Ф А2.2.1-32-367

MINISTRY OF HEALTH OF UKRAINE
NATIONAL UNIVERSITY OF PHARMACY
faculty for foreign citizens' education
department of Technologies of Pharmaceutical Preparations

QUALIFICATION WORK

on the topic: **«STUDY OF THE PROCESS OF EXTRACTING OF THE PLANT COLLECTION OF EXPECTORANT ACTION»**

Prepared by: higher education graduate of group Фм18(5,0д)англ-08
specialty 226 Pharmacy, industrial pharmacy
educational program Pharmacy
Amine OULED LAGHRIYEB
Supervisor: associate professor of higher education institution of department of Technologies of Pharmaceutical Preparations, PhD, associate professor Dmytro SOLDATOV
Reviewer: associate professor of higher education institution of department of Drugs technology, PhD, associate professor Volodymyr KOVALOV

Kharkiv – 2023

ANNOTATION

In this work the process of extracting of the plant collection of expectorant action were studied. The extraction process of the plant collection was examined, and the optimal extraction conditions were determined. These conditions included grinding the raw material to particles that can pass through a 2 mm sieve, using purified water as the extractant, maintaining a temperature of 90°C, and employing the double maceration method.

The work consists of the following parts: introduction, literature review, choice of research methods, experimental part, general conclusions, list of used literature sources, total volume of 51 pages, contains 7 tables, 40 references.

Key words: flowers of marigolds, chamomile flowers, rhizomes of ayru, althea roots, licorice roots, sage leaves, the herb of thyme.

АНОТАЦІЯ

У роботі досліджено процес отримання збору рослин відхаркувальної дії. Досліджено процес екстрагування колекції рослин та визначено оптимальні умови екстракції. Ці умови включали подрібнення сировини до частинок, які можуть проходити через сито 2 мм, використання очищеної води як екстрагенту, підтримання температури 90°C і використання методу подвійної мацерації.

Робота складається з таких частин: вступ, огляд літератури, вибір методів дослідження, експериментальна частина, загальні висновки, список використаних літературних джерел, загальний обсяг 51 сторінки, містить 7 таблиць, 40 посилань.

Ключові слова: квітки нагідок, квітки ромашки, кореневища аїру, коріння алтею, коріння солодки, листя шавлії, трава чебрецю.

CONTENT

LIST OF ABBREVIATIONS

API - active pharmaceutical ingredient

BAS – biologically active substance

EPh - European Pharmacopoeia

EU - European Union;

GMP - good manufacturing practice

RB - recurrent bronchitis

RP - recurrent pneumonia

RPA - rotary pulsation apparatus

SPhU - State Pharmacopoeia of Ukraine

WHO - World Health Organization

INTRODUCTION

The relevance of the topic

Plant-based medicinal products play a significant role in contemporary pharmacotherapy. These products encompass various forms, including chemically pure substances derived from plants, synthesized analogs based on plant compounds, purified complexes of natural substances, as well as a wide range of complex preparations derived from plants such as infusions, decoctions, collections, tinctures, and extracts.

The use of plants for medicinal purposes has a long history that spans centuries. Despite the remarkable advancements in modern organic chemistry, which have enabled the production of high-quality synthetic biologically active substances utilized in the pharmaceutical industry, the global popularity of herbal preparations continues to grow rather than diminish. This is due to several factors.

One of the advantages of utilizing plant-based remedies is the inherent similarity between the biochemical structures of medicinal plants and human tissues. This similarity facilitates a smooth increase in the pharmacological effect and contributes to the gentle nature of herbal preparations. Furthermore, the incidence of negative side effects, allergic reactions, and drug dependence associated with herbal preparations is minimal or rare. Additionally, herbal medicines are known for their low toxicity profile.

The extensive clinical use of herbal medicines over many years stands as a testament to their efficacy in the treatment of various diseases. This reinforces the confidence in their therapeutic potential.

Overall, the continued popularity and utilization of plant-based medicinal preparations can be attributed to their biochemical compatibility with the human body, their gentle yet effective pharmacological effects, the limited occurrence of adverse reactions, and their proven track record of therapeutic success.

Expectorant preparations derived from plants have long been recognized for their effectiveness in alleviating respiratory conditions characterized by excessive mucus and congestion.

Respiratory disorders, such as bronchitis, cough, and common cold, are widespread and can significantly impact an individual's quality of life. The ability to promote the expulsion of mucus from the respiratory tract is crucial in providing relief and facilitating recovery. While synthetic expectorants are available, the interest in plant-based collections with expectorant properties remains strong.

The utilization of plant collections with expectorant action offers several advantages. Firstly, these preparations often exhibit a multi-component nature, comprising a blend of bioactive compounds that work synergistically to enhance their therapeutic effects. This complexity allows for a broader spectrum of activity and may target multiple underlying mechanisms of respiratory congestion.

Secondly, plant-based expectorants are generally well-tolerated, with a low incidence of adverse effects compared to their synthetic counterparts. This characteristic is particularly important when considering long-term or recurrent use in managing chronic respiratory conditions.

Moreover, the availability and affordability of plant-based expectorant preparations make them accessible to a wide range of individuals seeking relief from respiratory symptoms. This is particularly relevant in regions where access to modern pharmaceutical options may be limited or where traditional herbal remedies hold cultural significance.

In conclusion, this topic oholds relevance due to the need for effective and well-tolerated therapeutic options for respiratory conditions. The utilization of plant-based expectorant preparations offers the potential for a holistic approach to respiratory care, leveraging the synergistic effects of bioactive compounds and catering to diverse populations. Further research and development in this area can contribute to the advancement of respiratory therapeutics and enhance patient outcomes.

The purpose of the study

Study of the process of extracting of the plant collection of expectorant action.

Research tasks are

1. To make the literature review about using of the plant collection of expectorant action in technology of medicines.

2. To study the technological parameters of plant materials.

3. To study of the extracting process of the plant collection.

The object of research

Flowers of marigolds, Chamomile flowers, Rhizomes of ayru, Althea roots, Licorice roots, Sage leaves, The herb of thyme.

The subject of the study

The process of extracting of the plant collection of expectorant action.

Research methods

Methods of technological research according to the methods of the State Pharmacopoeia of Ukraine were used.

Practical significance of the obtained results

The results of the study can be used in the development of the expectorant herb medicines at the pharmaceutical plants.

Elements of scientific research

The extraction process of the plant collection of expectorant action were studied.

Structure and scope of qualification work

Qualification work consists of the following parts: introduction, literature review, choice of research methods, experimental part, general conclusions, list of used literature sources, total volume of 51 pages, contains 7 tables, 40 references.

CHAPTER 1

CURRENT STATE OF THE PROBLEM OF CREATING MEDECINES FROM HERB RAW MATERIALS FOR THE TREATMENT OF DISEASES OF THE BRONCHO-PULMONARY SYSTEM

1.1 Etiology, pathogenesis and statistics of morbidity of the broncho-pulmonary system

Up to 80% of all diseases are respiratory diseases. Most of them, of course, are banal acute respiratory infections and tonsillitis, but at the end of the 20th and beginning of the 21st centuries, doctors noted a sharp increase in such serious diseases as bronchial asthma, chronic obstructive pulmonary disease and various types of pneumonia. In many ways, this situation is connected with a decrease in the immunity of the inhabitants of the planet, especially the townspeople [1.].

This leads to increased sensitivity of the respiratory system to pathogenic factors and contributes to the development of inflammatory diseases. We should not discount the deterioration of the ecological environment, which is full of allergic factors these days. Insufficient and untimely treatment of the bronchi and lungs leads to the development of chronic diseases that require serious and long-term therapy.

In recent years, official statistical data and the results of numerous studies testify to the deterioration of the state of health and physical development of children and adolescents in Ukraine [2.]. Today, children's bodies are increasingly affected by negative environmental factors associated with man-made activities and environmental problems. A constant high load on adaptation mechanisms in childhood leads to a breakdown in adaptation and the occurrence of disease. In particular, experts note a steady increase in the number of children who often and for a long time suffer from respiratory diseases [3.]. Thus, over the past 10 years, the number of respiratory diseases among children has increased by 3.6 times [4.].

At the same time, the leading position in the structure of pulmonary pathology in children (75–250 cases per 1000 children per year) is occupied by recurrent diseases, in particular, recurrent bronchitis (RB) and recurrent pneumonia (RP), which pose a serious threat to the child's health, because with insufficient effectiveness of diagnosis and treatment, they tend to have a long and complicated course, transformation into more complex forms with subsequent disability [5.] . Despite the successes in the study of etiology, pathogenesis, treatment and prevention of recurrent bronchopulmonary pathology, in recent years a certain pathomorphosis of these diseases and a tendency to their chronicity have been observed [6.].

The most common such diseases of the respiratory system are bronchial asthma, bronchitis, which can cause complications for the lungs, pulmonary heart, and pneumonia.

Human respiratory organs and lungs in particular are affected by such diseases as actinomycosis, aspergillosis, influenza, candidiasis, acute respiratory viral infection, tuberculosis, syphilis and other infections. AIDS may develop pneumocystosis.

Parasitic diseases that affect the lungs are pulmonary acariasis, alveococcosis, ascariasis, metastrongylosis, paragonimosis, strongyloidiasis, tominxosis, tropical pulmonary eosinophilia, schistosomiasis, echinococcosis, and others [7.].

Among other pathologies, there are various malformations of the lungs (agenesis, aplasia, hypoplasia, congenital localized emphysema of the lungs, etc.), fistulas, pneumopathies, oncological diseases (lung cancer, cysts), hereditary diseases (for example, cystic fibrosis), etc. Damage to the vessels of the chest wall can cause a hemothorax, and damage to the lung tissue can cause a pneumothorax.

The development of lung diseases is facilitated by smoking, poisoning by exhaust gases, and work in hazardous production. In particular, "dusting" of the lungs leads to pneumoconiosis, anthracosis, and silicosis[8.].

Pathology of the organs of the respiratory system can relate to the function of the respiratory center, the condition of the muscular and secretory apparatus of the bronchial tree, and the alveolar system. In general clinical practice, the number of patients with respiratory diseases is 25% of all patients who seek medical help. One in ten hospitalized patients is a patient with pneumonia. Chronic obstructive pulmonary diseases (chronic obstructive bronchitis, pulmonary emphysema, and bronchial asthma) have one of the highest morbidity and mortality rates in the world, and the death rate from this pathology is growing faster than from strokes and coronary heart disease [9.].

Among the substances that affect the functions of the respiratory organs, the following groups of drugs are distinguished: 1) respiratory stimulants; 2) antitussives; 3) expectorants; 4) drugs used for bronchial asthma; 5) means used for pulmonary edema.

With a wet cough, if the sputum does not go away well, it is necessary to prescribe drugs that facilitate its release - expectorants. Substances of this group change the quality of sputum: it becomes less viscous, which contributes to its removal.

All expectorants are divided into 2 groups: 1) secretomotor; 2) bronchosecretolytic, or mucolytics [10.].

Secretomotor agents increase the physiological activity of the ciliated epithelium of the bronchi, the peristaltic movements of the bronchioles, which contributes to the movement of sputum from the lower to the upper respiratory tract and its removal. This effect is usually combined with an increase in the secretory activity of the bronchial glands and some thinning of sputum. Secretomotor preparations are divided into means of reflex and direct action. The first include preparations of thermopsis, althea and other medicinal plants, and the second include iodides and sodium bicarbonate [11.].

Mucolytic drugs are divided into: 1) proteolytic enzymes (trypsin, chymotrypsin); 2) agents that stimulate the formation of surfactant (bromhexine, ambroxol); 3) mucolytics (acetylcysteine, carbocysteine) [12.].

Medicines that have the ability to reduce the tone of the smooth muscles of the bronchi, eliminate their spasm, and restore gas exchange in the lungs are called broncholytic drugs. Therefore, they are widely used for the treatment of bronchial asthma and other diseases that are accompanied by spasm of the bronchi, for example, poisoning with anticholinesterase agents. Their long-term reception prevents the appearance of new attacks of bronchial asthma [13.].

1.2. The use of plant raw materials for the treatment of diseases of the broncho-pulmonary system

Plants have been used for medicinal purposes for centuries. Despite the significant progress of modern organic chemistry, which ensures the production of high-quality synthetic biologically active substances used in pharmacy, the popularity of herbal preparations throughout the world not only does not decrease, but also steadily increases. The advantage of the wide use of preparations from plant raw materials is based on the identity of the biochemical structures of medicinal plants with the tissues of the human body, the smoothness of the increase of the pharmacological effect, the milder effect of herbal preparations, the absence or very rare manifestation of negative side effects, allergic reactions, the practical absence of drug dependence, low toxicity. Many years of use of herbal medicines in the clinic testify to their effectiveness in the treatment [14.].

The well-known different complexes preparation collection, which includes biologically active substances of natural origin, the medicinal properties of which have long been used in traditional and folk medicine. Combinations of medicinal plant raw materials included in the collection have a complex of biologically active compounds that provide broncholytic, anti-inflammatory, analgesic, antitussive, secretolytic, secretokinetic, antispasmodic, bactericidal and fungicidal effects. The share of each plant component and the rationality of their combination is determined taking into account the mechanisms of development of bronchopulmonary diseases. The composition of the collection contains various groups of biologically active substances (flavonoids, polysaccharides, essential oils, mucus, saponins, alkaloids, terpenoids, ascorbic and other organic acids, vitamins, gums, starch, sugars, resins) [15.].

Table 1.1

The composition and therapeutic effect of the collection "Bronchofit"

Storage	Ingredients, g	Active substances	Therapeutic effect
Flowers of marigolds	1.0	lavonoids, polysaccharides, essential oils, mucus, saponins, alkaloids, terpenoids, monoterpenes, sesquiterpenes, triterpenes, ascorbic and organic acids, vitamins, gums, starch, sugars, mineral salts, resins, etc.	expectorant, antitussive, antipyretic, antimicrobial, anti-inflammatory, soothing, antispasmodic, bacteriostatic, fungicidal, stimulating mucociliary transport, promoting the loosening of inflammatory plaques, thinning sputum and accelerating its evacuation, enveloping, improving the activity of the cardiovascular system and the respiratory center
Chamomile flowers	1.0		
Rhizomes of ayru	1.0		
Althea roots	1.0		
Licorice roots	1.0		
Sage leaves	1.0		
The herb of thyme	1.0		

1.3. The current state of the technology of extraction preparations

Currently, the extraction preparations derived from medicinal plant raw materials can be categorized into three groups based on their production technology: 1) total or galenic drugs; 2) new galenic drugs obtained through maximum purification; and 3) preparations of individual substances [16.].

When producing galenic preparations such as tinctures and extracts, the extracts obtained from raw materials do not consist of chemically isolated individual substances but rather complex mixtures. These extracts contain a combination of substances that can elicit different effects compared to the isolated pure substances. Consequently, the therapeutic effects of galenic preparations are attributed to the entire complex of biologically active substances present in them, which may enhance, diminish, or alter the actions of the main constituents [17.].

Extraction processes form the foundation of producing extractive preparations. In the field of pharmacy, these processes are extensively employed for preparing medicinal products using plant raw materials. Various types of preparations, including tinctures, liquid extracts, thick and dry extracts, concentrated extracts, maximally purified or new galenic preparations, as well as extracts derived from fresh plants, rely on extraction techniques [18.].

Overall, the use of extraction processes is vital in the production of extractive preparations from medicinal plant raw materials. These preparations encompass a wide range of pharmaceutical forms and are integral in harnessing the therapeutic potential of the complex mixtures of biologically active substances present in plants [19.].

The extraction process involves the transfer of substances through mass exchange processes, driven by diffusion from a region of high concentration. This diffusion occurs between the internal structures of material particles and the extractant, continuing until equilibrium concentrations are attained. In the state of equilibrium, an equal number of molecules pass from the material to the extractant as from the extractant to the material, resulting in a constant concentration.

Typically, the concentration within the material is higher than that in the extractant.

In the context of extracting biologically active substances from medicinal plant raw materials, diffusion takes place from the internal structures of the material particles. This process exhibits certain distinctive characteristics. Firstly, the presence of a porous barrier, intercellular spaces, and cell passages reduces the rate of diffusion. Additionally, only substances whose particle sizes do not exceed the pore dimensions are capable of passing through the partition's pores [20.].

The efficiency of the extraction process is influenced by various factors, including hydrodynamic conditions, the surface area of the phases involved, concentration differences, process duration, viscosity of the extractant, and temperature. Additionally, the completeness and speed of extraction can be affected by the addition of surface-active substances, the manner in which the raw materials are loaded, the choice of extractant, the porosity and permeability of the raw materials, the leaching coefficient, the influence of vibrations and pulsations, the application of electric pulses in a liquid environment, as well as the crushing and deformation of the raw materials during extraction [21.].

The surface area of phase separation (F) between the "solid medicinal raw material" and the liquid extractant depends on the degree of grinding of the raw material and tends to increase as the particle size decreases. However, it is important to note that excessively fine grinding can result in the aggregation of raw material particles, particularly if mucous substances are present, leading to poor penetration of the extractant. When the grinding is too fine, there is a significant increase in the number of ruptured cells, resulting in the washing out of accompanying substances that contaminate the extracts, such as proteins, mucus, pectins, and other high-molecular-weight compounds. Consequently, the extracted solutions become cloudy, challenging to clarify, and exhibit poor filtration properties. Therefore, it is recommended to optimize the size of the raw material particles: leaves, flowers, and herbs should be chopped to sizes ranging from 3-5 mm, while stems, roots, and bark should be reduced to 1-3 mm. Fruits and seeds, on the other hand, should be ground to sizes of 0.3-0.5 mm [22.].

The concentration difference between the raw material (C1) and the extractant (C4) serves as the driving force for the extraction process. It is crucial to aim for a maximum concentration gradient to promote efficient extraction, which can be achieved by employing techniques such as frequent extractant replacement (remaceration instead of maceration) or implementing countercurrent processes [23.].

The duration of the extraction, or the extraction time, is an important factor to consider. According to the fundamental mass transfer equation, the quantity of substance diffusing through the boundary layer is directly proportional to the extraction time. However, the goal should be to achieve maximum extraction efficiency within the shortest possible time, taking advantage of other factors that enhance the process intensification [24.].

Prolonged extraction times can lead to the contamination of extracts with high-molecular-weight compounds that have lower diffusion rates compared to the biologically active substances. Moreover, extended extraction durations may result in undesired enzymatic processes. The total extraction time is often determined by economic considerations. It is advisable to halt the process at an appropriate moment, considering that the additional amounts of extracted substances may not justify the added costs of valuable extractants, such as alcohol or ether [25.].

Temperature plays a significant role in the extraction process, with higher temperatures generally accelerating the process. However, in phytochemical production settings, heating is primarily employed for aqueous extracts. Alcoholic and particularly etheric extractions are carried out at room temperature or below, as higher temperatures can lead to increased loss of extractants, posing potential hazards and risks during handling [26.].

While heating is suitable for extracting vegetable oils, it should be used cautiously for heat-sensitive substances, limiting the exposure to elevated temperatures to short periods. Essential oil raw materials, in particular, should avoid excessive heating as it can result in significant loss of essential oils. It's important to note that using hot water can lead to starch polymerization and substance peptization, causing the extract to become slimy and complicating subsequent processing. However, raising the temperature can be beneficial when extracting from roots, rhizomes, bark, and leathery leaves. Hot water in these cases aids in better tissue separation and cell wall rupture, thereby facilitating the diffusion process [27.].

Tinctures and extracts are well-known examples of medicinal products obtained through extraction processes. Typically, a combination of water and alcohol serves as the preferred extractant. These preparations not only contain active substances but also include accompanying substances whose contribution to the overall pharmacological activity is not yet fully understood. The specific groups of biologically active substances or their complexes responsible for the pharmacological effectiveness of combined medications are still not clearly defined [28.].

At present, there exist various extraction methods, and the selection of a particular method depends on several factors such as the physicochemical properties of the biologically active substances, the polarity of the extractant, the morphological and anatomical structure of the plant material, the desired extraction efficiency, and the composition of the target product. Organic solvents such as acetone, 95% ethyl alcohol, ethyl acetate, and oils are employed to extract low-polar compounds. Water-alcohol mixtures, acetone, and n-butanol are used for extracting glycosides, while water is suitable for polar substances. Adjusting the temperature regime, hydrodynamic conditions, and other factors can enhance the yield of biologically active substances and the extraction speed. In the case of water-alcohol mixtures, heating is avoided to prevent the loss of the extractant [29.].

The effectiveness of extraction is heavily influenced by the quality of the plant raw materials and their technological properties. The technological properties of the raw materials are described by various parameters that consider the nature of the plant material, the degree of grinding, specific density, bulk density, porosity, porosity, free volume of the layer, specific surface area, and more [30.].

The presence of extractive substances is a critical characteristic used to assess the quality of an extract derived from medicinal plant raw materials. Several improved methods have been proposed to determine this indicator, which yield results approximately 7.5% higher compared to traditional method. Additionally, the quantitative content of active substances is also analyzed in the extracts.

The extraction process of substances from plant material comprises a series of interconnected processes that occur sequentially or nearly simultaneously. The extraction process initiates when the extractant comes into contact with the raw material, leading to wetting and penetration into the inner parts and spaces between the particles, driven by capillary forces. Wetting facilitates the dissolution of substances present on the surface of disrupted tissues and cell walls. Through molecular and convective diffusion, the dissolved substances are redistributed within the liquid layers adjacent to the raw material [31.].

The movement of substances within the extraction process is driven by concentration gradients, serving as the driving force. Substances migrate in both the outer regions and the inner regions of the particles. In the latter case, solutions are formed within the pores and internal spaces, gradually releasing the substances through the cell membranes [32.].

Consequently, the extraction processes of substances from plant raw materials can be conceptually divided into two phases: a rapid phase involving the dissolution and washing of substances from the surface, and a slow phase associated with the diffusion of substances through cell walls and stagnant layers of liquid within capillaries and cavities [33.].

Conventional extraction methods, such as maceration in various combinations, rely on achieving a balance of extracted substances within the overall mass of the extractant through slow internal diffusion across cell membranes. During these processes, the vegetable raw materials are typically processed into relatively coarse particles, ranging from 3 to 10 mm. Extraction procedures are time-consuming, lasting between 24 to 200 hours. However, the degree of depletion of the plant raw materials only reaches a modest level of approximately 60% [34.].

Percolation methods involve the filtration of the extractant through a layer of raw material particles [35.]. This process encompasses the wetting of the raw materials, dissolution and washing of substances from the particle surfaces, as well as the displacement of concentrated extracts. It is well-established that the extraction efficiency is directly influenced by the specific surface area of the finely crushed raw materials. Consequently, researchers have focused on exploring the extraction process using finely divided raw materials. This method offers notable advantages, including high productivity and the potential to obtain extracts with high concentrations and purity. However, there are also drawbacks, such as the inhibition of mass transfer in the areas near the contact points of the particles and the elevated resistance to the flow of the extractant.

In recent decades, there have been numerous attempts to enhance the extraction process. Although significant progress has been made, several challenges still remain. Many methods, such as vortex extraction and extraction using rotary-pulsation apparatus, have been developed to accelerate the mass transfer process. However, these methods often result in the grinding of raw materials and the leaching of high molecular weight compounds from disrupted cells, leading to cloudy extracts with a high concentration of finely dispersed solid particles. To eliminate impurities, these extracts are typically settled for several days or subjected to purification in settling supercentrifuges. Some studies have demonstrated the positive impact of pressing on the extraction efficiency of plant raw materials and have proposed the use of centrifugal extractors. In low-volume production, existing equipment can be utilized for extraction with intensified mass transfer through the application of pulsations, vibrations, electric pulses, or ionizing radiation. Alternatively, for small batch extraction of medicinal plant raw materials, the planetary apparatus method can be employed, which utilizes rollers made of elastic material or steel with an elastic coating as a substitute for layered bodies [25.].

The utilization of a two-phase extractant system enhances the extraction efficiency of lipophilic biologically active substances by the oil phase. This approach allows for the simultaneous extraction of both lipophilic and hydrophilic BASs in a single production cycle. The mechanism behind the two-phase extraction of plant raw materials involves the solvation and desorption of BASs by the polar water-alcohol phase, followed by the transfer of lipophilic substances to the oil phase based on their distribution coefficient in the two-phase system. A proposed application of two-phase extraction is the extraction of carotenoids and ascorbic acid from rowan and rosehip fruits, which offers a simplified alternative to complex multi-stage processing methods [36.].

The grinding of plant material plays a crucial role in increasing the yield of active substances and intensifying the extraction process. However, the processing of such raw materials is often challenging due to outdated technological equipment found in extraction facilities. The development of tincture and extract production technologies still primarily focuses on diffusion processes, resulting in extraction times ranging from 1 to 7 days. During this prolonged contact between the extract and the plant material, catalytic reactions such as hydrolysis and oxidation may occur, influenced by both the raw material and the equipment materials [37.].

Continuous countercurrent extraction with the mixing of raw materials and extractant involves the movement of plant material in the direction opposite to the extractant flow, facilitated by various transport devices such as augers, buckets, disks, belts, scrapers, or spring-blade mechanisms. The extraction apparatus receives a continuous supply of fresh raw material, which moves countercurrently to the extractant. The contact occurs between the fresh raw material and the extractant that is already saturated with extractive substances, resulting in further saturation of the extractant due to the higher concentration of BAR in the raw material. The depleted raw material is then extracted using a fresh extractant, which ensures a more complete extraction of the remaining extractives. From an extraction theory perspective, this method is highly effective as there is a concentration difference between the BAR in the raw material and the extractant at every point in the process and along the length (or height) of the apparatus. This allows for a process with high yield and low costs. Additionally, continuous processes can be automated, reducing the need for manual labor in loading and unloading raw materials from percolators [38.].

Extraction can be conducted using extractors of different types, including horizontal or vertical auger, disk, spring-blade, and more. One method of extraction is the rotary pulsation apparatus (RPA), which involves the repeated circulation of raw materials and extractant within the extractor with the aid of the RPA.

During the operation of the RPA, particles undergo mechanical grinding, while the processed mixture experiences intense turbulence and pulsation. In the technological process, the RPA is positioned below the extractor's perforated bottom. The raw material is loaded onto the extractor's perforated bottom and then poured with the extractant. The liquid phase enters the RPA through the fittings, while the raw material is moved by an auger. The crushed material and extractant mixture (known as the "remote") rises from the RPA and re-enters the extractor through a stirrer fitting. This process is repeated until a concentrated extract is obtained, reaching an equilibrium concentration. Simultaneous extraction and grinding occur throughout the process. Extractants such as dichloroethane, methylene chloride, mineral oils, and vegetable oils are commonly used. The use of RPA has proven effective in the extraction of sea buckthorn oil, calendula and valerian tinctures, and tannin from sumac leaves.

Ultrasound-assisted extraction is a technique that enhances the extraction process from raw materials, resulting in a more comprehensive extraction of active substances. The extraction apparatus, such as an extractor-percolator, is equipped with an ultrasound source attached to its outer side. The generated ultrasonic waves induce alternating pressure, cavitation, and sound wind. These effects lead to accelerated material swelling, faster dissolution of cell contents, increased flow velocity around raw material particles, and the formation of turbulent and eddy currents in the diffusion layer. Molecular diffusion within the material particles and the boundary diffusion layer is largely replaced by convective transport, promoting intensified mass transfer. Cavitation also contributes to the disruption of cellular structures, facilitating the release of active substances into the extractant through washing. The application of ultrasound enables the extraction process to yield a hood in a matter of minutes. The effectiveness of ultrasound-assisted extraction depends on various process parameters, including the intensity and duration of ultrasound, the selection of extractant, the ratio of raw materials to extractant, and other factors [39.].

Drawbacks of ultrasonic treatment include potential risks to personnel involved in the process. Furthermore, ultrasonic vibrations can induce cavitation, molecule ionization, and alterations in the properties of biologically active substances, potentially diminishing or enhancing their therapeutic activity. Therefore, the application of ultrasound necessitates thorough investigation and research.

Extraction employing electrical discharges offers a means to expedite the extraction process from raw materials with cellular structures. A pulsed electroplasmolyzer is employed for this purpose [39.].

Electroplasmolysis and electrodialysis are utilized in extraction processes. Electroplasmolysis involves treating raw materials with low and high-frequency electric currents, resulting in the plasmolysis of protoplasm. The method essentially involves the disruptive impact of the current on protein-lipid membranes in plant tissues while preserving the integrity of cell membranes. Electroplasmolysis yields optimal results when preparing preparations from fresh plant and animal-derived raw materials. Consequently, the obtained extracts exhibit heightened levels of active substances while containing only minimal quantities of accompanying substances.

Electrodialysis is employed to expedite the extraction of plant and animal-derived raw materials. The primary driving force behind this process is the disparity in concentrations of extractable substances on either side of a semipermeable partition, which, in the case of raw materials with a cellular structure, is represented by cell membranes. When an electric current is applied, the surface electric potentials of the raw material undergo alterations, leading to improved wetting properties and accelerated movement of ions containing biologically active substances within cell cavities and capillaries of cellular structures. Consequently, the internal diffusion coefficient is enhanced.

CONCLUSION

1. Extensive prevalence of respiratory diseases has been identified through the analysis of existing literature. Among the most commonly encountered respiratory conditions are bronchial asthma and bronchitis.

2. Medicinal products derived from plants are recommended for the treatment of such pathologies.

3. The comprehensive formulation called "Bronchofit" comprises naturally occurring biologically active substances. This preparation encompasses a diverse range of biologically active compounds that deliver bronchodilatory, anti-inflammatory, analgesic, antitussive, expectorant, mucus-moving, antispasmodic, bactericidal, and fungicidal effects.

CHAPTER 2
OBJECTS AND RESEARCH METHODS

2.1 Choice of general research methodology

Investigation into the Extraction Process of a Plant Collection with Expectorant Properties.

Objective:

The objective of this study is to analyze the process of extracting a plant collection known for its expectorant properties. The aim is to understand the extraction efficiency and identify the optimal conditions for obtaining the maximum amount of biologically active compounds with expectorant activity.

The stages of experiments may be as follows.

Selection of Plant Collection: A suitable plant collection with documented expectorant properties is chosen for the study. This may include a combination of medicinal herbs or specific plant parts known for their expectorant effects.

Raw Material Preparation: The selected plant collection is collected, properly identified, and prepared for extraction. This may involve drying, grinding, and sieving to ensure uniformity and increased surface area for extraction.

Choice of Extractant: Various extractants are considered based on their polarity and ability to selectively extract expectorant compounds. Common extractants include water, ethanol, methanol, or their combinations. The choice of extractant is determined by the nature of the target compounds and their solubility characteristics.

Extraction Methods: Different extraction techniques are evaluated to determine the most efficient method for extracting the expectorant compounds. This may include maceration, percolation, ultrasound-assisted extraction, or other advanced extraction methods. Factors such as extraction time, temperature, solvent-to-material ratio, and agitation are optimized to enhance extraction efficiency.

Analysis of Extract: The obtained extract is subjected to qualitative and quantitative analysis to determine the presence and concentration of expectorant compounds. Analytical techniques such as high-performance liquid chromatography (HPLC), gas chromatography-mass spectrometry (GC-MS), or spectrophotometric methods are employed.

Evaluation of Expectorant Activity: The extracted plant collection is evaluated for its expectorant activity using in vitro or in vivo models. This may involve measuring parameters such as mucus secretion, ciliary beat frequency, cough reflex, or other relevant markers of expectoration.

Optimization and Further Studies: Based on the results obtained, the extraction process can be optimized further to enhance yield and expectorant activity. Additional studies, such as stability testing, toxicity evaluation, or formulation development, may be conducted to facilitate the potential use of the extract in pharmaceutical or herbal medicine applications.

The study of the extraction process for a plant collection with expectorant action involves careful selection of plant materials, choice of suitable extractants, optimization of extraction parameters, and evaluation of expectorant activity. The findings from this investigation can contribute to the development of effective herbal formulations for respiratory conditions, providing natural alternatives for expectorant therapy.

The purpose of the study

Study of the process of extracting of the plant collection of expectorant action.

Research tasks are

1. To make the literature review about using of the plant collection of expectorant action in technology of medicines.

2. To study the technological parameters of plant materials.

3. To study of the extracting process of the plant collection.

2.2. Objects of research

The main object of research in research are Flowers of marigolds, Chamomile flowers, Rhizomes of ayru, Althea roots, Licorice roots, Sage leaves, The herb of thyme.

Flowers of marigolds

Marigold flowers, scientifically known as Calendula officinalis, are vibrant and beautiful flowers that belong to the Asteraceae family. They are native to Mediterranean regions but are cultivated worldwide for their medicinal and ornamental purposes. Marigold flowers have been used in traditional medicine for centuries and continue to be valued for their various pharmacological properties.

In pharmacy, marigold flowers are primarily used for their anti-inflammatory, antiseptic, and wound healing properties. The flowers contain a diverse range of active compounds, including flavonoids, triterpenoids, carotenoids, polysaccharides, and essential oils, which contribute to their medicinal benefits.

One of the key uses of marigold flowers in pharmacy is in the preparation of topical ointments, creams, and gels. These formulations are commonly used for treating skin conditions such as cuts, burns, wounds, insect bites, and eczema. The anti-inflammatory and wound healing properties of marigold flowers help reduce inflammation, promote tissue regeneration, and provide relief from pain and itching.

Marigold flowers are also utilized in the production of herbal teas and tinctures. These preparations are known for their potential benefits in supporting gastrointestinal health, alleviating digestive issues, and reducing inflammation in the digestive tract. The flowers' antispasmodic properties may help relieve muscle cramps and spasms in the gastrointestinal system.

Furthermore, marigold flowers have been investigated for their antimicrobial properties. They may exhibit antibacterial and antifungal activities against various pathogens, making them valuable in the treatment of skin infections and preventing microbial growth.

Apart from their medicinal uses, marigold flowers are often included in cosmetic products due to their soothing and rejuvenating effects on the skin. They are found in creams, lotions, and skincare formulations aimed at promoting healthy and radiant skin.

It is important to note that while marigold flowers are generally considered safe for topical and oral use, individuals with known allergies to Asteraceae family plants should exercise caution. As with any herbal remedy, it is recommended to consult with a healthcare professional or pharmacist before using marigold flowers for medicinal purposes, especially if you are taking any medications or have pre-existing medical conditions.

Overall, marigold flowers possess a wide range of pharmacological properties and have a long history of use in pharmacy. Their versatility and effectiveness make them a valuable natural resource for various therapeutic applications.

Chamomile flowers

Chamomile flowers, known scientifically as Matricaria chamomilla or Chamaemelum nobile, are small daisy-like flowers that belong to the Asteraceae family. They have a rich history of medicinal use dating back thousands of years and are renowned for their calming and soothing properties.

Chamomile flowers are native to Europe and western Asia but are now cultivated globally for their medicinal and aromatic qualities. They contain a variety of beneficial compounds, including volatile oils (such as bisabolol and chamazulene), flavonoids, and coumarins, which contribute to their pharmacological effects.

In pharmacy, chamomile flowers are widely used for their anti-inflammatory, sedative, antispasmodic, and digestive properties. One of the most common applications of chamomile flowers is in the form of herbal tea or infusion.

Chamomile tea is known for its calming effects, making it a popular choice for promoting relaxation, relieving anxiety, and improving sleep quality. It is often recommended as a natural remedy for mild insomnia or restlessness.

Chamomile flowers are also utilized in topical preparations such as creams, ointments, and essential oils. Due to their anti-inflammatory and soothing properties, these formulations are used to treat skin irritations, sunburns, rashes, and minor wounds. Chamomile-infused products are known to have a gentle and calming effect on the skin.

In addition, chamomile flowers are commonly used in the field of traditional medicine for their digestive benefits. Chamomile preparations can help alleviate gastrointestinal discomfort, including indigestion, bloating, and abdominal cramps. They are also believed to have mild antispasmodic properties that can help relax the smooth muscles of the digestive tract.

Furthermore, chamomile flowers have been investigated for their potential antimicrobial activity against certain pathogens. Although further research is needed, chamomile extracts have shown promising results in inhibiting the growth of bacteria and fungi, suggesting their potential use as a natural antimicrobial agent.

It's important to note that chamomile is generally considered safe for most individuals when used in moderation. However, individuals with allergies to plants in the Asteraceae family, such as ragweed or daisies, may be more prone to chamomile allergies. As with any herbal remedy, it is advisable to consult with a healthcare professional or pharmacist before using chamomile flowers for medicinal purposes, particularly if you have any underlying health conditions or are taking medications.

In summary, chamomile flowers have a long-standing reputation in pharmacy for their calming, anti-inflammatory, and digestive properties. They are valued for their versatility and gentle nature, making them a popular choice for various therapeutic applications. Whether consumed as a tea or used topically, chamomile flowers continue to be cherished for their beneficial effects on both physical and mental well-being.

Rhizomes of *Acorus calamus*

The rhizomes of Acorus calamus, commonly known as sweet flag or calamus, are an important medicinal plant widely used in traditional medicine systems. Acorus calamus is a perennial herbaceous plant native to Europe, Asia, and North America, and its rhizomes have been utilized for centuries due to their various pharmacological properties.

The rhizomes of Acorus calamus are horizontal underground stems that give rise to roots and shoots. They have a characteristic aromatic fragrance and contain numerous bioactive compounds, including essential oils, alkaloids, flavonoids, and phenolic compounds. The main active constituents responsible for the medicinal effects are found in the essential oil fraction.

In pharmacy, the rhizomes of Acorus calamus are primarily valued for their stimulating, carminative, and digestive properties. They have a long history of use in treating gastrointestinal disorders, including indigestion, flatulence, and loss of appetite. The essential oil present in the rhizomes is believed to enhance digestion by stimulating the secretion of digestive enzymes and improving the absorption of nutrients.

Acorus calamus rhizomes are also known for their calming and sedative effects on the nervous system. They have been used to alleviate anxiety, nervousness, and mental fatigue. The aromatic properties of the essential oil contribute to its relaxing and soothing effects, making it a popular choice in aromatherapy and herbal preparations for promoting relaxation and relieving stress-related symptoms.

Furthermore, the rhizomes of Acorus calamus have been traditionally employed for their antimicrobial properties. The essential oil derived from the rhizomes exhibits significant antimicrobial activity against a range of bacteria, fungi, and even some viruses. This antimicrobial potential has led to the use of

Acorus calamus in herbal preparations for various infectious conditions, although further research is needed to fully understand its efficacy and safety.

Additionally, Acorus calamus rhizomes have been explored for their potential anti-inflammatory and analgesic effects. They are sometimes used topically in the form of creams, oils, or poultices to relieve localized pain, inflammation, and swelling. However, it's important to note that direct application of the essential oil to the skin may cause irritation in some individuals, so caution should be exercised when using it topically.

It's worth mentioning that Acorus calamus contains certain toxic compounds, particularly β-asarone, which is considered to be potentially carcinogenic. As a result, the use of Acorus calamus and its essential oil in commercial products and medicinal preparations may be regulated or restricted in some countries. It is essential to consult with a healthcare professional or a qualified herbalist before using Acorus calamus or any herbal remedy.

In summary, the rhizomes of Acorus calamus possess diverse pharmacological properties, including digestive, sedative, antimicrobial, and anti-inflammatory effects. They have a long history of traditional use and continue to be utilized in various forms for their potential therapeutic benefits. However, due to the presence of certain toxic compounds, it is important to exercise caution and seek professional advice when using Acorus calamus for medicinal purposes.

Althea roots

Althea roots, also known as marshmallow roots, are the underground parts of the Althaea officinalis plant, a perennial herb native to Europe, Western Asia, and Northern Africa. These roots have been utilized for centuries in traditional medicine due to their mucilaginous properties and therapeutic benefits.

The roots of Althea officinalis are long, tapered, and brownish in color. They contain high amounts of mucilage, a gelatinous substance that swells in water and forms a soothing and protective coating when ingested or applied topically.

The mucilage is the primary bioactive component responsible for the medicinal properties of Althea roots.

In pharmacy, Althea roots are valued for their demulcent and emollient properties. The mucilage present in the roots has a soothing effect on inflamed or irritated mucous membranes, making it particularly beneficial for respiratory and gastrointestinal conditions. When ingested, preparations made from Althea roots can provide relief from sore throat, coughs, and gastrointestinal issues such as gastritis, ulcers, and irritable bowel syndrome.

Furthermore, the mucilage in Althea roots has mild expectorant properties, which means it helps to promote the expulsion of mucus from the respiratory tract. This makes Althea root preparations useful in relieving respiratory congestion, coughs, and bronchitis. The demulcent properties of Althea roots also make them valuable in soothing dry and irritated respiratory passages.

Althea roots are often prepared as infusions, decoctions, or syrups for internal use. These preparations can be consumed orally or used as a gargle for throat-related issues. Externally, Althea root extracts can be found in ointments, creams, and poultices, providing a soothing effect on skin irritations, burns, and minor wounds.

In addition to their mucilaginous properties, Althea roots also contain other bioactive compounds such as flavonoids, phenolic acids, and polysaccharides, which contribute to their antioxidant and anti-inflammatory effects. These compounds may have a protective effect on the body's cells and tissues, helping to reduce inflammation and oxidative stress.

It is important to note that while Althea roots are generally safe for most individuals, they may cause allergic reactions in some people. It is recommended to consult with a healthcare professional or a qualified herbalist before using Althea roots or any herbal remedy, especially if you have any underlying health conditions or are taking medications.

In summary, Althea roots possess demulcent, expectorant, and emollient properties due to their high mucilage content. They are commonly used in traditional medicine to soothe respiratory and gastrointestinal issues. Althea root preparations can provide relief from sore throat, coughs, bronchitis, and gastrointestinal discomfort. Additionally, they have mild antioxidant and anti-inflammatory effects. As with any herbal remedy, it is advisable to seek professional advice before using Althea roots for medicinal purposes.

Licorice roots

Licorice roots, derived from the Glycyrrhiza glabra plant, have been used for centuries in traditional medicine due to their numerous therapeutic properties. Licorice roots are native to Europe and Asia and are highly valued for their distinct flavor and medicinal benefits.

Licorice roots have a characteristic appearance, featuring long, woody, and fibrous brown roots that can extend several feet into the ground. The primary bioactive component responsible for the medicinal properties of licorice roots is glycyrrhizin, a compound that imparts the sweet taste to licorice and possesses several pharmacological activities.

In pharmacy, licorice roots are widely recognized for their expectorant, demulcent, anti-inflammatory, and anti-ulcer properties. Licorice root preparations are commonly used to alleviate respiratory conditions such as coughs, bronchitis, and sore throat. The expectorant properties help to loosen and expel mucus from the respiratory tract, promoting relief from congestion and facilitating easier breathing.

The demulcent properties of licorice roots make them beneficial for soothing and protecting irritated mucous membranes. Licorice root preparations can help alleviate discomfort and inflammation in the digestive system, including conditions like gastritis, ulcers, and acid reflux. Licorice roots are often used in herbal formulations for gastrointestinal support and to relieve symptoms associated with digestive disorders.

Another notable property of licorice roots is their ability to modulate the immune system. Licorice root extracts have shown immunomodulatory effects, enhancing the activity of certain immune cells and supporting overall immune function. This makes licorice roots valuable in formulations aimed at boosting the immune system.

Licorice roots also contain compounds with anti-inflammatory properties, including flavonoids and saponins. These compounds can help reduce inflammation in the body and provide relief from conditions such as arthritis, skin irritations, and inflammatory bowel disease.

In addition to its medicinal uses, licorice roots are commonly utilized as a flavoring agent in the food and beverage industry, particularly in confectionery products and herbal teas. The natural sweetness of licorice makes it a popular choice for adding flavor to various preparations.

It is important to note that licorice roots should be used with caution, as excessive consumption or prolonged use can lead to potential side effects. Licorice roots contain glycyrrhizin, which, when consumed in large amounts, can cause an increase in blood pressure, fluid retention, and electrolyte imbalances. Individuals with high blood pressure, heart conditions, or kidney disorders should exercise caution and consult with a healthcare professional before using licorice root preparations.

In summary, licorice roots are highly valued in pharmacy and traditional medicine for their expectorant, demulcent, anti-inflammatory, and immune-modulating properties. They are commonly used to alleviate respiratory conditions, soothe digestive discomfort, and support immune function. Licorice roots are also used as a flavoring agent in food and beverages. However, it is important to use licorice roots responsibly and seek guidance from healthcare professionals, particularly for individuals with specific health conditions or those taking medications.

Sage leaves

Sage (Salvia officinalis) is an aromatic herb with distinctive gray-green leaves that are widely used in both culinary and medicinal applications. It is native to the Mediterranean region and has been cultivated for centuries for its therapeutic properties. Sage leaves have a rich history of use in traditional medicine and are highly regarded for their various pharmacological benefits.

The leaves of the sage plant are characterized by their elongated shape, velvety texture, and silver-green color. They are known for their strong, pleasant aroma and have a slightly bitter and astringent taste. The medicinal properties of sage leaves are attributed to their rich content of essential oils, flavonoids, phenolic acids, and other bioactive compounds.

In pharmacy, sage leaves are valued for their antimicrobial, anti-inflammatory, antioxidant, and astringent properties. They are commonly used in herbal preparations to address a range of health conditions. One of the notable traditional uses of sage leaves is in the treatment of oral and throat infections. Sage mouthwash or gargles are often recommended to alleviate sore throat, mouth ulcers, and gum inflammation. The antimicrobial properties of sage help combat bacteria, fungi, and viruses, making it a valuable herbal remedy for oral health.

Sage leaves are also known for their ability to support digestive health. The essential oils present in sage leaves can stimulate digestion, relieve bloating, and reduce gastrointestinal discomfort. Sage tea or extracts are used to aid digestion and soothe digestive upsets, including indigestion, flatulence, and abdominal cramps.

In addition, sage leaves possess notable anti-inflammatory properties. They can be applied topically or used in herbal formulations to reduce inflammation associated with skin conditions like dermatitis, eczema, and minor wounds. Sage's astringent properties make it useful for toning and tightening the skin, as well as controlling excess oil production.

Furthermore, sage leaves have been investigated for their potential cognitive benefits. Some studies suggest that sage extracts may improve memory and cognitive function, particularly in age-related cognitive decline or mild cognitive impairment. The exact mechanisms behind these effects are still being researched, but it is believed that sage's antioxidant and neuroprotective properties play a role in supporting brain health.

Sage leaves are commonly prepared as infusions, extracts, or essential oils for medicinal use. They can be used alone or in combination with other herbs to enhance their therapeutic effects. It is important to note that while sage leaves are generally safe for most individuals when used in moderate amounts, prolonged or excessive use should be avoided, as it may lead to potential side effects.

In summary, sage leaves are highly regarded in pharmacy for their antimicrobial, anti-inflammatory, antioxidant, and astringent properties. They are commonly used to address oral and throat infections, support digestive health, soothe skin conditions, and potentially enhance cognitive function. Sage leaves can be prepared as infusions, extracts, or essential oils, but it is essential to use them responsibly and seek guidance from healthcare professionals, particularly for individuals with specific health conditions or those taking medications.

The herb of thyme.

Thyme (Thymus vulgaris) is an aromatic herb that belongs to the mint family. It is native to the Mediterranean region but is now cultivated and widely used around the world for culinary and medicinal purposes. The herb of thyme is known for its strong fragrance, small leaves, and woody stems.

In pharmacy, thyme is highly valued for its medicinal properties. The herb contains various bioactive compounds, including essential oils, phenols, flavonoids, and tannins, which contribute to its therapeutic effects. Thyme has been used in traditional medicine for centuries and continues to be a popular herb in modern pharmacology.

One of the primary uses of thyme in pharmacy is as an expectorant and bronchial antispasmodic. It is known for its ability to help alleviate respiratory conditions such as coughs, bronchitis, and congestion. Thyme's essential oils, particularly thymol, exhibit antimicrobial properties that can help fight respiratory infections and promote the clearance of mucus from the airways. Thyme is often used in herbal cough syrups, teas, and steam inhalations to provide relief and support respiratory health.

Thyme also possesses antibacterial and antiseptic properties, making it useful for topical applications. It can be used as a natural disinfectant for minor wounds, cuts, and skin infections. Thyme essential oil, when diluted properly, can be applied topically to help prevent infection and promote wound healing.

Furthermore, thyme is recognized for its antioxidant and anti-inflammatory effects. The antioxidants in thyme help neutralize harmful free radicals in the body, reducing oxidative stress and protecting against cellular damage. Thyme's anti-inflammatory properties may be beneficial in conditions like arthritis, inflammation of the gastrointestinal tract, and certain skin conditions.

Thyme has also been studied for its potential antimicrobial activity against various strains of bacteria and fungi. It has shown promising results in inhibiting the growth of certain pathogens, making it useful in the development of natural antimicrobial agents.

In addition to its medicinal uses, thyme is widely used as a culinary herb due to its aromatic and savory flavor. It is a common ingredient in Mediterranean cuisine and is often used to season meat, fish, soups, and stews. Thyme leaves can be used fresh or dried, and the essential oil of thyme is sometimes used as a flavoring agent in food products.

Thyme is available in various forms for pharmaceutical use, including dried leaves, essential oil, and liquid extracts. It can be used alone or in combination with other herbs to enhance its therapeutic effects. However, it is important to note that thyme may interact with certain medications and may not be suitable for everyone. It is advisable to consult with a healthcare professional before using thyme or thyme-based products, especially for individuals with specific health conditions or those taking medications.

In summary, thyme is a versatile herb with notable medicinal properties. It is commonly used as an expectorant, antiseptic, antioxidant, and anti-inflammatory agent. Thyme is particularly valued for its respiratory benefits, helping to relieve coughs and congestion. It also possesses antimicrobial properties and can be used topically for wound care. As with any herbal remedy, it is important to use thyme responsibly and seek guidance from healthcare professionals when needed.

2.3 Research methods

The following technological properties were studied according to the methods of SPhU.

Determination of specific density.

Specific density (dp) is the ratio of the mass of completely dry crushed raw materials to the volume of plant raw materials.

Determination of bulk density

Bulk density (do) is defined as the ratio of the mass of crushed raw materials at natural or specified humidity to its full volume, which contains pores, cracks and capillaries filled with air.

Determination of bulk density.

Bulk density (dn) is defined as the ratio of the mass of crushed raw materials at natural or specified humidity to the total volume occupied by the raw materials together with the pores of the particles and the free volume between them.

Determination of porosity

The porosity of the raw material determines the amount of voids inside the raw material particles and is defined as the ratio of the difference between the specific and bulk density to the specific density.

Determination of porosity

The porosity of the layer characterizes the amount of voids between the particles of plant material, defined as the ratio of the difference between bulk and bulk density to bulk density.

Determination of the free volume of the layer

The free volume of the layer characterizes the relative volume of free space in a unit of the raw material layer (voids inside the particles and between them). It is calculated as the ratio of the difference between the specific and bulk density to the specific density.

Determination of the absorption coefficient of the extractant

The absorption coefficient of the extractant characterizes the amount of solvent that fills the intercellular pores, vacuoles, air cavities in the raw material and is not removed from the meal. The absorption coefficient was calculated based on the difference between the volume of the extractant, which was filled with a known amount of raw material, and the volume obtained after draining and squeezing the meal.

Determination of humidity

Humidity was determined using a Sartorius MA-150 express hygrometer.

CHAPTER 3
DEVELOPMENT TECHNOLOGY OF EXTRACTION OF PLANT COLLECTION AND THEIR RESEARCH

3.1. Study of technological parameters of plant collection

Medicinal plant raw materials contain various chemical compounds that are part of cells. Depending on their presence of pharmacological activity, they are conditionally divided into active and concomitant. Extraction allows you to extract active substances from medicinal plant raw materials and introduce them into the composition of a convenient for use medicinal form. Currently, there are various methods of extraction, the effectiveness of which largely depends on the quality of the plant material and its technological properties. An important characteristic of extraction efficiency is the content of extractive substances, the qualitative and quantitative composition of biologically active substances, which determine the choice of extractant. Preference should be given to the method, which has a shorter duration in time and allows to achieve the maximum depletion of raw materials.

Collections (Species) are mixtures of chopped or coarsely crushed plant medicinal raw materials (except for plants containing potent substances), to which salts, essential oils or other substances are sometimes added. Translated from Latin, the word "collection" means "genus", "species" (a specific species or a mixture of different types of medicinal plants).

Raw materials, which are part of the collection, are crushed individually, depending on the structure and type. Leaves, grass, bark, roots and rhizomes are cut with grass and root cutters. The roots and rhizomes are then crushed in roller or other mills. Fruits, seeds and leathery leaves (mothberry, lingonberry or eucalyptus) are ground using different mills. Flowers, with the exception of linden blossom, mullein and pharmacy chamomile, are used whole.

The degree of crushing of plant material is determined by the purpose of collection. Collections for the preparation of infusions and decoctions (Species ad infusum et decoctum), intended for internal administration (tea), rinses and lotions should have the following particle sizes: leaves and herbs - 4-6 mm, stems, bark and roots - 3 mm, fruits and seeds - 0.5 mm; smoking fees (Species fumales) - 3 mm; fees for baths (Species pro balneo) - 2 mm.

Meetings have retained their importance until now due to their inherent advantages:

- the presence of active substances in raw materials in their natural form,
- ease of manufacture,
- cheapness

The disadvantages are:

- incompleteness of the dosage form (the patient must prepare tea, gargle, etc.)
- dosing inaccuracy (the patient often doses the collection himself).

Since the collections have such a drawback as dosage inaccuracy, we decided to investigate the variation of the dosage when preparing the collection.

For this purpose, we offered volunteers to collect one tablespoon of the collection from one pack of Bronchofit. Then the contents of the spoon were poured into a glass and weighed. Thus, the discrepancy in dosage was determined.

The results of determining the distribution of the masses that the volunteers considered as corresponding to "one tablespoon of the collection" are shown in table . 3.1.

The data of table 3.1 indicate that when preparing the collection at home, the mass of "one tablespoon" can vary from 2.90 g to 6.08 g. That is, different consumers can use the collection in a dosage that is more than 2 times different from one to another.

These data confirm the imperfection of the collection for the accuracy of the dosage given above.

Table 3.1

Distribution of the masses that the volunteers considered to correspond to one dose

Sample	1	2	3	4	5	6	7	8
Weight, g	2.90	3.05	3.69	3.78	4.42	4.99	5.03	6.08

Therefore, the development of the technology of an expectorant substance from the plant collection is relevant. This will make it possible to include it in the composition of dosed dosage forms, such as tablets, capsules.

For this purpose, it is necessary to conduct the following studies:

1. Determine the technological parameters of collection:
   - bulk density and density after shrinkage;
   - bulk and specific density;
   - porosity, porosity and free volume of the layer;
   - fluidity, angle of natural slope;
   - moisture content;
   - content of extractive substances;
   - absorption coefficient of the extractant;
   - fractional composition.
2. Investigate the extraction process, which is carried out in the conditions, as specified in the instructions for the collection.
3. To study the process of extraction of plant collection, which can be carried out in the conditions of a pharmaceutical enterprise.
4. Obtain the substance from the collection in the form of a soft extract.

The bulk density after shrinkage shows the extent to which the raw material can be shaken depending on its volume during free filling. In static conditions, air space is preserved between the particles of bulk raw materials. The technological process is accompanied by dynamic effects, which are manifested in the form of shaking, vibrations and contribute to a more compact arrangement of particles with a decrease in the air space between them. Therefore, it was necessary to study how substances undergo shrinkage under these conditions.

The moisture content significantly affects the physical and chemical stability, the characteristics of the dispersed structure, the technological behavior of the powder and the final quality of the dosage form. The study of hygroscopicity acquires special importance in the development of the technology of medicinal forms from plant raw materials, since substances of plant origin can absorb moisture, undergo microbial spoilage, and active substances are destroyed at high humidity.

Results of determination of bulk density and density after shrinkage; volume and specific density; porosity, porosity and free volume of the layer; fluidity, angle of natural slope; moisture content; the content of extractive substances; absorption coefficient of the extractant are given in table 3.2.

Table 3.1

Results of determination of technological parameters

1. Specific density, dp, g/ml	1.32±0.11
2. Bulk density, do, g/ml	0.54±0.05
3. Bulk density, dn, g/ml	
- to shrinkage	0.31±0.02
- after shrinkage	0.41±0.02
4. Porosity of raw materials, Ps	0.41
5. Layer porosity, Psh	0.42
6. Free volume, V	0.65
7. Fluidity, g/s	absent
8. Slope angle, degrees.	56.66±2.48
9. Humidity, %	7.22±0.23
10. Absorption coefficient, ml/g	3.05±0.18
11. Content of extractive substances, %	33.17±0.93

Note: n=5, P=95%

It can be seen from the data in the table that the bulk density of plants is very small. At the same time, it changes from 0.31±0.02 g/ml before shrinkage to 0.41±0.02 g/ml after shrinkage. Such a change in bulk density may be the reason for a change in the mass of the dose during volumetric dosing of the collection at home.

Specific, volumetric and bulk masses allowdetermineporosity, porosity and free volume of the layer, which makes it possible to determine the required ratio of raw materials and extractant. The higher the porosity of the raw material, the more internal juice is formed during swelling. The rate of wetting and swelling of the material depends on the amount of porosity and porosity. The rate of swelling increases with primary vacuuming of raw materials, as well as with increasing pressure and temperature. The higher the porosity and porosity, the higher the absorption property of the raw material.

The fluidity of the raw material is infinite (∞), that is, the sample is not loose, does not pour out of the funnel. Medicinal plant raw materials have a small flowability, which is confirmed by the fluidity, as well as the values of the bevel angle, it is relatively large. The fluidity and the angle of the natural slope characterize the mobility of raw materials and become necessary in the case of choosing devices for loading, unloading in extraction devices and transport devices.

When the humidity increases, the raw material will lose its properties and will deteriorate. Therefore, medicinal plant raw materials should be stored in a dry, well-ventilated room at the optimal temperature and air humidity - 30-40%. The moisture content of the raw material is 7.22±0.23% and is within acceptable limits.

As an extractant, we used purified water, which is one of the most acceptable extractants, which has a number of advantages, namely: it penetrates well through cell membranes impermeable to hydrophobic substances; dissolves and extracts substances better than other liquids; pharmacologically indifferent; very widespread; non-flammable and explosion-proof; affordable.

However, as an extractant, it has a number of negative aspects, for example: it does not dissolve and does not extract hydrophobic substances; does not have antiseptic properties, as a result of which microorganisms can develop in water hoods; due to water, hydrolytic splitting of many substances occurs, especially at high temperature; in an aqueous environment, enzymes can break down medicinal substances.

In addition, according to the instructions for the medical use of the "Bronchofit" collection, it is indicated that water must be used to prepare the extract. The content of extractive substances of 33.17±0.93% was used in the development of extraction methods in order to compare the efficiency of different methods of extracting extractive substances from the collection.

Determination of the fractional composition of the collection was carried out using sieves with the following hole sizes: 1; 2; 3; 4; 5 mm. The average weight of the collection weighing 50.0 g was placed on the upper sieve from the set. Cover with a lid and shake for 5 minutes. Each fraction was weighed and the particle size distribution of the collection was determined. The results of determining the fractional composition are shown in table 3.3.

Table 3.3

Fractional composition of the collection

Size of particles	Less 1 mm	1-2 mm	2-3 mm	3-4 mm	4-5 mm	More 5 mm
%	36.72	31.72	12.20	7.18	8.30	3.82

According to table 3.23 the largest amount consists of fractions with a particle size of less than 1 mm and a fraction with a particle size of 1-2 mm. These two factions make up a total of 68.44%. The size of the particles significantly affects the yield of extractive substances from medicinal plant raw materials in the extraction process. The smaller the size of the particles, the larger the phase contact area, which significantly speeds up the extraction process. Therefore, the presence of a significant part of the fraction with a particle size of less than 2 mm in the herbal collection should contribute to the rapid release of active substances.

3.2. Development of expectorant substance technology

The next stage of the research is to determine the efficiency of the extraction of plant raw materials in the conditions of obtaining the extract, as indicated in the instructions for the medical use of the collection.

Method of application and dosage.

Boil 2 tablespoons of the mixture in 500 ml of boiling water, insist in a closed container for 1 hour, strain. For adults and children after 7 years, take 2/3 cup (150 ml) 20-30 minutes before meals 3 times a day.

Previous studies have established that the average content of one tablespoon is equal to 5 g. Therefore, in order to be able to calculate the extraction efficiency, instead of dosing by volume (2 tablespoons), dosing by mass was used.

Calculation of the degree of depletion of medicinal plant raw materials by extractive substances will allow comparing different methods of extraction and determining their effectiveness.

Based on the results of determining the content of extractive substances in the extract, the degree of depletion of medicinal plant raw materials by extractive substances was calculated, which was 68.42±0.58%.

Our proposed scheme for obtaining an expectorant substance from the Bronchophyte plant collection includes the following stages of research:

- substantiation of the degree of grinding of raw materials;
- substantiation of the raw material-extractant ratio;
- justification of the type of extractant;
- selection of extraction method and conditions;
- obtaining a liquid extract according to the chosen method;
- evaporation of a liquid extract and obtaining a substance - a thick extract of a plant collection of expectorant action from the collection.

As shown by the results of the study of the fractional composition of the initial collection, shown in table 3.3, fractions with a particle size of crushed raw materials less than 1 mm and 1-2 mm are preferred.

In order to substantiate the degree of grinding of raw materials, a comparative study was conducted on extraction. For this purpose, the original, additionally unpulverized collection and the collection, crushed with a particle size of less than 2 mm, were used for extraction.

To do this, the entire contents of one bag were sifted through a sieve with a hole size of 2 mm. Millet was collected. The screening was ground on a laboratory grinder and sieved again. These operations were repeated until the entire contents of the package passed through the sieve. All screenings were combined and thoroughly mixed in a mortar to achieve homogeneity. In this way, a fraction of the collection with a particle size of less than 2 mm was obtained, which in terms of quantitative composition fully corresponds to the original collection.

Samples were taken from the initial collection and crushed collection (less than 2 mm) for further research. Extraction was carried out with purified water, as recommended in the instructions for use of the collection.

Samples were extracted under the following conditions. A sample weight of 20 g was mixed into a glass measuring cup with a volume of 200 ml. Thus, the raw material-extractant ratio is 1:10. The raw material was poured with purified water at a temperature of 90°C. The glass with the contents was weighed. It was covered with a lid and mixed in a water bath with a temperature of 90°C. The samples were kept in a water bath for 1, 2 and 3 hours. After the appropriate time, the beaker was removed from the bath, the outer surface was dried with filter paper. The mass of the beaker with the contents without a lid was adjusted to the initial mass with purified water at a temperature of 90°C. The contents were mixed and filtered through 4 layers of cheesecloth. The meal was squeezed, the squeezed extract was filtered through 4 layers of gauze and combined with the first. The volume of the finished product was determined, The content of extractive substances in the extract in terms of completely dry plant materialin percent (X) was determined. The degree of depletion of raw materials by extractive substances was calculated.

The results of determining the exhaustion of the initial collection by extractive substances are shown in table 3.4.

Table 3.4

Depletion of the initial collection for extractive substances

Time of extraction, hours	1	2	3
The degree of depletion, %	67.64	69.28	69.42

According to table 3.4, the degree of exhaustion after 1 hour of infusion almost does not change.

The results of determining the depletion of the crushed collection by extractive substances are shown in table 3.5.

Table 3.5

Depletion of the crushed collection for extractive substances

Time of extraction, hours	1	2	3
The degree of depletion, %	74.66	79.55	79.27

According to table 3.5 the degree of depletion of the crushed collection by extractive substances in 1 hour is 74.66±0.88%, which is 7.02% more than when using the original collection. During 2 hours of extraction, this parameter increases to 79.55±1.02%, another hour of infusion almost does not change it.

Thus, it was established that the use of grinding raw materials leads to an increase in the output of extractive substances from the Bronchofit collection. Therefore, the fraction with a particle size of less than 2 mm was further used. The degree of depletion of plant raw materials at a raw material-extractant ratio of 1:10, which is 74.66±0.88%, is quite large, so we consider it irrational to increase the raw material-extractant ratio.

Further research is aimed at determining the influence of the extraction frequency on the process of release of extractive substances from plant raw materials.

Samples were extracted under the following conditions. A sample weight of 20 g was mixed into a glass measuring cup with a volume of 200 ml. Thus, the raw material-extractant ratio is 1:10. The raw material was poured with purified water at a temperature of 90°C. The glass with the contents was weighed. It was covered with a lid and mixed in a water bath with a temperature of 90°C. The samples were kept in a water bath for 1 hour. After the appropriate time, the beaker was removed from the bath, the outer surface was dried with filter paper. The mass of the beaker with the contents without a lid was adjusted to the initial mass with purified water at a temperature of 90°C. The contents were mixed and filtered through 4 layers of gauze. The meal was squeezed, the squeezed extract was filtered through 4 layers of gauze and combined with the first. The meal was poured with purified water at a temperature of 90°C. The extraction was repeated two more times under the same conditions as mentioned above.

The volume of each of the three extractions was determined, from which, after cooling to room temperature, 10 ml of the extraction was taken with a pipette to determine the quantitative content of extractive substances.

The content of extractive substances in the extract in terms of completely dry plant materialin percent (X) was determined. The degree of depletion of raw materials by extractive substances was calculated.

The results of determining the depletion of the crushed collection by extractive substances are shown in table 3.6.

Table 3.6

Depletion of the crushed collection for extractive substances

Number of extraction (1 hour each)	1st	2nd	3rd
The degree of depletion, %	74.66	16.42	4.12

According to table 3.6, the use of double extraction provides the degree of exhaustion in the second extraction of 16.42±0.84% and in the combined first and second extraction - 91.08%. This exceeds the value of this parameter when obtaining the extract at home according to the instructions for medical use (68.42±0.58%) and when extracting the initial collection by the maceration method at a temperature of 90°C (according to table 3.4). The use of triple extraction provides an increase in the degree of depletion of plant raw materials by only 4.12±0.54%, which we consider irrational.

Thus, the optimal conditions for obtaining a liquid extract from the collection are:

• grinding of raw materials to the size of particles that pass through a sieve with a hole size of 2 mm;

• extractant - purified water;

• temperature - 90°C;

• the method of extraction is double maceration.

The extract obtained by the above-mentioned technology was evaporated on a rotary vacuum evaporator. A substance was obtained - a thick extract with a dry residue content of 78.5%.

The expectorant substance obtained from the collection can be used in the technology of the following dosage forms for the treatment of diseases of the respiratory system: tablets; capsules; syrups.

This will ensure a greater output of extractive substances compared to the preparation of the extract at home and the accuracy of dosing.

CONCLUSION

1. It has been found that different users can employ the collection in dosages that differ by more than twice.

2. The technological parameters of the collection were investigated, including bulk density, post-shrinkage density, bulk and specific density, porosity, porosity, free volume of the layer, fluidity, angle of natural slope, moisture content, extractive substance content, and extractant absorption coefficient.

3. The extraction process of the plant collection was examined, and the optimal extraction conditions were determined. These conditions included grinding the raw material to particles that can pass through a 2 mm sieve, using purified water as the extractant, maintaining a temperature of 90°C, and employing the double maceration method.

4. A plant-based expectorant substance, in the form of a thick extract with a dry residue content of 78.5%, was successfully obtained.

GENERAL CONCLUSION

1. Extensive prevalence of respiratory diseases has been identified through the analysis of existing literature. Among the most commonly encountered respiratory conditions are bronchial asthma and bronchitis.

2. Medicinal products derived from plants are recommended for the treatment of such pathologies.

3. The comprehensive formulation called "Bronchofit" comprises naturally occurring biologically active substances. This preparation encompasses a diverse range of biologically active compounds that deliver bronchodilatory, anti-inflammatory, analgesic, antitussive, expectorant, mucus-moving, antispasmodic, bactericidal, and fungicidal effects.

3. It has been found that different users can employ the collection in dosages that differ by more than twice.

4. The technological parameters of the collection were investigated, including bulk density, post-shrinkage density, bulk and specific density, porosity, porosity, free volume of the layer, fluidity, angle of natural slope, moisture content, extractive substance content, and extractant absorption coefficient.

5. The extraction process of the plant collection was examined, and the optimal extraction conditions were determined. These conditions included grinding the raw material to particles that can pass through a 2 mm sieve, using purified water as the extractant, maintaining a temperature of 90°C, and employing the double maceration method.

6. A plant-based expectorant substance, in the form of a thick extract with a dry residue content of 78.5%, was successfully obtained.

REFERENCES

1. Wijsenbeek M, Suzuki A, Maher TM. Interstitial lung diseases. The Lancet. 2022 Aug 11.
2. Długosz P, Liszka D, Bastrakova A, Yuzva L. Health Problems of Students during Distance Learning in Central and Eastern Europe: A Cross-Sectional Study of Poland and Ukraine. International Journal of Environmental Research and Public Health. 2022 Aug 15;19(16):10074.
3. Gryech I, Ghogho M, Mahraoui C, Kobbane A. An exploration of features impacting respiratory diseases in urban areas. International Journal of Environmental Research and Public Health. 2022 Mar 6;19(5):3095.
4. Ziou M, Tham R, Wheeler AJ, Zosky GR, Stephens N, Johnston FH. Outdoor particulate matter exposure and upper respiratory tract infections in children and adolescents: A systematic review and meta-analysis. Environmental Research. 2022 Jul 1;210:112969.
5. Lommatzsch M, Rabe KF, Taube C, Joest M, Kreuter M, Wirtz H, Blum TG, Kolditz M, Geerdes-Fenge H, Otto-Knapp R, Häcker B. Risk Assessment for patients with chronic respiratory conditions in the context of the SARS-CoV-2 pandemic statement of the German Respiratory Society with the support of the German Association of Chest Physicians. Respiration. 2022;101(3):307-20.
6. Aegerter H, Lambrecht BN. The pathology of asthma: what is obstructing our view?. Annual Review of Pathology: Mechanisms of Disease. 2023 Jan 24;18:387-409.
7. Oliveira LM, Nogueira DS, Geraldi RM, Barbosa FS, Amorim CC, Gazzinelli-Guimarães AC, Resende NM, Pinheiro-Rosa N, Kraemer LR, Mattos MS, Bueno LL. Genetic Background Affects the Mucosal Secretory IgA Levels, Parasite Burden, Lung Inflammation, and Mouse Susceptibility to Ascaris suum Infection. Infection and Immunity. 2022 Feb 17;90(2):e00595-21.

8. Lakhdar R, Mumby S, Abubakar-Waziri H, Porter A, Adcock IM, Chung KF. Lung toxicity of particulate and gaseous pollutants using ex-vivo airway epithelial cell culture systems. Environmental Pollution. 2022 Apr 18:119323.
9. Adeloye D, Song P, Zhu Y, Campbell H, Sheikh A, Rudan I. Global, regional, and national prevalence of, and risk factors for, chronic obstructive pulmonary disease (COPD) in 2019: a systematic review and modelling analysis. The Lancet Respiratory Medicine. 2022 May 1;10(5):447-58.
10. Macmillan AJ, Phoon KM, Edafe O. Safety of topical administration of nasal decongestants and vasoconstrictors in paediatric nasal surgery–A systematic review. International Journal of Pediatric Otorhinolaryngology. 2022 Feb 1;153:111010.
11. Rozkovskiy Y, Kresyun V, Shemonaeva K, Antonenko P, Lobashova K, Ostapchuk K, Antonenko K, Al-Nadavi N. Methodical instructions for the practical classes in pharmacology for the third year students of medical faculty.
12. Zhao D, Li D, Cheng X, Zou Z, Chen X, He C. Mucoadhesive, antibacterial, and reductive nanogels as a mucolytic agent for efficient nebulized therapy to combat allergic asthma. ACS nano. 2022 Jun 28;16(7):11161-73.
13. Mamlakathon Y. Varieties of Pharmacological Treatment of Bronchial Asthma. Eurasian Medical Research Periodical. 2023 Jan 20;16:29-36.
14. Saggar S, Mir PA, Kumar N, Chawla A, Uppal J, Kaur A. Traditional and Herbal Medicines: Opportunities and Challenges. Pharmacognosy Research. 2022;14(2).
15. Harinath Reddy C, Koushik Kumar BV, Sai Teja Varma N, Vidya S, Nagaraj P, Muthamil Sudar K. Risk Prediction of Lung Disease Using Deep Learning Approach. InSecond International Conference on Image Processing and Capsule Networks: ICIPCN 2021 2 2022 (pp. 462-471). Springer International Publishing.
16. Azwanida NN. A review on the extraction methods use in medicinal plants, principle, strength and limitation. Med Aromat Plants. 2015 Jul 6;4(196):2167-0412.

17. Djordjevic SM. From medicinal plant raw material to herbal remedies. Aromatic and Medicinal Plants: Back to Nature. 2017 Mar 15:269-88.
18. Peanparkdee M, Iwamoto S. Bioactive compounds from by-products of rice cultivation and rice processing: Extraction and application in the food and pharmaceutical industries. Trends in Food Science & Technology. 2019 Apr 1;86:109-17.
19. Kholmirzaev M, Khaydarov G, Saitkulov F. Method of obtaining herbal mint extract. International Bulletin of Medical Sciences and Clinical Research. 2023 Jan 24;3(1):66-9.
20. Stéphane FF, Jules BK, Batiha GE, Ali I, Bruno LN. Extraction of bioactive compounds from medicinal plants and herbs. Nat Med Plants. 2021.
21. Barwal A, Chaudhary R. To study the performance of biocarriers in moving bed biofilm reactor (MBBR) technology and kinetics of biofilm for retrofitting the existing aerobic treatment systems: a review. Reviews in Environmental Science and Bio/Technology. 2014 Sep;13:285-99.
22. Liu X, Luo M, Li M, Wei J. Depicting precise temperature and duration of vernalization and inhibiting early bolting and flowering of Angelica sinensis by freezing storage. Frontiers in Plant Science. 2022;13.
23. Muscolo A, Papalia T, Settineri G, Mallamaci C, Jeske-Kaczanowska A. Are raw materials or composting conditions and time that most influence the maturity and/or quality of composts? Comparison of obtained composts on soil properties. Journal of cleaner production. 2018 Sep 10;195:93-101.
24. Hu J, Webster D, Cao J, Shao A. The safety of green tea and green tea extract consumption in adults–results of a systematic review. Regulatory toxicology and pharmacology. 2018 Jun 1;95:412-33.
25. Houghton P, Raman A. Laboratory handbook for the fractionation of natural extracts. Springer Science & Business Media; 2012 Dec 6.
26. Ameer K, Shahbaz HM, Kwon JH. Green extraction methods for polyphenols from plant matrices and their byproducts: A review. Comprehensive Reviews in Food Science and Food Safety. 2017 Mar;16(2):295-315.

27. Doughari JH. Phytochemicals: extraction methods, basic structures and mode of action as potential chemotherapeutic agents. Rijeka, Croatia: INTECH Open Access Publisher; 2012 Mar 21.
28. Alamgir AN, Alamgir AN. Herbal drugs: their collection, preservation, and preparation; evaluation, quality control, and standardization of herbal drugs. Therapeutic Use of Medicinal Plants and Their Extracts: Volume 1: Pharmacognosy. 2017:453-95.
29. Brglez Mojzer E, Knez Hrnčič M, Škerget M, Knez Ž, Bren U. Polyphenols: Extraction methods, antioxidative action, bioavailability and anticarcinogenic effects. Molecules. 2016 Jul 11;21(7):901.
30. Meng Q, Fan H, Xu D, Aboshora W, Tang Y, Xiao T, Zhang L. Superfine grinding improves the bioaccessibility and antioxidant properties of Dendrobium officinale powders. International Journal of Food Science & Technology. 2017 Jun;52(6):1440-51.
31. Fornari T, Vicente G, Vázquez E, García-Risco MR, Reglero G. Isolation of essential oil from different plants and herbs by supercritical fluid extraction. Journal of Chromatography A. 2012 Aug 10;1250:34-48.
32. Velegol D, Garg A, Guha R, Kar A, Kumar M. Origins of concentration gradients for diffusiophoresis. Soft matter. 2016;12(21):4686-703.
33. Rombaut N, Tixier AS, Bily A, Chemat F. Green extraction processes of natural products as tools for biorefinery. Biofuels, Bioproducts and Biorefining. 2014 Jul;8(4):530-44.
34. Jha AK, Sit N. Extraction of bioactive compounds from plant materials using combination of various novel methods: A review. Trends in Food Science & Technology. 2022 Jan 1;119:579-91.
35. Soldatov D, Stepanenko S, Sayko I, Kukhtenko H. Research of Vitis vinifera leaves extraction process on Timatic laboratory extractor. Scripta Scientifica Pharmaceutica. 2019 Dec 20;6(1):45-52.
36. Barros SJ, Ferreira GM, Neves HP, de Lemos LR, Rodrigues GD, Mageste AB. Use of aqueous two-phase systems formed by Triton X and choline chloride for

extraction of organic and inorganic arsenic. Separation and Purification Technology. 2021 May 15;263:118082.

37. Bhargavi G, Nageswara Rao P, Renganathan S. Review on the extraction methods of crude oil from all generation biofuels in last few decades. InIOP conference series: materials science and engineering 2018 Mar 1 (Vol. 330, p. 012024). IOP Publishing.
38. Tunsu C, Menard Y, Eriksen DØ, Ekberg C, Petranikova M. Recovery of critical materials from mine tailings: A comparative study of the solvent extraction of rare earths using acidic, solvating and mixed extractant systems. Journal of Cleaner Production. 2019 May 1;218:425-37.
39. Tzima K, Brunton NP, Lyng JG, Frontuto D, Rai DK. The effect of Pulsed Electric Field as a pre-treatment step in Ultrasound Assisted Extraction of phenolic compounds from fresh rosemary and thyme by-products. Innovative Food Science & Emerging Technologies. 2021 May 1;69:102644.
40. Picot-Allain C, Mahomoodally MF, Ak G, Zengin G. Conventional versus green extraction techniques—A comparative perspective. Current Opinion in Food Science. 2021 Aug 1;40:144-56.

Ф А 2.2.1-32-366

National University of Pharmacy

Faculty for foreign citizens' education
Department Technology of pharmaceutical preparations
Level of higher education master
Specialty 226 Pharmacy, industrial pharmacy
Educational program Pharmacy

APPROVED
The Head of Department
Technology of pharmaceutical preparations

____
Oleksandr KUKHTENKO

"____" ________________

ASSIGNMENT
FOR QUALIFICATION WORK
OF AN APPLICANT FOR HIGHER EDUCATION

Amine OULED LAGHRIYEB

1. Topic of qualification work: «Study of the process of extracting of the plant collection of expectorant action», supervisor of qualification work: Dmytro Soldatov, PhD, assoc. prof.,

approved by order of NUPh from "06" of February 2023 № 35

2. Deadline for submission of qualification work by the applicant for higher education: ________ 2023.

3. Outgoing data for qualification work: to make the literature review about using of the plant collection of expectorant action in technology of medicines, to study the technological parameters of plant materials and the extracting process of the plant collection.

4. Contents of the settlement and explanatory note (list of questions that need to be developed): introduction, literature review, objects and methods of research, experimental part, conclusions, list of used sources

5. List of graphic material (with exact indication of the required drawings):
tables – 7

6. Consultants of chapters of qualification work

Chapters	Name, SURNAME, position of consultant	Signature, date	
		assignment was issued	assignment was received
1	Dmytro SOLDATOV, PhD, assoc. prof. of higher education institution of department Technology of pharmaceutical preparations		
2	Dmytro SOLDATOV, PhD, assoc. prof. of higher education institution of department Technology of pharmaceutical preparations		
3	Dmytro SOLDATOV, PhD, assoc. prof. of higher education institution of department Technology of pharmaceutical preparations		

7. Date of issue of the assignment: ___________________

CALENDAR PLAN

№ з/п	Name of stages of qualification work	Deadline for the stages of qualification work	Notes
1	Preparation of literature review	May-September 2022	**done**
2	Experiment planning	October-December 2022	**done**
3	Conducting an experiment	January-March 2023	**done**
4	Registration of results	April 2023	**done**
5	Submission to the examination commission	May 2023	**done**

An applicant of higher education _________ Amine OULED LAGHRIYEB

Supervisor of qualification work _________ Dmytro SOLDATOV

Ф А2.8-47-110

ВИСНОВОК

Комісії з академічної доброчесності про проведену експертизу щодо академічного плагіату у кваліфікаційній роботі здобувача вищої освіти

№ 113806 від «22 » травня 2023 р.

Проаналізувавши випускну кваліфікаційну роботу за магістерським рівнем здобувача вищої освіти денної форми навчання Улед Лагрієб Амін, 5 курсу, ______ групи, спеціальності 226 Фармація, промислова фармація, на тему: «Дослідження процесу екстракції рослинного збору відхаркувальної дії / Study of the process of extracting of the plant collection of expectorant action», Комісія з академічної доброчесності дійшла висновку, що робота, представлена до Екзаменаційної комісії для захисту, виконана самостійно і не містить елементів академічного плагіату (компіляції).

Голова комісії,
професор **Інна ВЛАДИМИРОВА**

2%

27%

ВИТЯГ З НАКАЗУ № 35
По Національному фармацевтичному університету
від 06 лютого 2023 року

нижченаведеним студентам 5-го курсу 2022-2023 навчального року, навчання за освітнім ступенем «магістр», галузь знань 22 охорона здоров'я. спеціальності 226 – фармація, промислова фармація, освітня програма – фармація, денна форма здобуття освіти (термін навчання 4 роки 10 місяців та 3 роки 10 місяців), які навчаються за контрактом, затвердити теми кваліфікаційних робіт:

Прізвище студента	Тема кваліфікаційної роботи		Посада, прізвище та ініціали керівника	Рецензент кваліфікаційної роботи
• **по кафедрі технологій фармацевтичних препаратів**				
Улед Лагрієб Амін	Дослідження процесу екстракції рослинного збору відхаркувальної дії	Study of the process of extracting of the plant collection of expectorant action	доцент Солдатов Д.П.	доцент Ковальов В.В.

Підстава: подання декана, згода ректора

Ректор

Вірно. Секретар

Ф А 2.2.1-32-353

REVIEW

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

Amine OULED LAGHRIYEB

on the topic: **«Study of the process of extracting of the plant collection of expectorant action»**

Relevance of the topic. The investigation of the process of extracting a plant collection with expectorant action is highly relevant due to the increasing demand for natural remedies for respiratory conditions. Understanding the extraction process of a plant collection with expectorant properties is crucial for developing effective and safe herbal medicines to alleviate respiratory congestion and promote healthy lung function.

Practical value of conclusions, recommendations and their validity. The developed technology of extracting of the plant collection of expectorant action can be implemented in pharmaceutical companies in drugs development reseaches. Conclusions and recommendations in the work are scientifically justified and reliable.

Assessment of work. The author while working learned to use the data of scientific literature, to search for the necessary information, proved to be a talented experimenter, able to draw sound conclusions from the results.

General conclusion and recommendations on admission to defend. In general, the qualification work of the applicant deserves high marks, meets the requirements and can be submitted for official defense to the examination commission of the National University of Pharmacy.

Scientific supervisor ___________________ Dmytro SOLDATOV

«___» ___________ 2023

Ф А 2.2.1-32-356

REVIEW

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

Amine OULED LAGHRIYEB

on the topic: **«Study of the process of extracting of the plant collection of expectorant action»**

Relevance of the topic. Investigating the extraction methods of the plant collection with expectorant activity can contribute to the development of new formulations and dosage forms that are safe, efficient, and accessible for individuals seeking natural alternatives for respiratory health.

Theoretical level of work. The work was performed at a high level using modern research methods according to the State Pharmacopoeia of Ukraine

Author's suggestions on the research topic. The studies are devoted to the technological parameters of the collection investigation, and extraction process of the plant collection examination. The author suggests to use grinding the raw material to particles that can pass through a 2 mm sieve, purified water as the extractant, maintaining a temperature of 90°C, and employing the double maceration method.

Practical value of conclusions, recommendations and their validity. The research results can be used in the development of the technology of extracting of the plant collection of expectorant action in industrial conditions.

Disadvantages of work. According to the text of the work there are some typographical errors, bad expressions. However, this does not reduce the value of the work and does not call into question the results obtained.

General conclusion and assessment of the work. The qualification work of the applicant deserves high marks, meets the requirements and can be submitted for official defense to the examination commission of the National University of Pharmacy.

Reviewer ________________ assoc. prof. Volodymyr KOVALOV

«__» _________ 2023

Ф А2.2.1-91-287

МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ
НАЦІОНАЛЬНИЙ ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ

Витяг з протоколу
засідання кафедри технологій фармацевтичних препаратів НФаУ
№ 10 від 24 квітня 2023 року

Голова: завідувач кафедри, доктор фарм. наук, проф. Кухтенко О. С.

Секретар: к. фарм. н., доц. Січкар А. А.

ПРИСУТНІ: зав. каф., проф. Кухтенко О. С., доц. Безрукавий Є. А., доц. Кутова О. В., доц. Ляпунова О. О., доц. Манський О. А., доц. Ніколай-чук Н. О., доц. Сайко І. В., доц. Січкар А. А., доц. Солдатов Д. П., доц. Трутаєв С. І.

ПОРЯДОК ДЕННИЙ:
1. Про представлення до захисту в Екзаменаційну комісію кваліфікаційних робіт здобувачів вищої освіти випускного курсу НФаУ 2023 року випуску

СЛУХАЛИ: Про представлення до захисту в Екзаменаційній комісії кваліфікаційної роботи на тему: «Дослідження процесу екстракції рослинного збору відхаркувальної дії»______________________________
здобувача вищої освіти випускного курсу Фм18(5,0д)англ-08 групи НФаУ 2023 року випуску ________________ Амін УЛЕД ЛАГРІЄБ______________________
(ім'я, прізвище)
Науковий (-ві) керівник (-ки)_к.фарм.н., доц. Дмитро СОЛДАТОВ__________
Рецензент_____________к.фарм.н., доц. Володимир КОВАЛЬОВ_____________

УХВАЛИЛИ: Рекомендувати до захисту кваліфікаційну роботу здобувача вищої освіти _5_ курсу _Фм18(5,0д)англ-08__ групи__Амін УЛЕД ЛАГРІЄБ__
(ім'я, прізвище)
на тему:__«Дослідження процесу екстракції рослинного збору відхаркувальної дії»____________

Голова
завідувач кафедри,
доктор фарм. наук, проф. ______________ Олександр КУХТЕНКО
(підпис)

Секретар
к. фарм. н., доцент ______________ Антоніна СІЧКАР
(підпис)

Ф А2.2.1-32-042

НАЦІОНАЛЬНИЙ ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ

ПОДАННЯ
ГОЛОВІ ЕКЗАМЕНАЦІЙНОЇ КОМІСІЇ
ЩОДО ЗАХИСТУ КВАЛІФІКАЦІЙНОЇ РОБОТИ

Направляється здобувач вищої освіти Амін УЛЕД ЛАГРІЄБ до захисту кваліфікаційної роботи
за галуззю знань 22 Охорона здоров'я
спеціальністю 226 Фармація, промислова фармація
освітньою програмою Фармація
на тему: «Дослідження процесу екстракції рослинного збору відхаркувальної дії».

Кваліфікаційна робота і рецензія додаються.

Декан факультету ________________________ / Світлана КАЛАЙЧЕВА /

Висновок керівника кваліфікаційної роботи

Здобувач вищої освіти Амін УЛЕД ЛАГРІЄБ виконав кваліфікаційну роботу на високому рівні, з логічним викладенням матеріалу та обговоренням, оформлення роботи відповідає вимогам НФаУ до випускних кваліфікаційних робіт та робота може бути рекомендована до захисту в ЕК НФаУ.

Керівник кваліфікаційної роботи

______________ Дмитро СОЛДАТОВ

«___» ________ 2023 р.

Висновок кафедри про кваліфікаційну роботу

Кваліфікаційну роботу розглянуто. Здобувач вищої освіти Алі Хосні ІБРАХІМ допускається до захисту даної кваліфікаційної роботи в Екзаменаційній комісії.

Завідувач кафедри
технологій фармацевтичних препаратів

______________ Олександр КУХТЕНКО

« 24 » квітня 2023 року

Qualification work was defended

of Examination commission on

« ____ » ____________ 2023

With the grade __________________________

Head of the State Examination commission,

DPharmSc, Professor

___________________________ / Oleh SHPYCHAK /