAS №: 9004-62-0). White to off-white granular or fibrous powder, non-ionic cellulose derivative, soluble in both cold and hot water forming clear, highly viscous colloidal solutions.

HEC acts as a thickening, stabilizing, and film-forming polymer. It improves the consistency of gel systems and enhances spreadability over mucosal surfaces. Due to its non-ionic nature, it demonstrates high compatibility with plant extracts and ionic excipients [13].

In vaginal gel formulations, HEC contributes to improved rheological stability, reduces syneresis, and enhances controlled release of active substances. It also increases mucosal adhesion time, thereby prolonging therapeutic action.

Glycerol (PhEur, USP; CAS №: 56-81-5). Colorless, odorless, hygroscopic viscous liquid with sweet taste, fully miscible with water and ethanol.

Chemical formula: $C_3H_8O_3$ [13, 29, 30].

Glycerol functions as a humectant, moisturizer, and plasticizer in topical formulations. It attracts and retains water molecules, thereby improving hydration of mucosal tissues and preventing dehydration of gel systems during storage and application.

In vaginal gels, glycerol enhances elasticity of the formulation, improves patient comfort, and reduces friction during application. It also contributes to improved sensory properties of the dosage form.

Purified water (PhEur; CAS №: 7732-18-5). Highly purified, colorless, and odorless liquid free from dissolved impurities, pyrogens, and microbiological contamination [13, 29, 30].

Purified water serves as the main dispersion medium for hydrophilic polymer systems. It ensures uniform distribution of active pharmaceutical ingredients and excipients, enabling formation of homogeneous gel structure.

From a technological perspective, water quality is critical for stability, viscosity development, and microbiological safety of the final dosage form. It also influences the hydration kinetics of polymers such as carbomer and HEC.

2.2 Methods of the research

Organoleptic and macroscopic evaluation. The organoleptic and macroscopic evaluation of the developed vaginal gel was performed at room temperature (20 ± 2 °C). A representative sample of the formulation was placed on a clean glass surface and examined under natural and artificial lighting conditions.

The appearance, color, odor, and consistency of the gel were evaluated visually and by tactile assessment. The presence of mechanical impurities, aggregates, or phase separation was determined by spreading a thin layer of the gel on a glass plate and observing its uniformity.

The gel was considered acceptable if it demonstrated a homogeneous structure without visible particles or phase separation, had a characteristic odor corresponding

to the herbal components, and showed uniform color distribution throughout the sample [1].

pH determination. The pH value of the developed gel was determined potentiometrically using a calibrated digital pH meter at 20 ± 2 °C.

For measurement, the gel sample was dispersed in purified water in a ratio of 1:10 (w/v) and stirred until a uniform suspension was obtained. The electrode was immersed into the prepared dispersion, and readings were recorded after stabilization of the signal.

All measurements were performed in triplicate, and the mean value was calculated.

The acceptable pH range for the developed vaginal gel was considered to be 3.8–5.5, with an optimal physiological range of 4.0–4.5 [1].

Rheological properties. The rheological properties of the gel were studied using a rotational viscometer at 25 ± 1 °C.

A defined amount of gel was placed in the measuring chamber, and viscosity was determined at different rotational speeds (5, 10, 20, 50, and 100 rpm). Each measurement was performed after a stabilization period of 30–60 seconds.

Flow curves (shear stress vs shear rate) were constructed to evaluate the rheological behavior of the system. The presence of pseudoplastic flow and thixotropic properties was assessed by comparing ascending and descending curves.

The results were expressed as dynamic viscosity (mPa·s) [1].

Uniformity of the gel system. The uniformity of the developed gel was evaluated visually and microscopically at 20 ± 2 °C.

A thin layer of the gel was spread on a glass slide and examined under an optical microscope at magnification ×40 and ×100. The presence of undissolved particles, aggregates, or phase separation was recorded.

Additionally, a sample was centrifuged at 3000 rpm for 30 minutes to assess physical stability under accelerated conditions.

The gel was considered uniform if no phase separation or sedimentation was observed after centrifugation and microscopic examination [1].

Microbiological quality control. Microbiological quality control of the developed vaginal gel was performed in accordance with pharmacopeial requirements for non-sterile dosage forms intended for mucosal application. The evaluation included determination of the total aerobic microbial count (TAMC) and the total yeast and mold count (TYMC), as well as testing for the absence of specified pathogenic microorganisms. For quantitative analysis, samples of the gel were aseptically prepared, appropriately diluted in sterile buffered solutions, and inoculated onto nutrient agar for bacterial growth and Sabouraud dextrose agar for fungal growth. Incubation was carried out at 30–35 °C for bacteria for 48–72 hours and at 20–25 °C for fungi for 5–7 days under controlled laboratory conditions [1].

In addition, the presence of specified microorganisms, including *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*, was assessed using selective culture media. The formulation was considered to meet microbiological quality requirements if no growth of the above-mentioned pathogenic microorganisms was observed in the tested samples.

Mucoadhesive properties. The mucoadhesive properties of the developed vaginal gel were evaluated in vitro using a mucosal tissue model and a detachment force measurement method.

The study was carried out at 37 ± 0.5 °C in order to simulate physiological conditions of the human body. A freshly excised mucosal membrane (e.g., porcine or bovine vaginal mucosa) was used as a biological model. The tissue was thoroughly rinsed with isotonic solution and fixed onto a rigid support to ensure stability during the experiment.

A defined amount of gel was applied onto the surface of the mucosal membrane, and intimate contact between the formulation and the tissue was established under a controlled pressure for a fixed period of time (typically 1–2 minutes). Subsequently, the force required to detach the gel from the mucosal surface was measured using a texture analyzer or a modified balance system.

The mucoadhesive strength was calculated as the maximum detachment force normalized to the contact area and was expressed in N/m^2 [1, 13].

In addition, the mucoadhesion time was determined, defined as the duration of retention of the gel on the mucosal surface until complete detachment under the influence of a model medium (isotonic solution at 37 °C with gentle agitation).

The obtained results allowed evaluation of the ability of the gel to remain on the mucosal surface for an extended period and to predict its in vivo biopharmaceutical performance.

The formulation was considered to possess satisfactory mucoadhesive properties if it demonstrated sufficiently high adhesion strength and prolonged residence time without rapid wash-off by the model medium.

Antimicrobial activity. The antimicrobial activity of the developed gel was evaluated using the agar disk diffusion method under standardized laboratory conditions. Nutrient agar plates were inoculated with microbial suspensions adjusted to 0.5 McFarland standard, corresponding to *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans*. Sterile paper disks impregnated with the tested gel were carefully placed on the surface of the inoculated agar. The plates were then incubated at 37 ± 0.5 °C for 24 hours for bacterial strains and for 48 hours for fungal cultures.

Following incubation, the antimicrobial effect was assessed by measuring the diameter of the inhibition zones in millimeters, which reflected the ability of the formulation to suppress microbial growth.

The minimum inhibitory concentration (MIC) was determined using the broth microdilution method. Serial two-fold dilutions of the gel were prepared in nutrient broth, after which each dilution was inoculated with a standardized microbial suspension. The samples were incubated at 37 ± 0.5 °C for 24 hours, and the MIC was defined as the lowest concentration of the formulation at which no visible microbial growth was observed [1].

Stability studies. Stability studies of the developed vaginal gel were conducted to evaluate its physicochemical and microbiological stability under both accelerated and long-term storage conditions. The samples were stored in tightly closed containers protected from light exposure under accelerated conditions at 40 ± 2 °C

and 75 ± 5% relative humidity, as well as under long-term conditions at 25 ± 2 °C and 60 ± 5% relative humidity [13].

The study was designed for a total duration of two months, with evaluations performed at predetermined time points of 0, 7, 14, 30, and 60 days. At each time point, the samples were analyzed for changes in pH using the potentiometric method, viscosity using a Brookfield viscometer at a fixed rotational speed, and organoleptic characteristics including color, odor, and consistency. Additionally, the presence of phase separation or sedimentation was assessed visually as an indicator of physical stability of the gel system.

CONCLUSIONS TO CHAPTER 2

1. The physicochemical characteristics of the active pharmaceutical ingredients and excipients used in the development of a vaginal gel formulation based on medicinal plant raw materials were analyzed.

2. Appropriate research methods for the development and evaluation of key quality attributes of the base formulation and experimental samples of the vaginal dosage form were selected and systematically reviewed, taking into account its rheological, microbiological, and pharmaceutic-technological properties.

CHAPTER 3. DEVELOPMENT OF THE COMPOSITION AND TECHNOLOGY OF AN EXTEMPORANEOUS VAGINAL GEL

3.1. Market analysis of products containing medicinal plant raw materials

The global market of herbal medicinal products is characterized by a clear segmentation by dosage forms, therapeutic areas, types of medicinal plant raw materials, and geographical production regions, which allows a detailed assessment of market structure and identification of key development trends in pharmaceutical technology [3].

In the structure of dosage forms, oral preparations dominate the market, accounting for 48% of the total share. This segment includes tablets (21%), capsules (17%), and liquid oral forms such as syrups and infusions (10%). Topical semisolid dosage forms represent 33% of the market and are subdivided into creams (14%), ointments (11%), and gels (8%). Liquid extracts and tinctures account for 12% of the market, while suppositories and vaginal dosage forms together represent 7%, within which vaginal gels and creams constitute 4%, and vaginal suppositories account for 3% (Fig. 3.1).

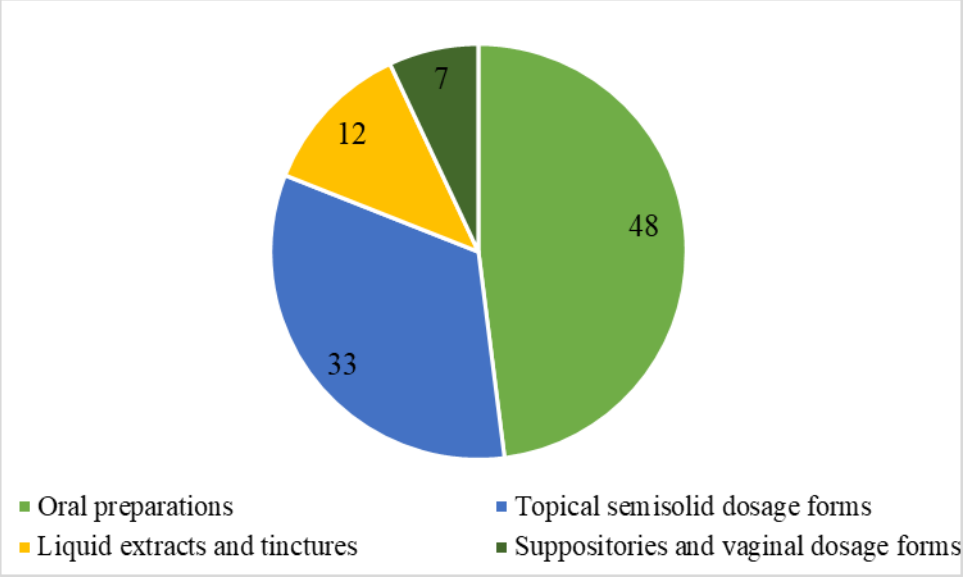

Fig. 3.1 Market by dosage forms, %

According to therapeutic use, dermatology represents the largest segment at 28%, including anti-inflammatory skin products (12%), wound-healing agents (9%), and antiseptic formulations (7%). The gastroenterological segment accounts for 24% and is composed of hepatoprotective agents (10%), spasmolytics (8%), and choleretic drugs (6%). Respiratory system-related herbal medicines represent 18%, including expectorants (9%), antitussives (5%), and anti-inflammatory respiratory agents (4%). The gynecological segment accounts for 12% of the market and is divided into anti-inflammatory vaginal preparations (6%), antimicrobial agents (4%), and regenerative products (2%). Urological and proctological products together constitute 10%, while other indications account for 8% (Fig. 3.2).

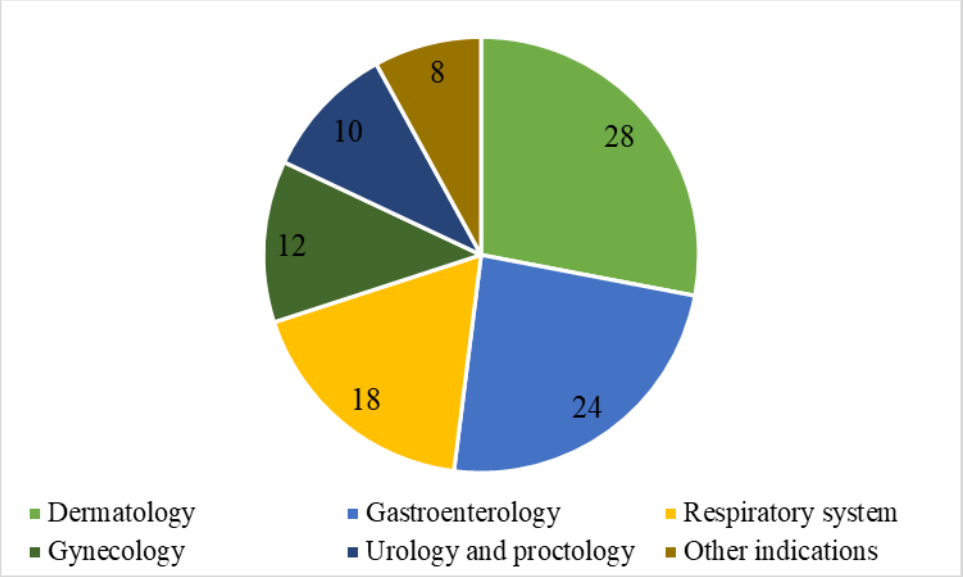

Fig. 3.2 Market by therapeutic use, %

The classification of medicinal plant raw materials according to major bioactive compound groups shows that flavonoid-rich plants account for 31%, including *Matricaria chamomilla L.*, *Calendula officinalis L.*, and *Hypericum perforatum L.*, which provide anti-inflammatory and antioxidant effects. Essential oil-bearing plants represent 26% and include *Salvia officinalis L.*, *Thymus vulgaris L.*, and *Lavandula angustifolia L.*, known for their strong antimicrobial activity. Tannin-containing plants account for 18%, including *Quercus robur L.* and *Hamamelis virginiana L.*, which exhibit astringent and anti-inflammatory

properties. Polysaccharide-rich plants represent 15%, such as *Aloe vera* and *Althaea officinalis L.*, providing moisturizing and reparative effects. Alkaloid-containing plants account for 10% and are primarily used for their potent pharmacological activities affecting various biological targets (Fig. 3.3).

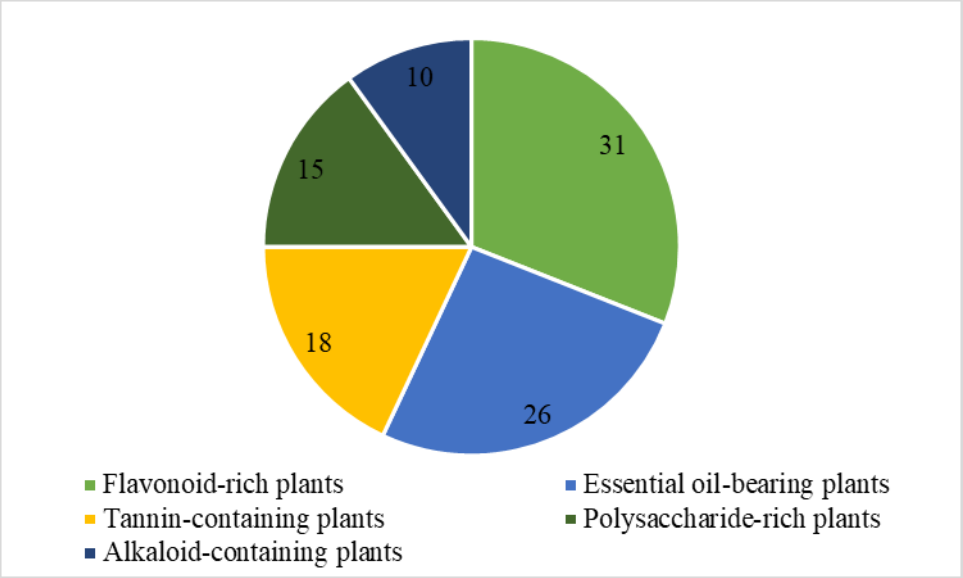

Fig. 3.3 Medicinal plant raw materials by bioactive compounds, %

The geographical distribution of herbal medicinal product manufacturing also demonstrates detailed segmentation. Europe accounts for 33% of global production, including Germany (12%), France (8%), Italy (7%), and other EU countries (6%). The Asia-Pacific region represents 38%, with China accounting for 18%, India 12%, Japan 5%, and other countries 3%. North America contributes 22%, primarily driven by the United States (19%) and Canada (3%), while other regions collectively account for 7%, including Latin America, the Middle East, and Africa (Fig. 3.4).

The obtained market structure indicates that herbal vaginal dosage forms, representing only 7% of the topical herbal product segment, remain relatively underrepresented but demonstrate significant growth potential. In particular, gel-based vaginal formulations (4% of the vaginal segment) are gradually replacing conventional suppositories due to improved mucoadhesive properties, controlled release of active substances, and higher patient compliance.

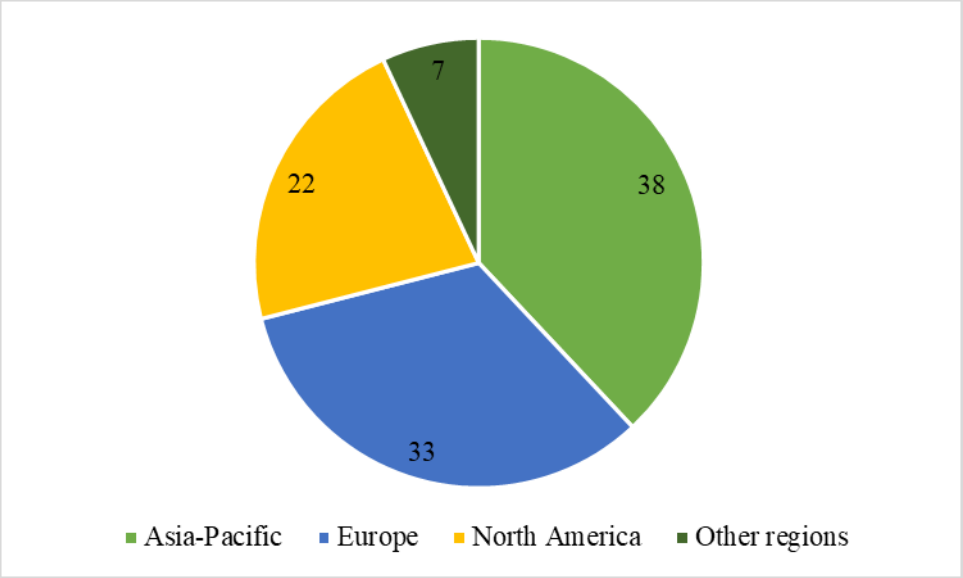

Fig. 3.4 Geographical distribution of manufacturing, %

Thus, the detailed market segmentation confirms the relevance of developing a vaginal gel based on medicinal plant raw materials as a modern, technologically justified, and highly promising dosage form for the local treatment of inflammatory conditions

3.2 Formulation rationale of the vaginal gel

The development of the vaginal gel formulation was based on the principles of rational pharmaceutical technology aimed at creating a multicomponent system with pronounced anti-inflammatory, antimicrobial, moisturizing, and reparative effects. As active components, extracts of medicinal plants *Salvia officinalis L.* and *Matricaria chamomilla L.* were selected due to their rich composition of biologically active compounds, including flavonoids, phenolic acids, terpenoids, and essential oils. The synergistic action of these constituents provides a multifactorial influence on the pathogenesis of inflammatory processes affecting the mucosal membrane.

The selection of the polymeric gel base was justified by the need to develop a stable system with optimal rheological and mucoadhesive properties. Carbomer was used as the primary gelling agent, providing the formation of a structured polymer network, high viscosity at low concentrations, and prolonged retention of the dosage

form on the mucosal surface. Hydroxyethyl cellulose additionally stabilizes the system, improves gel texture, and promotes uniform release of active substances.

To enhance hydration and reparative properties, sodium hyaluronate was incorporated as a natural component of the extracellular matrix, playing a key role in epithelial regeneration processes. Lactic acid was included as a pH regulator and as a component supporting the physiological vaginal microflora, promoting the growth of lactobacilli.

Glycerol was used as a humectant providing an additional osmotic effect and improving patient comfort during application. Triethanolamine serves as a neutralizing agent for carbomer and a regulator of gel structure formation. Purified water acts as the dispersion medium, ensuring uniform distribution of all formulation components.

Thus, the selected composition combines pharmacologically active herbal ingredients with a modern polymeric base, enabling the development of a stable, biocompatible, and effective vaginal dosage form.

3.3 Calculation of composition and concentrations

The quantitative composition of the developed vaginal gel was determined based on literature data, pharmaceutico-technological properties of the components, and the results of preliminary studies aimed at optimizing the rheological and mucoadhesive characteristics of hydrophilic polymer-based systems.

The concentration of *Salvia officinalis L.* and *Matricaria chamomilla L.* extracts was selected considering their pharmacological activity and the requirement for safe local application without irritation potential. Carbomer was used at a concentration sufficient to form a stable three-dimensional gel network with high mucoadhesive properties. Hydroxyethyl cellulose was included as a co-structuring agent to enhance system stability and improve rheological behavior.

Sodium hyaluronate was incorporated at low concentrations sufficient to provide moisturizing and reparative effects, while lactic acid was used as a pH regulator and a component maintaining physiological vaginal conditions. Glycerol

was applied as an osmotically active humectant, improving patient comfort and tolerability of the formulation.

Triethanolamine was used in the minimal required amount to neutralize carbomer and initiate gel network formation. Purified water represents the main dispersion medium, ensuring uniform distribution of all formulation components (Table 3.1).

Table 3.1

Quantitative composition of the developed vaginal gel

Component	Concentration, %	Functional role
Salvia officinalis L. extract	1.5	Anti-inflammatory, antimicrobial, antioxidant activity
Matricaria chamomilla L. extract	1.5	Anti-inflammatory, spasmolytic, reparative effect
Carbomer	0.8	Gelling agent, structural matrix formation, viscosity enhancement
Hydroxyethyl cellulose	0.5	Stabilizer, rheology modifier, texture improvement
Sodium hyaluronate	0.2	Hydrating and reparative agent, epithelial regeneration support
Lactic acid	0.8	pH regulator, maintenance of physiological vaginal environment
Glycerol	7.0	Humectant, moisturizing agent, improvement of patient comfort
Triethanolamine	q.s. (to pH 4.2–4.5)	Carbomer neutralization, gel structure formation
Purified water	up to 100	Dispersion medium

We present the quantitative composition of the developed vaginal gel and the functional contribution of each component. The formulation was designed to ensure

optimal rheological behavior, mucoadhesive properties, and a balanced combination of anti-inflammatory, antimicrobial, and moisturizing effects suitable for local application on the vaginal mucosa.

3.4 Manufacturing process of the vaginal gel

The vaginal gel was prepared under laboratory-controlled conditions following the principles of good pharmaceutical practice and standard technological procedures for semi-solid dosage forms. All operations were carried out at a controlled temperature of 20 ± 2 °C using previously calibrated laboratory equipment.

Step 1. Preparation of the polymeric gel base. Purified water was measured and transferred into a clean mixing vessel. Carbomer was gradually dispersed into the water under continuous stirring to avoid the formation of agglomerates. The dispersion was stirred until a homogeneous swollen polymer system was obtained and then left for complete hydration of the polymer for 30–45 minutes.

Step 2. Preparation of auxiliary phase. In a separate container, glycerol and hydroxyethyl cellulose were mixed until a uniform solution was formed. Sodium hyaluronate was then slowly added to the mixture under continuous stirring until complete dissolution. Lactic acid was incorporated into this phase to ensure uniform distribution and pH adjustment in subsequent steps.

Step 3. Incorporation of active substances. Aqueous or hydroalcoholic extracts of *Salvia officinalis L.* and *Matricaria chamomilla L.* were gradually introduced into the hydrated polymer base under constant low-speed stirring to ensure homogeneous distribution of active compounds throughout the gel matrix.

Step 4. Gel formation and neutralization. Triethanolamine was added dropwise under continuous stirring to neutralize carbomer and induce gel network formation. The pH of the system was carefully adjusted to the target physiological range (approximately 4.2–4.5), resulting in the formation of a stable, structured gel.

Step 5. Homogenization and deaeration. The obtained gel was homogenized at low speed to ensure uniform consistency and then allowed to stand for deaeration to remove entrapped air bubbles and stabilize the structure.

Step 6. Packaging and storage. The final gel was transferred into sterile, airtight containers, protected from light, and stored at room temperature for further evaluation of physicochemical and microbiological properties.

The identification of critical process parameters (CPP) is essential for ensuring the reproducibility, quality, and stability of the developed vaginal gel. Control of mixing conditions, temperature, hydration time, and neutralization rate directly influences the formation of the polymeric network, rheological behavior, and homogeneity of the final dosage form. Maintaining defined CPP ranges ensures consistent product performance and compliance with pharmaceutical quality standards (Table 3.2).

Table 3.2

Critical process parameters for the manufacturing of the vaginal gel

Process stage	Critical process parameter	Target value / range	Quality impact
1	2	3	4
Polymer dispersion (Carbomer hydration)	Stirring speed	300–500 rpm	Homogeneity, absence of agglomerates, gel clarity
Polymer dispersion	Hydration time	30–45 min	Gel structure formation, viscosity development
Temperature control	Processing temperature	20 ± 2 °C	Stability of plant extracts, polymer swelling efficiency

Continuation of tab. 3.2

1	2	3	4
Addition of active substances	Addition rate	Slow, continuous	Uniform distribution, prevention of phase separation
Mixing stage	Mixing speed during incorporation	150–300 rpm	Content uniformity, rheological consistency
Neutralization step	Triethanolamine addition rate	Dropwise addition	Gel formation control, prevention of local over-neutralization
pH adjustment	Final pH	4.2–4.5	Microbiological stability, mucosal compatibility
Rheological development	Post-neutralization equilibration time	20–30 min	Final viscosity, gel network stabilization
Deaeration	Resting time	15–30 min	Absence of air bubbles, improved appearance and stability
Final product handling	Storage conditions	20 ± 2 °C, protected from light	Long-term physical and chemical stability

3.5 Quality control of the developed vaginal gel

The developed vaginal gel demonstrated a homogeneous semitransparent structure with a light brown color and a characteristic mild herbal odor, which confirms successful incorporation of *Salvia officinalis L.* and *Matricaria chamomilla L.* extracts without evidence of phase incompatibility or precipitation phenomena. The absence of mechanical inclusions and uniform distribution of

components indicates high physicochemical compatibility between the polymeric base and plant-derived active substances (Table 3.3).

Table 3.3

Main quality parameters of the developed vaginal gel

Parameter	Method	Result
1	2	3
Appearance	Organoleptic evaluation (20 ± 2 °C)	Homogeneous semitransparent gel
Color	Visual assessment	Light brown with slight greenish tint
Odor	Sensory analysis	Mild herbal odor (sage–chamomile)
Consistency	Tactile evaluation	Smooth, uniform, non-gritty
pH	Potentiometric method	4.32 ± 0.05
Dynamic viscosity (50 rpm)	Brookfield viscometer	28,450 ± 1,120 mPa·s
Rheological behavior	Flow curve analysis	Pseudoplastic, thixotropic system
Homogeneity	Microscopy (×40, ×100)	No particles or aggregates detected
Centrifugation stability	3000 rpm / 30 min	No phase separation
TAMC	Pharmacopeial method	<10 CFU/g
TYMC	Sabouraud agar	<10 CFU/g
E. coli	Selective media	Not detected
Staphylococcus aureus	Selective media	Not detected
Pseudomonas aeruginosa	Selective media	Not detected
Mucoadhesive strength	Texture analyzer	1.85 ± 0.12 N/m²
Mucoadhesion time	In vitro mucosal model	6.4 ± 0.3 h

Continuation of tab. 3.3

1	2	3
Inhibition zone (*S. aureus*)	Disk diffusion	18.6 ± 0.8 mm
Inhibition zone (*E. coli*)	Disk diffusion	15.2 ± 0.6 mm
Inhibition zone (*C. albicans*)	Disk diffusion	17.1 ± 0.7 mm
MIC (all strains)	Broth microdilution	0.78 mg/mL

The pH value of 4.32 ± 0.05 falls within the physiological vaginal range, which is crucial for maintaining microbiocenosis stability and ensuring patient tolerability. This pH level is also optimal for the stability of carbomer-based gel systems, preventing structural degradation of the polymer network.

Rheological analysis demonstrated a pronounced pseudoplastic and thixotropic behavior, which is characteristic of modern mucoadhesive vaginal formulations. Such flow properties ensure ease of application under shear stress while maintaining high viscosity under static conditions, thereby prolonging residence time on the mucosal surface. The relatively high viscosity value confirms the formation of a well-developed three-dimensional polymer network capable of sustaining controlled release of active compounds.

Microbiological testing confirmed compliance with pharmacopeial requirements for non-sterile mucosal preparations. The very low levels of TAMC and TYMC, together with the absence of pathogenic microorganisms, indicate both effective raw material quality control and appropriate manufacturing hygiene conditions. This is particularly important for vaginal dosage forms, where microbiological safety directly influences the risk of dysbiosis or secondary infections.

The mucoadhesive evaluation demonstrated strong adhesion to biological mucosal tissue, with a retention time exceeding 6 hours. This suggests that the

combination of carbomer and hydroxyethyl cellulose provides an effective bioadhesive matrix capable of maintaining prolonged contact with the vaginal epithelium, which is essential for sustained local drug delivery and improved therapeutic efficacy.

Antimicrobial testing revealed pronounced activity against all tested strains. The largest inhibition zones were observed against *Staphylococcus aureus*, which is consistent with the known sensitivity of Gram-positive bacteria to phenolic and essential oil components of sage and chamomile extracts. The MIC value of 0.78 mg/mL confirms a relatively high biological potency of the formulation and supports the synergistic interaction between plant extracts and the gel matrix.

Overall, the obtained results confirm that the developed vaginal gel possesses a balanced combination of physicochemical stability, favorable rheological behavior, high mucoadhesive capacity, microbiological safety, and significant antimicrobial activity, which makes it a promising candidate for local therapy of inflammatory and dysbiotic conditions of the vaginal mucosa.

3.6 Stability studies of the developed vaginal gel

The stability assessment demonstrated that the developed vaginal gel retains its key physicochemical characteristics over the entire 60-day observation period under both accelerated and long-term conditions. A slight, gradual decrease in pH and viscosity was observed, however, these changes remained within pharmaceutically acceptable limits and did not affect the structural integrity of the gel system (Table 3.4).

No phase separation, sedimentation, or microbiological contamination was detected throughout the study, confirming the high physical and microbiological stability of the formulation. The minor darkening observed at later time points can be attributed to natural oxidation processes of plant-derived polyphenolic compounds, which did not significantly influence the functional properties of the gel.

Table 3.4

Stability profile of the vaginal gel under storage conditions

Time, days	pH, 25 °C	Viscosity, mPa·s	Appearance	Phase separation
0	4.32 ± 0.05	28,450 ± 1,120	Homogeneous	Absent
7	4.31 ± 0.04	28,210 ± 1,050	Unchanged	Absent
14	4.30 ± 0.05	27,980 ± 1,100	Unchanged	Absent
30	4.28 ± 0.06	27,450 ± 1,200	Slight darkening	Absent
60	4.25 ± 0.05	26,900 ± 1,150	Slight darkening	Absent

Overall, the obtained data confirm that the developed formulation possesses satisfactory stability and is suitable for further preclinical and technological development as a vaginal delivery system based on medicinal plant raw materials.

CONCLUSIONS TO CHAPTER 3

1. The current state of the global market for herbal medicinal products was studied, and its clear segmentation by dosage forms, therapeutic areas, types of medicinal plant raw materials, and geographical production regions was established. It was determined that vaginal dosage forms demonstrate stable growth potential, which substantiates the feasibility of developing new local drug delivery systems based on plant-derived components.

2. The selection of plant-derived active pharmaceutical ingredients, in particular extracts of *Salvia officinalis* L. and *Matricaria chamomilla* L., was justified as multicomponent sources of biologically active compounds with pronounced anti-inflammatory, antimicrobial, and reparative activity. The rationale for their combination with a polymeric gel base was confirmed in order to achieve a synergistic pharmacological effect.

3. The composition and concentrations of the developed dosage form were elaborated taking into account the pharmaceutico-technological properties of polymers, the biological activity of plant extracts, and the requirements for local vaginal delivery systems. An optimal ratio of excipients was determined, ensuring stability, biocompatibility, and functional performance of the gel system.

4. The manufacturing process of the vaginal gel was developed and described, including stages of polymer hydration, incorporation of active components, gel network formation, neutralization, and homogenization. The critical process parameters were identified and defined.

5. A comprehensive evaluation of the physicochemical, microbiological, and pharmaco-technological properties of the developed gel was performed, confirming its homogeneity, optimal rheological behavior, physiologically acceptable pH level, high mucoadhesive capacity, and pronounced antimicrobial activity. Compliance of microbiological quality indicators with pharmacopeial requirements for non-sterile vaginal dosage forms was established.

6. The stability of the developed dosage form was investigated under short-term storage conditions, which demonstrated the preservation of key physicochemical characteristics throughout the observation period without signs of phase instability or microbiological contamination.

CONCLUSIONS

1. Medicinal plant raw materials remain one of the most important and promising sources of biologically active compounds for the development of modern pharmaceutical products, including those intended for topical application.

2. Plant-derived substances are characterized by a wide spectrum of pharmacological activity, including anti-inflammatory, antimicrobial, antioxidant, immunomodulatory, and reparative effects, which makes them highly suitable for the treatment of inflammatory and infectious diseases.

3. The multicomponent nature of herbal preparations provides a synergistic therapeutic effect, allowing simultaneous influence on different stages of pathological processes and improving overall treatment efficacy.

4. The use of medicinal plant raw materials in pharmaceutical technology is associated with several challenges, including variability of chemical composition, the need for standardization, and ensuring stability and reproducibility of active compounds in finished dosage forms.

5. Modern technological approaches, including advanced extraction methods, nanotechnology, and computational tools such as artificial intelligence and molecular modeling, significantly enhance the development, optimization, and evaluation of phytopharmaceuticals.

6. Topical dosage forms based on medicinal plant raw materials are of particular interest due to their ability to provide localized therapeutic action, reduced systemic exposure, and improved patient compliance, especially in gynecological, dermatological, and proctological practice.

7. The integration of medicinal plant raw materials with modern pharmaceutical excipients and drug delivery systems creates new opportunities for the development of safe, effective, and multifunctional extemporaneous medicinal products.

8. The physicochemical characteristics of the active pharmaceutical ingredients and excipients used in the development of a vaginal gel formulation based on medicinal plant raw materials were analyzed.

9. Appropriate research methods for the development and evaluation of key quality attributes of the base formulation and experimental samples of the vaginal dosage form were selected and systematically reviewed, taking into account its rheological, microbiological, and pharmaceutic-technological properties.

10. The current state of the global market for herbal medicinal products was studied, and its clear segmentation by dosage forms, therapeutic areas, types of medicinal plant raw materials, and geographical production regions was established. It was determined that vaginal dosage forms demonstrate stable growth potential, which substantiates the feasibility of developing new local drug delivery systems based on plant-derived components.

11. The selection of plant-derived active pharmaceutical ingredients, in particular extracts of *Salvia officinalis* L. and *Matricaria chamomilla* L., was justified as multicomponent sources of biologically active compounds with pronounced anti-inflammatory, antimicrobial, and reparative activity. The rationale for their combination with a polymeric gel base was confirmed in order to achieve a synergistic pharmacological effect.

12. The composition and concentrations of the developed dosage form were elaborated taking into account the pharmaceutico-technological properties of polymers, the biological activity of plant extracts, and the requirements for local vaginal delivery systems. An optimal ratio of excipients was determined, ensuring stability, biocompatibility, and functional performance of the gel system.

13. The manufacturing process of the vaginal gel was developed and described, including stages of polymer hydration, incorporation of active components, gel network formation, neutralization, and homogenization. The critical process parameters were identified and defined.

14. A comprehensive evaluation of the physicochemical, microbiological, and pharmaco-technological properties of the developed gel was performed,

confirming its homogeneity, optimal rheological behavior, physiologically acceptable pH level, high mucoadhesive capacity, and pronounced antimicrobial activity. Compliance of microbiological quality indicators with pharmacopeial requirements for non-sterile vaginal dosage forms was established.

15. The stability of the developed dosage form was investigated under short-term storage conditions, which demonstrated the preservation of key physicochemical characteristics throughout the observation period without signs of phase instability or microbiological contamination.

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APPENDICES

Appendix A

МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ
НАЦІОНАЛЬНИЙ ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ

ГРАМОТА

нагороджується

Агутан Уіам

за участь у секційному засіданні студентського наукового товариства кафедри аптечної технології ліків

XXXII МІЖНАРОДНОЇ НАУКОВО-ПРАКТИЧНОЇ КОНФЕРЕНЦІЇ МОЛОДИХ ВЧЕНИХ ТА СТУДЕНТІВ «АКТУАЛЬНІ ПИТАННЯ СТВОРЕННЯ НОВИХ ЛІКАРСЬКИХ ЗАСОБІВ»

Ректор закладу вищої освіти **Олександр КУХТЕНКО**

МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ Національний фармацевтичний університет №02010936

15 квітня 2026 р. м. Ужгород

Appendix B

МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ
НАЦІОНАЛЬНИЙ ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ
РАДА МОЛОДИХ ВЧЕНИХ
СТУДЕНТСЬКЕ НАУКОВЕ ТОВАРИСТВО
ГО «УКРАЇНСЬКА ФАРМАЦЕВТИЧНА СТУДЕНТСЬКА АСОЦІАЦІЯ»

ПРОГРАМА

XXXII Міжнародної науково-практичної конференції молодих вчених та студентів «АКТУАЛЬНІ ПИТАННЯ СТВОРЕННЯ НОВИХ ЛІКАРСЬКИХ ЗАСОБІВ»

15-17 квітня 2026 р.

Харків, Ужгород – 2026

Continuation of app. B

9. **Розроблення екстракту сухого для лікування захворювань репродуктивної системи жінок**
Доповідач: Закарлюка Анастасія
Науковий керівник: Марченко М.В., к. фарм. н., доцент
10. **Аналіз підходів до використання рослинних компонентів у складі супозиторіїв**
Доповідач: Зуєва Софія
Науковий керівник: Марченко М.В., к. фарм. н., доцент
11. **Аналіз підходів до фармакотерапії посттравматичного стресового розладу у деяких країнах**
Доповідач: Білозор Ксенія,
Науковий керівник: Вишневська Л.І., д. фарм. н., проф.
12. **Development of the composition and technology of extemporaneous antiseptic liquid soap**
Доповідач: Аллалі Аюб,
Науковий керівник: Вишневська Л.І., д. фарм. н., проф.
13. **Development of the composition and technology of a cream-gel with keratolytic activity**
Доповідач: Шукрі-Хаміуі Аюб,
Науковий керівник: Ковальова Т.М., к. фарм. н., доцент
14. **Development of the composition and technology of an extemporaneous drug based on medicinal plant raw materials**
Доповідач: Агутан Уіам,
Науковий керівник: Іванюк О.І., PhD, асистент
15. **Сучасні напрями виготовлення лікарських препаратів з лікарської рослинної сировини**
Доповідач: Яворська Валерія,
Науковий керівник: Боднар Л.А., PhD, асистент

Ф А 2.2.1-36-366

National University of Pharmacy

Faculty pharmaceutical
Department drug technology
Level of higher education master
Specialty 226 Pharmacy, industrial pharmacy
Educational and professional program Pharmacy

APPROVED
The Head of Department

_____
Liliia VYSHNEVSKA

"07" October
2025

ASSIGNMENT

FOR QUALIFICATION WORK

OF AN APPLICANT FOR HIGHER EDUCATION

Ouiam AGHOUTANE

1. Topic of qualification work: «Development of the composition and technology of an extemporaneous drug based on medicinal plant raw materials», supervisor of qualification work: Olena IVANIUK, Philosophy Doctor

approved by order of NUPh from "06" of October 2025 № 266

2. Deadline for submission of qualification work by the applicant for higher education: May 2026.

3. Outgoing data for qualification work: vaginal gel, medicinal plant raw materials, extemporaneous technology, semi-solid dosage forms.

4. Contents of the settlement and explanatory note (list of questions that need to be developed):
- to review, analyze, and summarize literature data on the use of medicinal plant raw materials in dosage forms;
- to conduct a market analysis of products containing medicinal plants;
- to justify the selection of plant-derived active pharmaceutical ingredients and other excipients for the developed formulation;
- to develop technological approaches for the preparation of the dosage form;
- to describe the expected quality indicators and pharmaco-technological characteristics of the developed composition.

5. List of graphic material (with exact indication of the required drawings): tables 4, figures 4.

6. Consultants of chapters of qualification work

Chapters	Name, SURNAME, position of consultant	Signature, date	
		assignment was issued	assignment was received
1	Olena IVANIUK, assistant of the drug technology department	07.10.2025	07.10.2025
2	Olena IVANIUK, assistant of the drug technology department	24.11.2025	24.11.2025
3	Olena IVANIUK, assistant of the drug technology department	24.01.2026	24.01.2026

7. Date of issue of the assignment: "07" October 2025

CALENDAR PLAN

№ з/п	Name of stages of qualification work	Deadline for the stages of qualification work	Notes
1	Justification of the research design	October 2025	**done**
2	Analysis of literature sources	November 2025	**done**
3	Conducting experimental research	December 2025 – January 2026	**done**
4	Analysis, interpretation, and synthesis of the results	January-March 2026	**done**
5	Designing a work	April 2026	**done**

An applicant of higher education _____ Ouiam AGHOUTANE
Supervisor of qualification work _____ Olena IVANIUK

ВИТЯГ З НАКАЗУ
По Національному фармацевтичному університету

«06» жовтня 2025 р. **№ 266**
Фармацевтичний факультет

Затвердити теми кваліфікаційних робіт здобувачам вищої освіти 5 курсу 2025-2026 н. р., група Фм21(4,10д)англ-01, освітня програма «Фармація», спеціальність «226 Фармація, промислова фармація», галузь знань «22 Охорона здоров'я», рівень вищої освіти другий (магістерський), денна форма здобуття освіти, термін навчання 4 роки 10 місяців, мова навчання англійська.

Прізвище, ім'я здобувача вищої освіти	Тема кваліфікаційної роботи (українською мовою)	Тема кваліфікаційної роботи (англійською мовою)	Керівник кваліфіка-ційної роботи	Рецензент кваліфіка-ційної роботи
Кафедра аптечної технології ліків				
Агутан Уіам	Розроблення складу і технології екстемпорального лікарського засобу на основі лікарської рослинної сировини	Development of the composition and technology of an extemporaneous drug based on medicinal plant raw materials	ас. Іванюк О.І.	доц. Солдатов Д.П.

Підстава: подання декана фармацевтичного факультету доцента Олександра ГОНЧАРОВА

Ректор
Вірно. Секретар

НАЦІОНАЛЬНИЙ ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ УКРАЇНА
ФАРМАЦЕВТИЧНИЙ ФАКУЛЬТЕТ
№02010936 МІСТО ХАРКІВ

ФА2.8-03-317

ВИСНОВОК

експертної комісії про проведену експертизу

щодо академічного плагіату у кваліфікаційній роботі

здобувача вищої освіти

«11» травня 2026 р. № 333812508

Проаналізувавши кваліфікаційну роботу здобувача вищої освіти АГУТАН Уіама, групи Фм21(4,10д)англ-01, спеціальності 226 Фармація, промислова фармація, освітньої програми «Фармація» очної (денної) форми здобуття освіти на тему: «Розроблення складу і технології екстемпорального лікарського засобу на основі лікарської рослинної сировини / Development of the composition and technology of an extemporaneous drug based on medicinal plant raw materials», експертна комісія дійшла висновку, що робота, представлена до Екзаменаційної комісії для захисту, виконана самостійно і не містить елементів академічного плагіату (компіляції).

Заступник голови Комісії,
заступник директора інституту
в складі ЗВО ННІПФ,
доцент Олена НОВОСЕЛ

Ф А 2.2.1-36-353

REVIEW

of scientific supervisor for the qualification work of the master's level of higher education of the specialty 226 Pharmacy, industrial pharmacy

Ouiam AGHOUTANE

on the topic: «Development of the composition and technology of an extemporaneous drug based on medicinal plant raw materials»

Relevance of the topic. Vaginal inflammatory diseases remain one of the most common problems in gynecological practice and often require the use of local medications with anti-inflammatory, antiseptic, and regenerative properties. In recent years, increasing attention has been paid to medicinal plant raw materials as sources of biologically active compounds with a favorable safety profile and good tolerability. Extracts of chamomile and sage are widely known for their anti-inflammatory, antimicrobial, soothing, and healing effects, which makes them promising components for the development of vaginal dosage forms. Among semisolid dosage forms, gels are considered particularly suitable for vaginal application due to their convenient administration, prolonged contact with mucosal tissues, uniform distribution of active substances, and improved patient compliance. An important stage in the development of extemporaneous preparations is the study of their stability, which determines the preservation of physicochemical properties, homogeneity, and effectiveness during storage. Therefore, the development of the composition and technology of an extemporaneous vaginal gel based on chamomile and sage extracts, as well as the evaluation of its stability, is a relevant task of modern pharmaceutical technology.

Practical value of conclusions, recommendations and their validity. The qualification work presents a comprehensive analysis of modern approaches to the development of extemporaneous vaginal semisolid dosage forms based on medicinal plant raw materials. The physicochemical and technological characteristics of chamomile and sage extracts were taken into account during the formulation development. A rational composition of the vaginal gel was substantiated, and the technological stages of its

preparation under pharmaceutical conditions were proposed. Particular attention was paid to the study of stability indicators, including appearance, homogeneity, consistency, and preservation of the gel properties during storage. The obtained results confirm the feasibility of using medicinal plant extracts in extemporaneous vaginal preparations and may be implemented in pharmacy practice for the preparation of effective and safe local gynecological agents.

Assessment of work. The qualification work is performed at a high scientific and methodological level. The material is logically presented, scientifically substantiated, and supported by relevant professional literature. The author demonstrates a good understanding of pharmaceutical technology principles, especially regarding the development of semisolid extemporaneous dosage forms based on medicinal plant raw materials. The conducted stability studies confirm the practical significance and reliability of the obtained results. The conclusions correspond to the objectives and tasks of the research and are characterized by practical orientation.

General conclusion and recommendations on admission to defense. The qualification work meets the requirements for master's level theses and can be submitted for defense to the Examination Commission of the National Pharmaceutical University for the award of the Master of Pharmacy degree.

Scientific supervisor _____ Olena IVANIUK

«13» of May 2026

Ф А 2.2.1-36-356

REVIEW

for qualification work of the master's level of higher education, specialty 226 Pharmacy, industrial pharmacy

Ouiam AGHOUTANE

on the topic: «Development of the composition and technology of an extemporaneous drug based on medicinal plant raw materials»

Relevance of the topic. Vaginal inflammatory diseases remain among the most common gynecological disorders and require the development of effective local therapeutic agents with anti-inflammatory, antimicrobial, and regenerative properties. Chamomile and sage extracts are characterized by pronounced anti-inflammatory, antiseptic, soothing, and healing effects, which makes them promising active ingredients for vaginal dosage forms. The therapeutic effectiveness of such preparations largely depends on the selected dosage form, which should ensure uniform distribution of active substances, prolonged contact with the mucous membrane, and patient comfort during use. Vaginal gels are considered particularly promising because of their favorable rheological properties, ease of administration, and ability to provide controlled release of biologically active compounds. Therefore, the development of the composition and technology of an extemporaneous vaginal gel based on chamomile and sage extracts, as well as the assessment of its stability, is a relevant task of modern pharmaceutical technology aimed at creating safe and effective gynecological preparations.

Theoretical level of work. The work presents a systematic analysis of modern approaches to the development of extemporaneous semisolid vaginal dosage forms based on medicinal plant raw materials. The author summarized current scientific data concerning the pharmacological properties of chamomile and sage extracts and their application in local gynecological therapy. Particular attention was paid to the physicochemical and technological characteristics of vaginal gel systems, including their structural properties, stability, homogeneity, and ability to ensure prolonged release of active substances. The theoretical part of the study demonstrates a solid understanding of pharmaceutical technology principles, extemporaneous compounding, and the requirements for vaginal

drug delivery systems.

Author's suggestions on the research topic. The author independently substantiated the selection of a gel system as a rational dosage form for the local administration of medicinal plant extracts in gynecological practice. Based on literature analysis and technological considerations, a scientifically justified composition of the vaginal gel containing chamomile and sage extracts was proposed. A rational technological scheme for the preparation of the extemporaneous formulation under pharmacy conditions was developed. The methodological approach included the selection of optimal technological stages and stability assessment criteria aimed at ensuring homogeneity, physicochemical stability, and acceptable consumer properties of the final product. The proposed solutions correspond to the objectives of developing an effective and stable herbal vaginal preparation.

Practical value of conclusions, recommendations and their validity. The obtained results have practical significance for pharmaceutical technology and extemporaneous pharmacy practice. The proposed composition and preparation technology of the vaginal gel based on chamomile and sage extracts may be applied in pharmacy compounding for the preparation of safe and effective local gynecological agents. The conducted stability studies confirm the feasibility of using the developed formulation under appropriate storage conditions. The study contributes to the expansion of herbal extemporaneous preparations intended for local gynecological therapy and supports the development of patient-oriented pharmaceutical care.

Disadvantages of work. The work contains minor stylistic and technical inaccuracies, as well as isolated formatting inconsistencies in the references section. However, these shortcomings are insignificant and do not affect the overall scientific and practical value of the study.

General conclusion and assessment of the work. The qualification work meets the requirements for master's level research and can be submitted for defense to the Examination Commission of the National Pharmaceutical University for the award of the Master of Pharmacy degree.

Reviewer _____as. prof. Dmytro SOLDATOV

«14» of May 2026

Ф А2.2.1-36-230

МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ
НАЦІОНАЛЬНИЙ ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ

ВИТЯГ З ПРОТОКОЛУ № 14
«15» травня 2026 року
м. Харків
засідання кафедри
аптечної технології ліків
(назва кафедри)

Голова: завідувачка кафедри, професор Вишневська Л.І.
Секретар: докт. філ., ас. Боднар Л.А.

ПРИСУТНІ:

проф. Половко Н.П., проф. Семченко К.В., проф. Зуйкіна С.С., доц. Ковальова Т.М., доц. Буряк М.В., доц. Олійник С.В., доц. Марченко М.В., ас. Іванюк О.І.

ПОРЯДОК ДЕННИЙ:

1. Про представлення до захисту кваліфікаційних робіт здобувачів вищої освіти.

СЛУХАЛИ: проф. Вишневську Л. І. – про представлення до захисту доЕкзаменаційної комісії кваліфікаційних робіт здобувачів вищої освіти.

ВИСТУПИЛИ: Здобувач вищої освіти групи Phm21(4,10d)eng-01 спеціальності 226 «Фармація, промислова фармація» Ouiam AGHOUTANE – з доповіддю на тему «Development of the composition and technology of an extemporaneous drug based on medicinal plant raw materials» (науковий керівник, Олена ІВАНЮК).

УХВАЛИЛИ: Рекомендувати до захисту кваліфікаційну роботу.

Голова
Завідувачка кафедри, проф. _____ Лілія ВИШНЕВСЬКА
(підпис)

Секретар
Асистент _____ Любов БОДНАР
(підпис)

Ф А2.2.1-36-042

НАЦІОНАЛЬНИЙ ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ

ПОДАННЯ
ГОЛОВІ ЕКЗАМЕНАЦІЙНОЇ КОМІСІЇ
ЩОДО ЗАХИСТУ КВАЛІФІКАЦІЙНОЇ РОБОТИ

Направляється здобувач вищої освіти Ouiam AGHOUTANE до захисту кваліфікаційної роботи
за галуззю знань 22 Охорона здоров'я
спеціальністю 226 Фармація, промислова фармація
освітньо-професійною програмою Фармація
на тему: «Development of the composition and technology of an extemporaneous drug based on medicinal plant raw materials»

Кваліфікаційна робота і рецензія додаються.

Декан факультету _____/ Олександр ГОНЧАРОВ /

Висновок керівника кваліфікаційної роботи

Здобувач вищої освіти Ouiam AGHOUTANE представила кваліфікаційну роботу, яка за об'ємом теоретичних та практичних досліджень повністю відповідає вимогам до оформлення кваліфікаційних робіт.

Керівник кваліфікаційної роботи

_____ Олена ІВАНЮК

«13» травня 2026 р.

Висновок кафедри про кваліфікаційну роботу

Кваліфікаційну роботу розглянуто. Здобувач вищої освіти Ouiam AGHOUTANE допускається до захисту даної кваліфікаційної роботи в Екзаменаційній комісії.

Завідувачка кафедри
аптечної технології ліків

_____ Лілія ВИШНЕВСЬКА

«15» травня 2026 р.

Qualification work was defended
of Examination commission on
« 09 » of June 2026
with the grade _____
Head of the State Examination commission,
Doctor of Pharmaceutical Sciences, Professor

_____ / Volodymyr YAKOVENKO /