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QUALIFICATION WORK

on the topic: « **PHARMACOGNOSTIC STUDY OF THE BORAGE
«ALBA» VARIETY** »

Prepared by: higher education graduate of group

ΦM18(5.0Д)АНГЛ-03

specialty 226 Pharmacy, industrial pharmacy

educational program Pharmacy

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ABSTRACT

Azikou Hajar « Pharmacognostic study of the Borage «Alba» variety».

The qualification work is devoted to the phytochemical study of the herb of Borage «Alba» variety. The qualitative composition of biologically active substances of raw materials was established and their quantitative content was determined.

Key words: Borage «Alba» variety, herb, biological active compounds, identification, mineral elements.

АНОТАЦІЯ

Азіку Хажар «Фармакогностичне дослідження трави огіркової трави сорту «Альба»

Кваліфікаційна робота присвячена фітохімічному дослідженню трави огіркової трави сорту «Альба». Встановлено якісний склад біологічно активних речовин сировини та визначено їх кількісний вміст.

Ключові слова: огіркова трава, біологічно активні речовини, ідентифікація, мінеральні елементи.

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LIST OF CONVENTIONAL ABBREVIATIONS

ALA– α -Linolenic acid

BAC – biological active compounds;

cm – centimeter;

EuPh – Europea Pharmacopoeia;

FAO – Food agriculture organization;

GLA – gamma-linolenic acid

MAPs – Medicinal and Aromatic Plants (

NUPh – National university of Pharmacy;

PC – paper chromatography;

Rt – retentional time;

SDA– stearidonic acid

UV- light – ultra violet light;

vit. C – vitamin C.

WHO – World Health Organization

INTRODUCTION

The topic actuality. The therapeutic use of medicinal plants in human health is an ancient practice, historically constructed on the common-sense knowledge that articulates culture and health, since these aspects do not occur isolatedly, but are inserted in a certain historical context. Despite considerable advances in phytotherapy, as plants used for therapeutic purposes are called in academic language, they often continue being used for health promotion and recovery on the mere base of popular culture.

World Health Organization (WHO) has been promoting the use of alternative therapies integrated with technical knowledge of Western Medicine since. According to WHO, about 85% of the world population uses phytotherapeutic medicines for therapeutic purposes. Alternative methods have been used more, because of the lack of credibility in allopathic medicine and the low cost of phytotherapy. The growing use of medicinal plants by the population is due to low cost and easy access.

Many people maintain the idea that natural substances can attenuate drug toxicity and that the more herbs are used, the more benefits there will be, particularly with regard to drug-related side effects [13]. The subjects most at risk are children and seniors who are self-medicating, as well as patients with comorbidities, oncological diseases, cardiovascular diseases, diabetes, chronic renal failure, human immunodeficiency virus, and drug or food allergies [14]. For this reason, it is important to remember that a number of variables might have an impact on the adverse effects that herbal medications may produce:

Geriatric age: patients over the age of 60 have a lower tolerance to natural or synthetic medications, which doubles their risk of overdosing and adverse responses [15];

Renal and hepatic insufficiency: it is not recommended to consume any phytotherapies that are processed by these organs, such as aristolochia and magnolia officinalis for the kidney and all plants containing pyrrolizidine alkaloids for the liver [16];

Obesity: it is well recognized that having an excessive amount of body fat can change the way drugs operate in the body, either making them more or less effective [17];

Diet: The majority of interactions happen at the point of absorption, particularly when food intake is sufficient to prevent medication contact with the intestinal mucosa or when there is calcium or iron present, since these substances bind to pharmaceuticals, reducing their adsorption

Phytotherapies, such as synthetic drugs, act on the human organism as well as the animal due to the chemicals they contain, which are responsible for pharmacological activities. These so-called phytomedicines are, for all intents and purposes, plant-based drugs, since they are aimed at carrying out a therapeutic action. Their effect depends on the nature and concentration of the pharmacologically active chemical constituents. Although for each vegetable source, some characteristic active ingredients have been roughly identified, to which a certain therapeutic action is ascribed; in the vegetable source, there are other extraordinary mines of complementary substances that contribute to modulating their action.

In certain instances, while having a therapeutic action, the chemicals found in plant material are not used in high enough concentrations to produce biological activity *in vivo* [2]. A plant material preparation that exerts the best pharmacological activity cannot be obtained and applied in clinical trials due to the lack of exact identification of chemical elements in plant preparations that are required to accomplish specific therapeutic action. All clinical and interventional trials carried out for complex natural mixes are thought to be affected by these characteristics, which are regarded as a primary source of heterogeneity and differences in outcomes and a common source of ambiguity in their meta-analyses [3]. The synergy between components may be a crucial component of efficacy [4,5]. Since no clear active principles have been identified, it is frequently hypothesized that a variety of bioactive elements may have contributed to the reported therapeutic outcomes, perhaps in a synergistic manner. However, there

has not been any research performed to date that would support this theory for natural remedies. As a result, the synergism hypothesis is currently also thought to serve as a justification technique for natural products that lack active principles that have been discovered [6,7].

Combined with conventional therapy, the use of phytodrugs is efficacious as adjunctive therapy.

The aim of investigation was study the chemical composition of Borage «Alba» variety underground part.

To achieve the goal, the following **tasks** should be completed:

- To analyze the existing scientific primary sources regarding the botanical characteristics and use of Borage «Alba» variety in official and folk medicine;
- To analyze information on the current state of phytochemical research on *Borage «Alba» variety* and compile an overview of this issue;
- To establish the qualitative composition and quantitative content of biologically active compounds of *Borage «Alba» variety* herb;
- To investigate its trace element composition.

The object of study was herb of *Borage «Alba» variety*, variety Bolivar F.

The subject of study was identification and determination of the content of different classes of BAC in raw materials (amino acids, polysaccharides, organic acids, carotenoids, chlorophylls, flavonoids, procyanidins).

Methods of study: physical - determination of loss in mass during drying; physical and chemical - chromatography in a thin layer of sorbent, paper chromatography; chemical - BAC identification reactions, their quantitative determination; instrumental, physical and chemical – chromat-mass-spectrometry, photocolrimetry.

Practical significance of the obtained results.

The practical value of the qualification work is due to the fact that as a result of the conducted research, the acquirer expanded the information on the chemical composition of *Borage «Alba» variety* herb, variety Bolivar F with the aim of further introducing as additional source of biologically active substances, in

particular volatile compounds. In view of the classes of identified substances and their pharmacological activity, described in the literature, it is possible to assume the perspective of *Borage «Alba» variety* herb in the development of antibacterial and antifungal agents for external use.

Elements of scientific research. Based on the analysis of scientific literature, the acquirer compiled an overview and formulated the main issues of the research, experimentally carried out identification and determination of the quantitative content of BAC in raw materials.

Structure and scope of qualification work. The work consists of an introduction, an abstract in English and Ukrainian, a literature review, two chapters of own research, general conclusions, a list of used literature, which includes 59 foreign languages sources and appendices. The content of the work is laid out on 44 pages of the main text and illustrated with 12 tables and 12 figures.

CHAPTER 1. CURRENT STAGE OF STUDY OF BORAGE (LITERATURE REVIEW)

1.1. Phytotherapeutic practices in Morocco.

Many of the miracle drugs of today are molecules or variations on compounds that were originally extracted from medicinal plant species. In fact, various chemicals and biotechnological products are being screened by major multinational pharmaceutical industries in the hope of discovering new compounds for curing various health ailments. Indeed, Morocco, endowed with an immense range of climates, cultures, human and natural resources, has rich and ancient phytotherapeutic traditions.

Today herbs are the main source of medical practices in developing countries, especially in remote areas. Such attitudes and treatment practices are used to alleviate suffering due to diseases. The main reasons of these behavioral is linked to various parameters such as the history, the belief or socioeconomic condition such as the lack of health facilities and poor access to basic services which are considered as distinctive features of rural life. These natural resources, used in phytotherapy, play a crucial role in health care needs of people around the world especially in developing countries. About 80 % of the population of most developing countries still depends on the use of traditional medicine derived from plants [1].

It is well known that Medicinal and Aromatic Plants (MAPs) have been an important resource for human health care from prehistoric times to the present day. Between 40,000 and 50,000 plant species are known to be used in traditional and modern medicine systems throughout the world [2]. The people using this type of medicine are convinced that the treatment with natural products is safe, effective, and improve the general health, contrary to conventional treatments. Medicinal plants have remained useful not only as remedy for different sickness, that affect human, but also suitable substratum for the discovery of bioactive compounds which are always in demand and are a central point of research.

In Morocco, traditional uses of herbs by population to treat various ailments are widespread and have been in existence for many years. The useful information about these practices is still passed from one generation to another by oral communication. People living in this country, especially those in remote areas, depend more extensively on traditional medicine for their health care needs instead of modern systems which are out of reach. The shift to empirical medical practices is due to the vulnerability of the socio-cultural status, the historic belief and the availability of the resources derived from medicinal plants. However, this medical practice is completely forsaken by the national health system.

Besides, the non-organisation of the MAPs sector leads to an over-harvesting of these herbs which are increasingly threatened. These facts posing the danger of losing these natural resources and could have a marked negative impact on folk medicine traditions from disappearance. We have become aware that the ecosystems from where the medicinal plants are extracted have been under a constant deteriorating process which has gotten worse due to climatic change, expressed in long lasting droughts and to an increase in the demand for these plant remedies, which is an aspect that needs immediate attention, if not, these resources could be lost. Besides, the sudden evolution of society towards technological patterns and the increasing use of synthetic remedies, in spite of the progress of pharmacological technology, the memory of popular medicine hardly survives, when necessary, has seen a consequent erosion of a rich cultural heritage. So, In Morocco, the current and potential value of medicinal plants, as traditional remedies and commercial pharmaceuticals, requires the urgency to collect, document, and to save the renewable botanical resources and how know related. To improve and develop the medicinal plants sector in Morocco, the scientific community has to know about ethnobotanical resources in this country.

Even today, the majority of Moroccan people continued to use this ancestral medical approach to meet their primary health care needs. In fact, the majority of the Moroccan people, especially in remote area, continued to use this ancestral medical approach to meet its primary health care and subsistence needs as

income.

There is a general belief amongst consumers around the world that medical herbs are inherently safe, because they are “natural”. However, just because the product is natural, that does not assure their safety. Empirical use of medicinal plants involves potential hazardous risks attributed to both inherent toxic effect of herbal medicine, misused of plants as well as its misidentification, overdose and toxicity induced by adulterant/contaminants of plants.

In Morocco, phytotherapy can be considered as an integral part of primary health care especially for the poorest people. Indeed, traditional medicine, in this society, has always occupied an important place in the traditions of medication. This strong attachment to popular medicine is due to the low level of socioeconomic status of most people, the lack of health infrastructure, especially in remote area. Unfortunately, this cultural and natural heritage enjoyed by the local population is threatened with extinction for two reasons: Primarily, indigenous knowledge about the use of wild plant resources is rapidly disappearing from traditional communities, leading to the decrease of these phytotherapeutic practices, secondly, the degradation of phytogenetic resources due to several factors, mainly urbanization, climatic hazards as well as the anthropogenic actions could have negative impact. In addition, the lack of documentary databases related to traditional medical practices and the scarcity of ethnobotanical information archives aggravate the loss of this natural and cultural heritage.

Undoubtedly, the extensive experiences in use of medicinal plants in traditional medicine coupled to scientific study and identification of active plant compounds and their effects can lead to the discovery of new therapeutic benefits and the production of nature-based products in the future.

1.2. Botanical characteristics of *Borago*.

Borago officinalis from Boraginaceae family is known as borage, burrage, bourrache, and bugloss[16-19]. Other names: Bee Plant, Beebread, Borage Flower, Borage Leaf, Borage Oil, Borage Seed Oil, Borago, *Borago officinalis*, Borraja, Bourrache, Bourrache Commune, Borage, Burrage, Common Borage, Common Bugloss, Cool Tankard, Feuille de Bourrache, Fleur de Bourrache, Huile de Bourrache, Huile de Graines de Bourrache, Langue de Bœuf, Ox's Tongue, Pain-des-Abeilles, Talewort, Starflower, Starflower Oil.

It comprises only five species *Borago officinalis*, *Borago trabutii*, *Borago longifolia*, *Borago pygmaea*, and *Borago morisiana*, all them native to the Mediterranean Basin. *Borago officinalis* constitutes the only farmed taxon in this genus and can be found outside this region. The remaining species are endemics and threatened for extinction.



<https://www.discoverlife.org/mp/20m?kind=Borago+officinalis>

Fig. 1.1 Range Borage

Originally from Western Asia and the Mediterranean, borage has now conquered almost the entire world. It rarely naturalises as a “garden escapee” and is considered non-invasive. It can be found in Europe and North America, as well as in New Zealand, West Asia and South America. Even the ancient Greeks and Romans were familiar with the herb and used it in many different ways. Borage

made its way to the rest of Europe in the late Middle Ages, where it was first cultivated in France. Today, it is hard to imagine our herb gardens without it.

Borage is an annual, herbaceous and hairy plant which height changes between 70 to 100 cm[3,20]. Stems are straight, often branched[21], hollow, and covered by tough fibers. Its leaves are alternate and simple. Its leaves are covered with tough fibers[22]. The flowers are blue and rarely appear white or rose colored[23]. Their calycle and corolla are fiveparts which are divided into some parts and make flowers polypetalous appearance.

One of the features of the corolla is that lamina parts lead to a tube which is almost seen in plants in this family, which differentiates it from other various plants. Each flower has five flags with anthers near to each other and there is a vertical appendage in their tube base. The pistil has a superior ovary which is changed to a fruit with 3 to 4 brownish nutlet after growing and there is a dark but no albumin seed inside each. The fruit of borage is a small brownish oval wrinkled nutlet[24]. Ripe nutlets are dark without albumin[23]



Fig. 1.2 Borage

Borage leaves and stems are covered with fine hairs called trichomes. The

dark green leaves can grow to between 10 and 15 centimetres long and are lance-shaped. Borage plants flower between May and July in white or blue, depending on the variety. If the star-shaped flowers are pollinated, they develop into fruits called drupes, which is a typical borage family trait. Each drupe is made up of 4 nutlets – the seeds are contained within these nutlets.



Fig. 1.3 Borage leaves.

Common borage is an annual and the best known of the species. This species forms blue flowers with a vivid hue and black stamens. Two varieties of common borage deserve a special mention:

Borago officinalis 'Variegata': this variety displays delicate blue flowers and variegated leaves
Borago officinalis 'Alba': also called white borage, this variety usually flowers later in the season

Bell-flowered borage, also known as *Borago laxiflora* or pygmy borage, is ideal as a potted plant thanks to its dainty growth. Unlike *Borago officinalis*, *Borago pygmaea* is a perennial. This species originates from Sardinia and Corsica and is similar to common borage in both taste and use.



Fig. 1.4 Flowers Borage.

Borage produces bright blue to purple flowers from May to September. The aesthetics of the blossoms and their star shape have given it the not so familiar name starflower. The special about borage is that the blossoms change in their development like a chameleon. The young blossoms are usually colored pink, whereas the adult blossoms are usually bright blue. The reason for this is due to the changing pH-value during flower development. The blossom itself consists of five greenish sepals, five purple stamens and five blue petals.

If the flowers are pollinated, they develop the clumps typical of the plant family. Each fruit contains several partial fruits (mericarp fruit) which contains the black seeds up to 6 mm.

1.3. Biological active compound of *Borage*.

Borago officinalis or borage is an annual herb which is cultivated for medicinal and culinary uses, even though it is commercially cultivated for borage seed oil. Borage seeds oil is the richest plant source of the gamma-linolenic acid (GLA) which is used as dietary or food supplement. GLA is sometimes prescribed as anti-inflammatory drug with this belief that it lacks some of the common sideeffects of other anti-inflammatory drugs. GLA is also used for the treatment of multiple sclerosis, diabetes, heart diseases, arthritis, eczema, autoimmune disorders, cancer and premenstrual syndrome[1,2].

Borage is a medicinal plant which has different usages in pharmaceutical, industrial and forage fields and is used in production of drinks and salads. This plant is known as high plant in Mediterranean regions. Borage is cultivated around the world but is native to Europe, North Africa and Asia Minor[3,4]. Borage has oil seed which contains a high amount of the GLA (30%-40%). GLA is one of the volatile fatty acids which is synthesized just by a few plant varieties and often found in their seeds[5]. The main sources of the GLA are borage and evening primrose[6,7]. Borage produces 300 to 600 kg seed in Britain so as to increase the amount of GLA in available crops and produce GLA in common oilseed productions[7,8]. Ninety percent of selling rate of GLA oil is related to evening primrose. But borage is a better resource of the GLA since its seeds contain 30%-40% oil of which 20%-30% is GLA. This amount is approximately twice as many as that of in evening primrose. The oil of borage is more constant and its process is simpler than the oil of the evening primrose[7,10].

Stems, leaves, and flowers many researchers have reported about the fatty acids available in leaves or the whole plant of borage, but there are few information about changes in fatty acids during growth period. A research evaluates the quality and the amount of fatty acids available in borage in different growth stages and reported as follows[4]. The amount of dry matter in all considered growth stages was very low. Chemical compound was closely related to

the growth stages of plant and the amount of fiber was increasingly raised. The amount of raw protein decreased and the amount of lignin showed age-related increase. Indigestibility of the organic substance decreased in the beginning of the seed formation stage. This decrease was attributed to interactions of some factors including significant increase in fibers parts, relative increase in lignin during growth stages and changes in the ratio of plant tissues components. The amount of total energy was almost constant in first three stages and then increased a little. Since nutritional value during growth period was constant optimum harvest stage of the borage is in the beginning of seed formation stage when performance of dry matter is minimum. The profile of the fatty acids changes upon growth stages. α -Linolenic acid (ALA) and stearidonic acid (SDA) are the main compounds in germination stage which then decreased later. In the beginning of seed formation stage LA is in highest level and the amounts of GLA and acid oleic increase.

The leaves of borage contains following compounds: a few amount of pyrrolizidine alkaloids, licosamin, intermedin, sopinin, sopindian, yezan, colin; fatty acids including ALA (55%) and GLA (more than 4%); silicic acid (1.5%-22.0%); potassium, calcium, nitrate potassium (3%), acetic, lactic and malic acid; δ -bornesitol, cianozhens; fresh leaves also contain mucilage hydrolysable to glucose, galactose, arabinose and alantoein up to 30%; leaves of borage in seeding stage contain 2.5-5.0 mg GLA and 5.7-9.0 mg SDA[34,35]. The most amount of the gama-linolenic fatty acids are seen in May or June and the most amount of that in upper leaves of the stem in August or September[36].

The amount of gum and mucilage available in leave and stem is 3.8% and in inflorescence is 5.4%. The amounts of potassium and calcium are reported 5.3% and 6.2% respectively[11,37,38]. Compared to inflorescence, less amounts of potassium, gum and mucilage are present in stem and leave but more calcium is in stem and leave. Inflorescence of borage contains mucilage, tannin, calcium, potassium and ash insoluble in acid and alkaloid but has not saponins, flavonoids and cyanogenic glycosides[1,19,20,38]. The flowers of borage and generally all parts of the plant contain 30% mucilage. Green parts of the plant contain nitrate

potassium, resin, malate and a little amount of essence, manganese, phosphoric acid and allantoin[39-41]. SDA is a precursor for prostaglandin synthesis which is found a little in oil of the borage seed while SDA is second frequent fatty acid in leaves of borage[11,42]. Since animals have very low ability to synthesize this kind of necessary fatty acids, they must be included in daily diet. This vital compounds bearing therapeutic value could increase animals health and quality of life[4]. Linolenic acid and palmetic acid are collected from flowers and high levels of ALA is in mature leaves[42]. 2.4.2. Seed Boraginaceae family is one of the most known resources of GLA. In a chemotaxonomic study on 45 plant biomasses from Boraginaceae family it was determined that all biomasses contain GLA and the lowest amount (7%) was related to *Cerinthe* major L. species and the highest amount related to borage species (28%). This fatty acid is available in plant in a few amounts but is very important due to its nutritional and medicinal value[43]. SDA is other fatty acid which is found in plants in a little amount but it is found in Boraginaceae family in amount of 2%[7]. Several studies have been conducted on combination of fatty acid available in seed oil of planted and wild species of Boraginaceae. The amount of linoleic acid, ALA, GLA, SDA and erucic acid are of special importance in chemotaxonomic inside this family. Tocopherols are also natural effective antioxidants and borage species have high amount of δ -tocopherols[44,45]. Phenolic compounds exist in oil seeds and various studies have proved their antioxidant properties. Borage is important due to high amount of GLA available in its seed oil. In a comprehensive research, antioxidants properties of borage extracts have been reported[46,47]. These excellent antioxidants properties of borage are attributed to phenolic compounds. It has been determined that rosmarinic acid, synergic acid and synaptic acid are main phenolic compounds available in extract of borage seed. Rosmarinic acid is the main component of rosemary extract which is used extensively in food industries. On the other hand synergic acid and synaptic acid are included in phenol and main antioxidants of rapeseed and canola[39,48,49]. There is potential for borage antioxidants to be used in food formulations and in skin health products as compounds which absorb

UV. It has been suggested that linoleic acid and palmitic acid are dominant fatty acids available in mature seeds of borage[42]. Borage oil due to high amount of GLA is investigated by food and pharmaceutical research groups[50]. Oils containing GLA is used to treat some diseases resulted from lack of GLA in human[51].

Epidemiological studies have shown that the intake of fruits and vegetables is correlated with a reduced risk of chronic diseases, while recent works highlight the significant link between phenolics-containing foods and their antioxidant properties. Phenolics have constrictive action on capillaries and can reduce the damage caused by pro-oxidant processes, thus they are useful for the prevention and treatment of reactive oxygen species (ROS)-induced diseases, such as cancer, diabetes immune dysfunctions, Parkinson's and Alzheimer's, multiple sclerosis, and inflammatory lung disorders. Nowadays, there is a growing demand of natural plant extracts with antioxidant activity because of the increased report on carcinogenic effects of some synthetic antioxidants, which are currently used as food additives, cosmetics and in pharmaceutical formulations. In addition to their antioxidant capacity, plant phenolics act as cytotoxic anti-cancer agents by promoting apoptosis and reducing angiogenesis, growth and differentiation of tumours. For instance, the anticarcinogenic activity of common borage (*Borago officinalis* L.) leaves has been related to their phenolic composition.

1.4. Application of Borage official and in folk medicine.

Pharmaceutical applications. Raw leaf obtained from borage is used as anticonvulsant, bronchodilator, vasodilator. It also has cardio-depression property. Today GLA and SDA supplements and oils containing these fatty acids are used in diet to meet the shortage of necessary fatty acids and prostaglandin. They also are used in treating thrombosis, inflammation and cancer[51,52].

Atopic dermatitis is an inherited and regressive disease which is seen in 5%-10% of children and now local corticosteroid is often used to remove inflammatory and itchy rashes seen in patients. Results of recent researches have shown that patients affected by this disease due to lack necessary fatty acids. Borage is one of the rich resources of these acids and seems to be beneficial to these patients. Borage also has effect on the treatment of obsessivecompulsive disorder. It has been determined that the extract of this plant is effective on stress models in mouse. Studies have shown that patients affected to psoriasis due to lack free fatty acids and if this lack is removed symptoms will be decreased and even recovered. Borage plant is one of the rich resources of GLA which effect on recovery of inflammatory chronic diseases is approved. Borage seed oil has been affective on recovery of Psoriasis vulgaris rashes[53-55]. Researches about borage seed oil analysis show that existence of alkaloids induced side effects is possible. Borage seed oil is also used for chronic skin inflammatory disease in order to prevent manifestation of these effects.

Skin itch and stimulation problems are also ameliorated by this plant extract[49,56]. Several plants in Boraginaceae family, specially Borage and its Iranian variety (*Echium amoenum*), have been used in Iranian traditional medicine as tranquillizer from ancient times. Phytochemical studies have shown presence of flavonoids in this plant and they can produce benzodiazepine like effects by attaching to benzodiazepine receptors. Methanol extract of *Echium amoenum* has also shown anticonvulsant effects in mouse. The main effective substances in this plant are pyrrolizidine alkaloids, flavonoides, rosmarinic acid, anthocyanins,

saponins, unsaturated terpenoids and sterol. Likely anticonvulsant effects of this plant are performed by flavonoids, rosmarinic acid and some of the above substances[57]. Of course proof of this subject requires special researches on these substances. Borage plant causes increase in urine excretion, decrease in blood pressure and kidney function benefits[38,56].

Effects related to GLA GLA is one of the compounds available in borage and some other plants seed oil which is extensively used in food supplements and to treat different diseases. Unsaturated fatty acids are very important in animals cells since they are affected in maintaining structure and function of cell membrane, adjusting synthesis and transfer of cholesterol and in avoiding water loss from skin and precursor of eicosanoids like prostaglandins and leucotrienes. In animals these fatty acids are synthesized from necessary fatty acid linolenic acid and first stage of this process is desaturation of GLA by Δ -Desaturase [43]. Synchronous decrease in activity of this enzyme and advancement of age, stress, eczema, diabetes, and some infections or increase in GLA catabolism simultaneously due to oxidation or fast cell division leads to GLA lack.

Clinical experiments have shown that consumption of food supplements containing GLA could be useful in the treatment of some diseases such as local eczema, mastalgia, diabetes, virus infections and some kind of cancers. Oils containing GLA are used vastly as health public supplement and their medicinal use is approved. Generally GLA is used as food supplement and drug prescript to treat diseases like local eczema, heart diseases, cyclical mastalgia, diabetes, arthritis and multiple sclerosis[58,59]. High validity of borage and its increasing demand is related to increase in documents about fatty acids quality and also their amount in human diet regarding health and effect of improving atherosclerosis. Polyunsaturated fatty acids are not synthesized by human body and must be supplied by special diets. They are the most important precursor for active physiological compounds like prostaglandin, thromboxanes and leucotrienes[60]. Human body skin cannot biosynthesize GLA from linolenic acid or arachidonic acid precursor. So daily consumption of borage seed oil which is rich in GLA

significantly improves skin condition. After using this oil skin dryness and itch are decreased[61].

Antioxidant effects Fat oxidation is one of the main reasons of decrease in the quality of fatty foods. This process affect on color, favor, tissue and nutritional value of foods[62]. Free radicals such as superoxide, hydroxyl, hydroperoxyl and nitric oxide radicals can cause fat oxidation[63]. Using synthetic antioxidants in foods could delay oxidation but using them in food products is subject to limitation regarding rules since these compounds have anti-health potential. This subject causes us to prefer natural antioxidants instead of them. Medicinal plants with natural antioxidants have been shown to be beneficial in a variety of complications such as cancer[64- 66], burn[67,68], diabetes[69-71], hyperlipidemia[72-74], and amnesia[75,76], These compounds are able to prevent or cure the side effects of other compounds[71,77-80]. Many natural antioxidants already have been extracted from different kinds of plant materials such as oilseeds, vegetables, leaves, roots, spices, cereal and plants leaves[81]. Among natural antioxidants, phenolic antioxidants are extensively available in plants[66,82-84].

Borage oil is rich in unsaturated fatty acids like GLA which is high resistance to oxidation. This resistance is resulted from existence of tocopherols and several phenol compounds in tissues containing oil. When oil is extracted antioxidants such as tocopherols are extracted with oil which are main factors in protecting the oil. Borage flour contains large amounts of phenol compounds after extracting oil. These antioxidants can be concentrated as raw extracts or be used as phenol compounds in unsaturated oils like seed oils [46,47].

Borage flour and its extracts have concentration-related antioxidant properties. Products containing high amount of antioxidant can be obtained from borage flour under optimum condition. Maximum antioxidant activity of extract is resulted if extraction is performed with 52% ethanol in 74 °C for 60 min. The ability of this extract to delay fat oxidation is attributed to the phenol compounds to eliminate reactive species of oxygen. Borage extract may be added to oils and

meat products instead of antioxidants to delay fats oxidation. But, low amount of the hydrophobic phenols may lead to weak

Borage seed oil is used for skin disorders including eczema, seborrheic dermatitis, and neurodermatitis. It is also used for rheumatoid arthritis (RA), stress, premenstrual syndrome (PMS), diabetes, attention deficit-hyperactivity disorder (ADHD), acute respiratory distress syndrome (ARDS), alcoholism, pain and swelling (inflammation), and for preventing heart disease and stroke.

The seed oil of *Borago officinalis* is considered one of the richest natural sources of γ -linolenic acid (GLA, 18:3n6), ranging from 20 to 23% of the total fatty acid (FA) composition. GLA displays interesting medicinal properties, such as anti-inflammatory, anti-cancer, emollient of the skin and mucous membranes, among others, and for this reason, this oil is widely marketed.

Borage flower and leaves are used for fever, cough, and depression.

Borage is also used for a hormone problem called adrenal insufficiency, for "blood purification," to increase urine flow, to prevent inflammation of the lungs, as a sedative, and to promote sweating. Borage is also used to increase breast milk production and to treat bronchitis and colds.

Borage is applied to the skin for infantile seborrheic dermatitis and is also used in a dressing to soften the skin.

In foods, borage is eaten in salads and soups. Зеленые листья можно собирать круглый год. Выбирайте только молодые, нежные листья — старые обычно более опушенные и более кислые. Для лучшего вкуса всегда используйте зелень сразу после сбора. В середине лета попробуйте собирать листья утром до того, как на них попадет солнце. Это когда содержание воды в растениях все еще самое высокое, и они будут храниться дольше. Свежие листья можно хранить в холодильнике несколько дней.

Borage has long been used as a kitchen herb. It tastes of fresh cucumbers with a slightly sour note. The fragrance and the aroma of these herbs can already be perceived when you rub a leaf between your fingers.

In the kitchen, only fresh leaves should be used, as the plant loses its aroma

quite quickly when drying. Finely chopped borage leaves can be a real treat in freshly made herb quarks, salads or in combination with tomatoes. Even a simple sandwich with cucumber and a light pinch of salt and pepper is an ideal summer meal.

Borage is very often used as an addition to cucumber salad. It gives the salad a pleasant freshness and a more intense cucumber taste. Frequently, borage is done in conjunction with dill, which is an ideal supplement. Fresh leaves can also be used for cottage cheese or cream cheese preparations. Cooked, however, the herb does not bring much, as it loses all aroma and active ingredients. For the refinement of sauces, the borage leaves should be used only when the sauce is no longer simmer and a little cooled.

Not only the leaves are used, the flowers are also suitable for various applications. For example, the flowers can be candied and desserts such as cake muffins, semolina pudding, jams can be garnished. The flowers sometimes occur as decoration in wild herbs or wild herb soups.

If you want to preserve the taste of borage, you can put it in oil or vinegar. Borage, unlike many other herbs, is not suitable for drying. Oregano, marjoram, sage or thyme become more intense when dried in the aroma, while borage simply does not taste as good as dry herb. Likewise, the active ingredients are lost.

It is known that the plant may contain higher levels of pyrrolizidine. These alkaloids may have liver damaging effects in long-term or high and frequent use. It is therefore recommended by public authorities (including National Institute of Food and Agriculture or the Federal Office for Risk Assessment) to consume only a small amount of borage. Nevertheless, there is still a more acute need for research with regard to the bioavailability of pyrrolizidine. It is also not yet possible to conclude which individual substances from the group of pyrrolizidine actually represent a hazard. The occasional consumption of some leaves is therefore usually not a problem.

Conclusions

1. *Borago officinalis* is an important medicinal plant of medeterrian region. Borage is an annual plant that grows wild in the Mediterranean countries and has been cultivated elsewhere. The primary chemical constituents of Borage leaves and flowers include mucilage, tannin, saponins, essential oil, alkaloid (pyrrolizidine), vitamin C, calcium and potassium. The plant reported to contain essential fatty acids, linoleic acid and gamma-linolenic acid.

2. Literature survey reveals that Borage acts as a restorative agent on the adrenal cortex; in other words, it is believed to revive and renew the adrenal glands after a medical treatment of cortisone or steroids. There is a growing need for remedies that will aid the main system of medication i.e. allopathic system of medication, therefore its urgent need to do research on medicinal plants such as *Borago officinalis* to explore their medicinal value for the sake of mankind. It's suggested that the research work on *Borago officinalis* related to activities such as Cardiovascular, Anti-inflammatroy, gastrointestinal disorders may be explored.

EXPERIMENTAL PART

CHAPTER 2.

PHARMACOGNOSTIC STUDY MORPHOLOGICAL AND ANATOMICAL SIGNS OF THE BORAGE «ALBA» VARIETY

The object of the study became the above-ground part (herb) of *Borage* «*Alba*» variety (Fig.2.1).



Fig. 2.1 *Borage* «*Alba*» variety

For the study we are used the raw materials, collected in August 2021. We are used air dry herb.

Morphological characteristics of the *Borage* «*Alba*» variety.

Leaf is simple, obovate or ovate in shape, with an obtuse apex and crenate margin, the upper leaves are sessile or shortly stalked while the lower ones exhibit a decurrent petiole. The leaves have dark green upper surface with greyish green lower due to the prickly hairs .

Microscopic characteristics of the *Borage* «*Alba*» variety: The upper epidermis of lamina is covered with a thin, smooth cuticle and consists of one layer of polygonal cells with almost straight anticlinal walls. Stomata occur fairly frequently and are mainly anisocytic type, some are animocytic.



Fig. 2.2 Stomata occur fairly frequently and are mainly anisocytic type, some are anisomorphic.

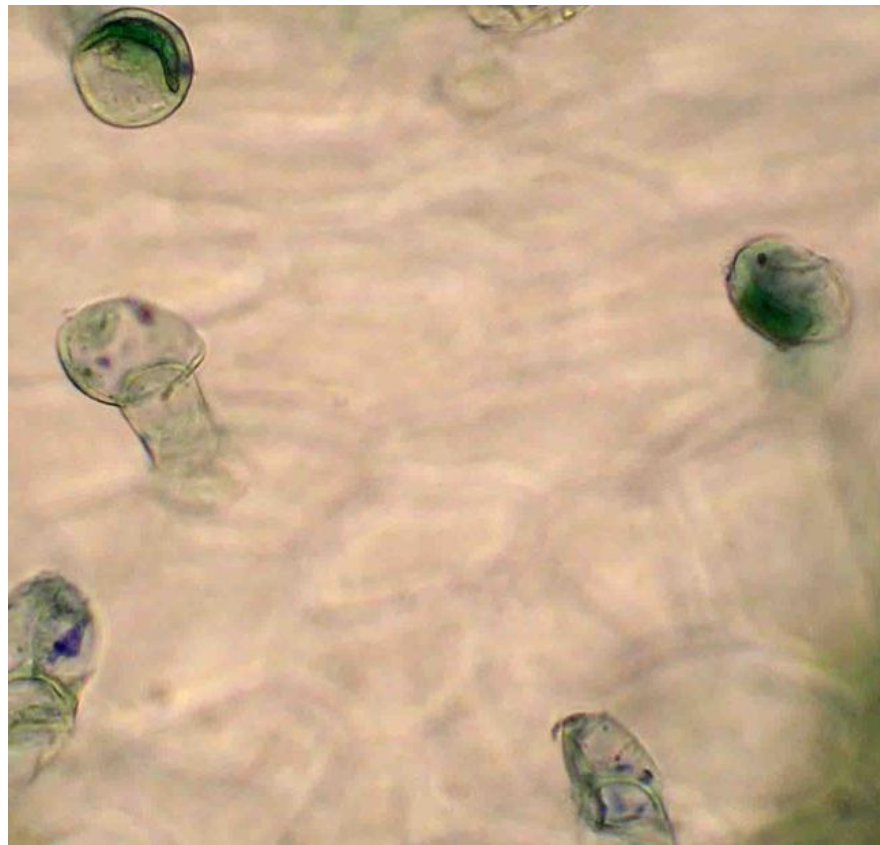


Fig. 2.3 Glandular trichomes consist of a unicellular stalk and a unicellular, sub-spherical head.

Covering trichomes are numerous, they are unicellular, straight having cellulose walls and tapering apices. The lumen is visible throughout the entire length, the base is somewhat swollen and may contain crystalline inclusions. Glandular trichomes consist of a unicellular stalk and a unicellular, sub-spherical head.



Fig. 2.4 Covering trichomes are numerous, they are unicellular, straight having cellulose walls and tapering apices.

The midrib has a typical dicotyledonous structure, the diameter of the central bundle increase from the apex to the base of the leaf. Large trichomes have their base surrounded by several small and the walls are sometimes warty. These types of trichomes are not as frequent as those with at the bulbous base. The cortex contains one or two rows of hypodermal collenchymas below the upper epidermis and above lower epidermis. The endodermal sheath is consisting of a single layer of cells containing starch grains. In transverses section this layer is horse-shoe shaped. The mristele is sub-spherical in shape and well defined in transverses section. The pericycle consists of a well defined area of collenchyma above the

xylem and below the phloem. The tranverse section through the petiole is similar to that of the midrib with a exception that cells are slightly large due to the ncrease in size of the total structure. Some trichomes contain crystalline deposits in their bases.

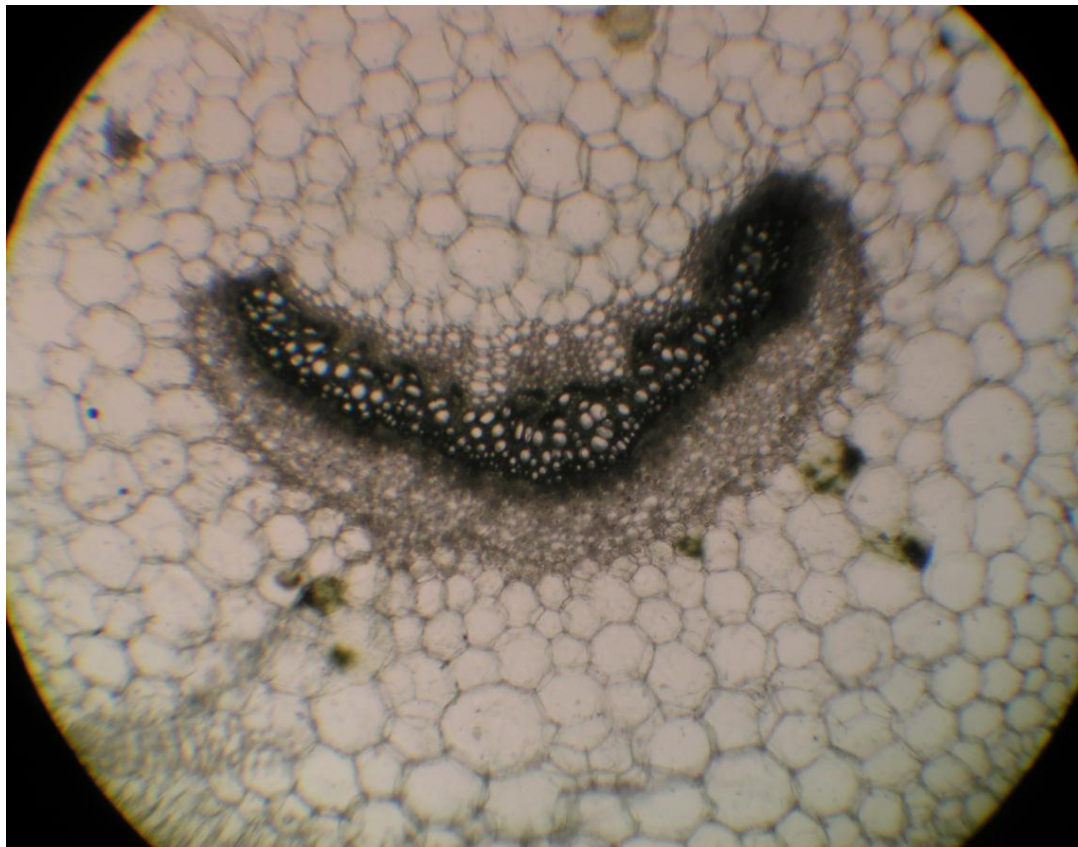


Fig. 2.5 he tranverse section through the petiole is similar to that of the midrib with a exception that cells are slightly large due to the increase in size of the total structure.

Powder microscopy: The powdered drug is light brown with greenish tinge and has cucumber like odour and taste. On microscopic study it contain various glandular and non-glandular unicellular trichomes, palisade and spongy mesophylls, collenchymas, and thin layer parenchymatous cells. The tracheidal vessels with annual and spiral thickenings are also seen scattering with epidermal fragments.

CHAPTER 3.
STUDY OF QUALITATIVE COMPOSITION OF BAS OF *BORAGE*
«ALBA» VARIETY HERB

For identification of BAC used qualitative chemical reactions and chromatographic methods. Chromatographic research were carried out using two-dimensional paper chromatography in solvent system: I direction - ethyl acetate-formic acid-water (10:2:3); II direction - 2% acetic acid.

3.1. Polysaccharides

For extraction of polysaccharides cutting 1.0 g of raw material to the particle size of 2 mm. Sample was placed in a flask with 50 ml shliftom. Poured raw material 10 ml of purified water.

We closed flask air refrigerator and boil in water bath for 20 minutes. Cooled extract and percolated through cotton wood. To 1 ml of the filtrate add 3 ml of 96% ethanol. There was an amorphous precipitate in observation.

The presence of polysaccharides in the studied raw material was detected.

3.2. Iridoids

The reaction with the reagent Stahl: in a test tube add 1 ml of herbal extracts and 0.5 ml of reagent Stahl, the mixture was heated in a water bath for 1-2 minutes (Stahl reagent 5 ml of concentrated hydrochloric acid, 1.0 g of p-dymethylaminobenzaldehydu dissolved in 96% ethanol solution in volumetric flask containing 100 ml.

The reaction with the reagent Trim-Hill: test tube add 1 ml of the extract and 0.5 ml of reagent Trim-Hill.

The mixture was heated in a water bath for 1-2 minutes (Trim-Hill reagent: a mixture of of acetic, concentrated hydrochloric acid and 0.2% aqueous solution of copper sulfate) [20].

After the reaction the specific blue-green color is formed

Based on the color of the spots after processing the chromatogram with the Stahl reagent, it can be assumed that the herb of *Borage* «Alba» variety contain iridoids, which appeared on the chromatogram as blue-green spots. It can also be assumed that the raw materials contain catechins, which gave a crimson-red color on the chromatogram and flavanones - a brown color.

3.3. Phenolic compounds

3.3.1. Simple phenols

0,5 g of powdered material was placed in a flask and add 10 ml of water, boil for 2-3 minutes, filtered after cooling. To 1 ml of the filtrate add crystal iron chloride.

Observation. As a result of the reaction formed gray tint of solution.

To 2 ml of the filtrate was added 4 ml of ammonia solution and 1 ml of 10% sodium phospho-molybdenum in hydrochloric acid.

This reaction is specific for members of simple phenols.

Observation. Formed a dark green solution.

The results of the reaction established the presence of simple phenols, in particular arbutin in herb.

3.3.2. Coumarines

Reaction with alkali and diasoreagent: 3-5 ml alcohol solution extract was added 5 drops of 10% potassium hydroxide solution and heated in a water bath for several minutes. After you have added 3-5 drops diasosulfanilic acid. In observation the red color of the solution.

Lactone test: 3-5 ml of extract was added 5 drops of 10% alcohol solution of potassium hydroxide, heated in a water bath, was added 5.10 ml of distilled water, mixed well, add 10 drops of 10% hydrochloric acid [37]. The formation of a white precipitate, it showed that the raw materials contains coumarins.

The results of the qualitative determination some of BAC are given in Table 2.1.

Table 2.1.

The results of the qualitative determination of BAC in *Borage «Alba» variety* herb

Class of compound	96% ethanol	FeCl ₃	Sodium phospho-molybdenum in hydrochloric acid	Alkali and diasoreagent	Lactone test
Polysaccharides	amorphous precipitate	-	-	-	-
Simple phenols	-	gray tint of solution	dark green solution	-	-
Coumarines	-	-	-	red color	white precipitate

3.3.3. Flavonoids and hydroxycinnamic acids

For preliminary identification of flavonoids used cyanidine reaction by Briant, the reaction with 10% alcohol-water solution of alkali, reaction with lead acetate, reaction with FeCl₃ [19, 37].

Obtaining the extract for investigation. Cutting 3.0 g of raw material to the particle size of 2 mm. Sample was placed in a flask with 100 ml. To raw material added 35 ml of 70% ethanol. Closed flask air refrigerator and boil in water bath for 20 minutes, stirring occasionally. After cooling, the conducted filtration. The filtrate was used for further study.

Cyanidine reaction.

To 1 ml of purified extract was added 2-3 drops of concentrated hydrochloric acid and a few pieces of metallic magnesium powder.

After the end of the allocation of gas bubbles to the colored solution was added butanol, diluted with water to the separation of layers and shaken.

Observation: The formation of the organic phase pink color and yellow color of the aqueous phase.

Reaction with alkali.

To 1 ml of the extract was added 1-2 drops of 10% alcohol-water solution of potassium hydroxide.

Observation: The formation of a yellow precipitate.

Reaction with $FeCl_3$.

To 1 ml of the extract was added 1-2 drops of 10% solution of ferric chloride

Observation: The formation of yellow-green precipitate.

Reaction with lead acetate.

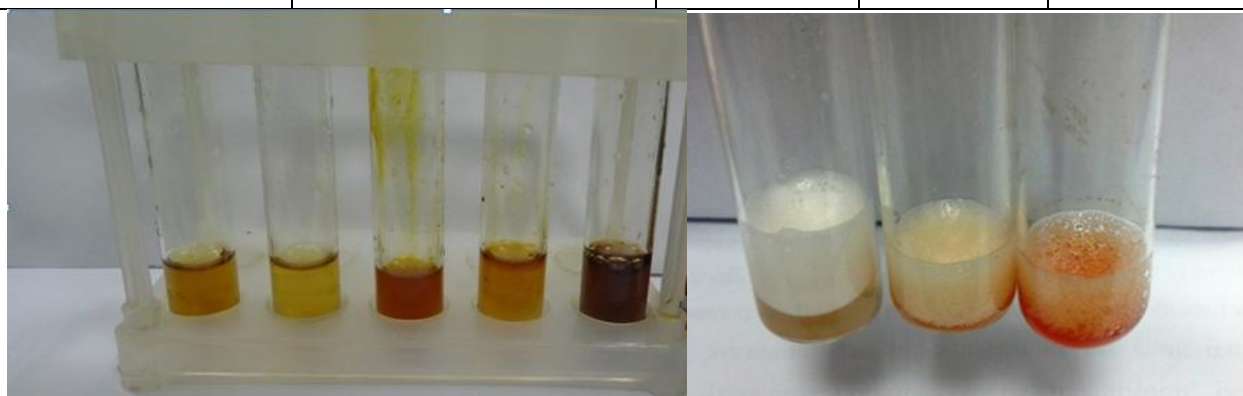
Observation: The formation of intense yellow amorphous precipitate.

The results of the qualitative determination of flavonoids are shown in Tab. 2.2

Table 2.2

Results of the qualitative determination of flavonoids
in *Borage «Alba»* variety herb

Raw material	Reagent			
	Cyanidine reaction	Solution KOH	$FeCl_3$	Lead acetate
<i>Borage «Alba»</i> variety herb	pink color of the organic phase and the water phase yellow	yellow precipitate	yellow-green color of solution	yellow amorphous precipitate



As a result of qualitative reaction, the presence flavonoids in studied raw materials was established. Cyanidine reaction is specific for this type of compounds shown, that herb contains aglycones and glycosides derivatives of flavonoids.

For identification of phenolic compounds used chromatographic methods. Chromatographic research were carried out using two-dimensional paper

chromatography in solvent system: I direction - ethyl acetate-formic acid-water (10:2:3); II direction - 2% acetic acid. Chromatograms were analyzed in daylight and UV- light after processing of ammonia pairs and an alcoholic solution of alkali. Also used chromatography in compared whis standard compounds [19, 20].

The results of chromatographic studies are shown in Fig. 3.4 and Table 3.3.

Table 2.3

Chromatographic characteristic of phenolic compounds from

Borage «Alba» variety herb

№ of spot	Fluorescence in UV-light	
	before processing the reagent	after processing of ammonia pairs
1	Blue	Blue
2	Light blue	Light blue
3	Light blue	Turquoise
4	Yellow	Yellow
5	Yellow	Yellow -green
6	Yellow	Yellow
7	Blue	Blue
8	Yellow	Brown
9	Yellow	Brown
10	Yellow	Yellow -green
11	Yellow	Yellow -green
12	Yellow	Brown
13	Yellow	Brown
14	Yellow	Brown
15	Yellow	Brown
16	Yellow	Brown
17	Yellow	Brown
18	Yellow	Brown
19	Yellow	Brown
20	Yellow	Yellow -green
21	Yellow	Yellow -green
22	Yellow	Yellow -green

23	Yellow	Yellow -green
24	Yellow	Yellow -green

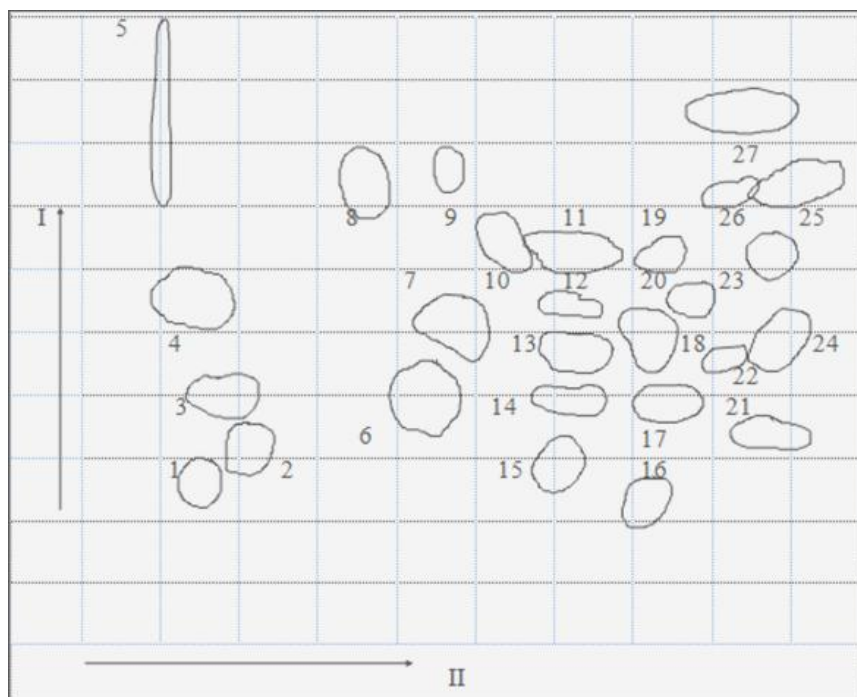


Fig.3.4 Chromatogram of phenolic compounds of *Borage «Alba» variety* herb

As the shows Tab. 2.3., in *Borage «Alba» variety* herb presence of at least 8 compounds of phenolic nature, among wham according Rf values compounds 4, 5, 6 and 8 have flavonoid nature and compounds 1, 2, 3, 7 are derivatives of hydroxycinnamic acids.

When compared with standart sample compound 3 identified as chlorogenic acid, 4 - as quercetin.

3.3.4. Tannic compounds

Extraction

Cut raw materials and sifted through a sieve with 1 mm diameter holes. 1 g of sample material was placed in a flask containing 250 ml, add 100 ml of water and heated in boiling water bath for 20 minutes. Cooled hoods and percolated cotton wool.

Reaction 1. To 2 ml of purified extract was added a few drops of 1% solution of quinine chloride [39]. In observation we detected the formation of a white precipitate.

Reaction 2. To 2 ml of extract was added 4 drops of iron-ammonium alum. We saw the olive color of the solution.

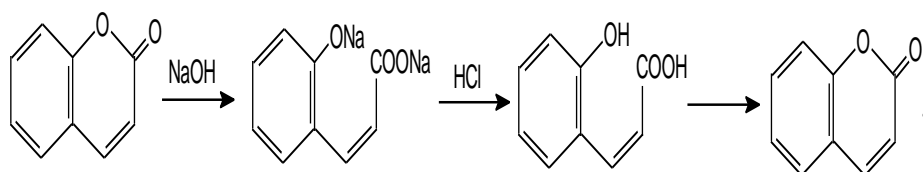
Reaction 3. To 1 ml of extract was added 2 ml of 10% acetic acid and 1 ml of salt lead acetate. We saw the formation of brown precipitate.

Reaction 4. To 2 ml of extract was added a few crystals of sodium nitrate and 2 drops of 0.1 N hydrochloric acid. Was formed light yellow color solution.

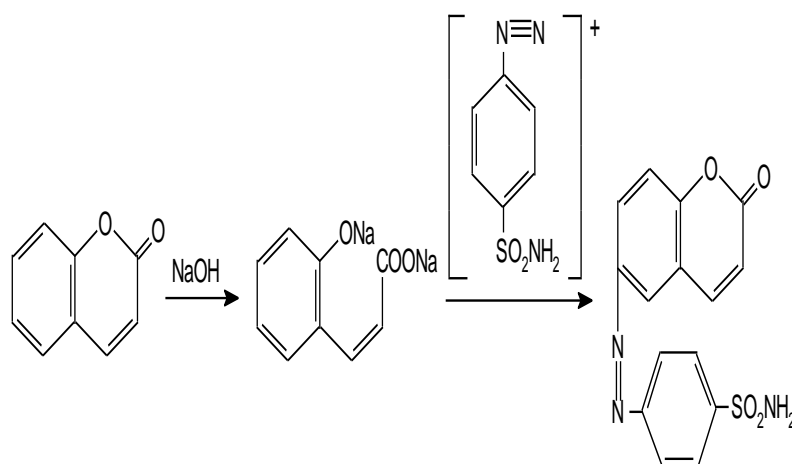
Reaction 5. Up to 2 ml of extract was added 2 drops of ferric chloride. Observed black -green color.

The results of the qualitative determination of tannic compounds are given in Table 2.4.

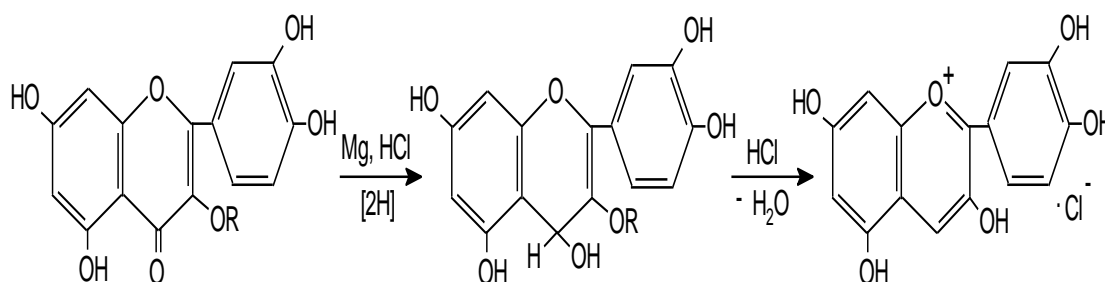
1



2



3



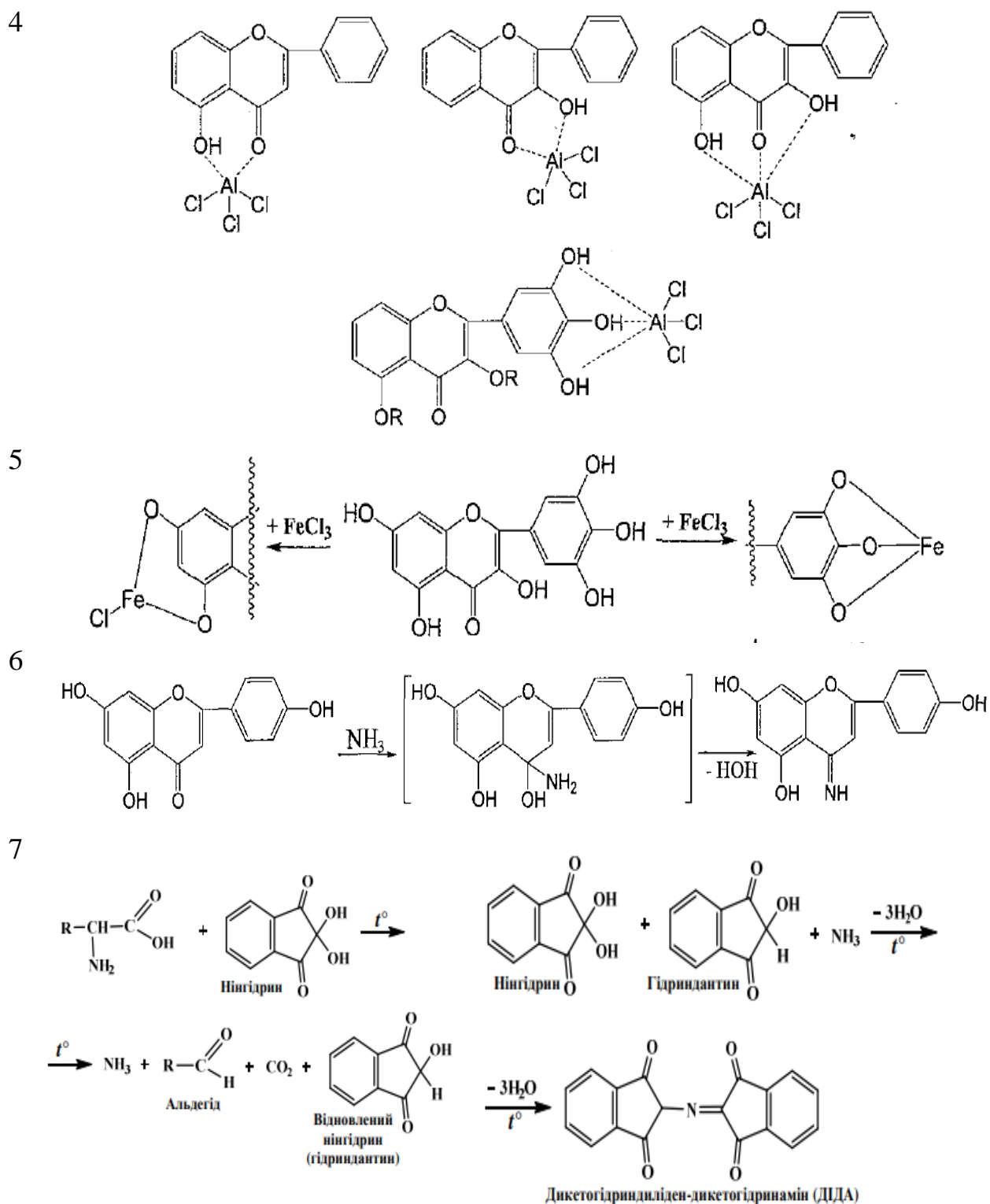


Fig. 2.5. Schemes of the main qualitative reactions of identification of biologically active substances of the collection for use in the complex therapy of skin diseases: 1 - lactone test; 2 - reaction with alkali and diazoreactive; 3 - cyanidin test according to Briant; 4 - reaction with aluminum chloride; 5 – ferum reaction (III) chloride; 6 - reaction with ammonia; 7 - reaction with nindrin

Table 3.4.

The results of the qualitative determination of tannic compounds in
Borage «Alba» variety herb

Reagent				
iron-ammonium alum	1% solution of quinine chloride	$\text{CH}_3\text{COOH} + (\text{CH}_3\text{COO})_2\text{Pb}$	$\text{NaNO}_2 + \text{HCl}$	FeCl_3
olive color of the solution	white precipitate	brown precipitate	light - yellow	yellow - brown

According to the study identified the presence of oxidation of polyphenolic compounds in the tested raw materials.

3.4. Saponins

For the study we placed 50 g of powdered plant in a conical flask of 100 ml reflux and poured 50 ml of 50% alcohol. Content of the flask heated in a boiling water bath for 15 minutes. Extract cooled and filtered. 20 ml of the filtrate was evaporated in a water bath to 10 ml. The aqueous extract was used for qualitative reactions.

1. Test of foam formation

Place 2-3 ml of the obtained water extract in a test tube. Shake during 1 minute.

Observation: a foam forming.

2. Laphone reaction (color reaction).

To 2 ml of alcohol-water extract was added 1 ml of 10% solution of copper sulfate and 1 drop of concentrated sulfuric acid and gently heated. Formed blue-green precipitate.

3. To 1 ml of extract was added 3-4 drops of *barite water*. We so white opalistsents.

4. Up to 1 ml of extract was added 3-4 drops of 10% lead acetate solution. The formation of a yellow precipitate finally.

The results of qualitative research of saponins are shown in Table 2.5.

Table 3.5.

The results of qualitative research of saponins in *Borage «Alba» variety* herb

Reagent/reaction		
Laphone reaction	Barite water	$(\text{CH}_3\text{COO})_2\text{Pb}$
Blue-green opalistsents	White opalistsents	Yellow precipitate

Conclusions. As a result of qualitative reactions determined presence of saponins in *Borage «Alba» variety* herb.

3.5. Alkaloids

For extraction of alkaloids place 1.0 g of powdered herb in a glass conical flask, add 25 ml of 1% hydrochloric acid. Attach a reflux condenser to the flask and boil on a water bath for 30 min. Cleaned the filter the solution through a paper filter. For reactions used the filtrate.

To establish the presence of alkaloids qualitative chemical reactions and chromatography methods were used

Methods of carrying out qualitative reactions

1 drop of extraction was placed on a glass slide, 1 drop of the reagent was applied. The result was evaluated by the formation of colored precipitates.

The following reagents were used for the analysis: Wagner's reagent, Dragendorff's reagent, Sonnenstein's reagent, picric acid, Lugol reagent (Table 2.6).

Table 3.6

Results of identification of alkaloids in raw materials

Reagent	Results of reaction
Wagner's reagent	brown precipitate
Dragendorff's reagent	dark-brown precipitate
Sonnenstein's reagent	green precipitate
1% picric acid	yellow precipitate

Conclusions

1. By used the qualitative chemical reactions and chromatographic methods the qualitative composition of BAC of *Borage «Alba» variety* herb of variety Bolivar F was carried out. In herbal drugs was determined the compounds of different chemical structure: polysaccharides, phenolic compounds, saponins, alkaloids.
2. According the results of PC whis standard samples in *Borage «Alba» variety* herb detected 8 phenolic compounds, among which 4 compounds (4, 5, 6, 8) had flavonoid nature and compounds 1, 2, 3, 7 are derivatives of hydroxycinnamic acids.
3. The primary chemical constituents of Borage leaves and flowers include mucilage, tannin, saponins, essential oil, alkaloid (pyrrolizidine), vitamin C, calcium and potassium

CHAPTER 4.

QUANTITATIVE DETERMINATION OF BAC OF *BORAGE «ALBA» VARIETY HERB*

4.1. Determination the content of flavonoids

Flavonoids are secondary natural compounds widespread in plants and offer various health-promoting properties, such as antioxidative [1], anticancer [2], and anti-inflammatory activities [3,4]. They are mainly present as glycosides, differing in binding type and sugar moiety. Although most of them exist as O-glycosides where the sugar is linked to the aglycone via an O-glycosidic bond, several plants also accumulate C-glycosides with sugar and aglycone linked via a C-C-glycosylic bond

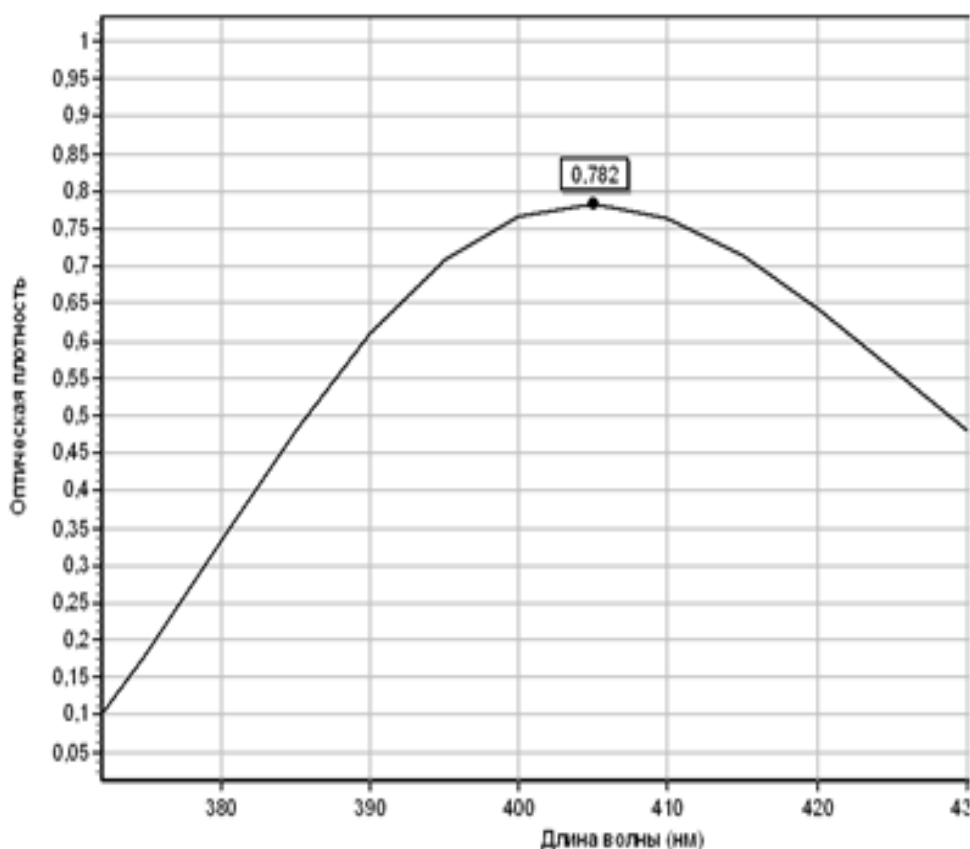


Fig 4.1 UV spectrum of flavonoids

The quantitative content of the sum of flavonoids in the raw material was carried out by the spectrophotometric method at a wavelength of 410 ± 2 nm in terms of rutin [8]. The results are presented in table 4.1.

Table 4.1.

Metrological characteristics average results of flavonoids determination

Xi	n	Xcp.	S ²	S	t(P,f)	Sxcp.	ΔX	ΔXcp.	E	Ecp.
0,18	5	0,318	0,0734	0,2709	2,5700	0,1211	0,6961	0,113	30,0316	13,4306
0,17										
0,24										
0,21										
0,29										

The content of total flavonoids in the borage «alba» variety herb was 0,32%.

4.3. Research the essential oil components of *Borage «Alba» variety herb*

4.3.1. Obtaining and quantitative determination essential oil from *Borage «Alba» variety herb*

Quantitative determination of essential oil in raw material is carried out by steam distillation in a Ginsberg's apparatus. The distillate is collected in the graduated tube, the aqueous phase is returned to the distillation flask.

Place 10 g of cut crude drug (weigh out with precision $\pm 0,01$ g) into a flask and add 300 ml of water, introduce the receiver in to the flask and attach the reflux condenser, heat to the temperature of boiling and distil for the prescribed time. Stop the heating, allow to cool and read the volume of volatile oil collected in the receiver [31].

Calculate the result as millilitres per 100 g of drug from the expression:

$$X = \frac{a \times 100 \times 100}{b(100 - w)}$$

a - volume of a volatile oil, ml;

b - mass of vegetable drugs, g; w – loss on drying, %

Was obtained essential oils from *Anethum graveolens* herb. The quantitative content of essential oil was 0,25%.

Determination the physical-chemical properties of Borage «Alba» variety

herb essential oil

Refraction index. Get acquainted with the employment of a Refractometer. Refraction index of essential oil of *Borage «Alba» variety* herb at 20° is 1,28.

Solubility. Essential oil soluble in 96% alcohol, unsoluble in water.

Determine colour and transparency. Place 5 ml of a volatile oil into a cylinder (d= 2-3 cm). It is light green liquid.

Odour. Placed two drops of a volatile oil on a strip of a filtrate paper (12x5 cm) and compare the odour with the odour of the (for 1 h in every 15 min). Essential oil with characteristic smell.

Taste. Placed one drop of a volatile oil on a sugar and with the help of tongue determined its taste. Essential oil has characteristic sweet-bitter taste.

As a result of the conducted research, it was established that *Borage «Alba» variety* herb essential oil is oily, light green, clear liquid, with a characteristic, pleasant smell and sweet-bitter taste.

4.3.2. Chromatography - mass - spectrometry research of components of essential oils from *Borage «Alba» variety* herb.

Qualitative and quantitative determination of essential oil components conducted chromatography-mass spectrometric method in gas chromatography-mass spectrograph company "Hewlett-Packard" (NC), United States, consisting of the brand chromatograph HP6890 GC and mass - selective detector 5973N.

The components were separated on a silica capillary column HP company (HP 19091J-433 HP-5) length of 30 m and an inner diameter of 0.25 mm, filled with 5% phenilmethylsyloxanom.

Column temperature programming was used: initial temperature 600 final - 2400. Distillation period (from the initial to the final temperature of isothermal sections of the program) 1 hour. Sweep The speed 3 hrad/1hv. Sample volume was 0.3 ml with a coefficient of flow separation and 1:15 inlet pressure of 40 kPa column; carrier gas - helium. Recording time - 0.5 sec. [1, 59].

The resulting spectra are seen as based on the general laws of fragmentation

of molecules of organic compounds under electron impact, or by searching mass spectral library databases «Flavor2.L.» And «NIST98 L.».

Before carrying out the search for each chromatographic peak calculated average mass spectrum from which the background subtracted spectrum . The identification of compounds was performed by comparison of mass spectra of the chromatographic peak of the mass spectra of reference compounds with high probability recognition program identified in the array spectra database [59].

The quantitative content of the compounds was calculated by the ratio of the peak component to the sum of the areas of all peaks in the chromatogram (method of normalization).

Research conducted chromatography-mass spectrometric method using the built-processing program of mass spectra.

Mass spectra corresponding chromatographic peaks were identified by comparing their mass spectra with reference compounds.

Results of chromat-mass-spectrometry research of *Borage «Alba» variety* herb essential oil shown in Table 4.3.

Table 4.3.

Results of chromat-mass-spectrometry research
of *Borage «Alba» variety* herb essential oil

№	Rt, min.	Compound	Content, (%)
1	16,56	piperitone	0,37
2	19.96	eugenol	0,78
3	23,96	β -ionol	1,49
4	26,52	megastigmatriyenone	0,65
5	31,70	farnesylacetone	1,03
6	31,75	methylpalmitate	1,22
7	33,56	heneikosan	2,06
8	33.74	phytol	5,28
9	39,98	squalen	2,95

As seen from Table 3.3 in 40 compounds. Dominated in quantitative content are eugenol, squalen and phytol.

Tc display lipophilic antioxidant properties to prevent lipid peroxidation, and they also act as scavengers of reactive oxygen species. Therefore, their main role in plants is related to the protection of lipids against oxidation. Furthermore, all these compounds reportedly possess antitumor activities, prevent cardiovascular diseases and diabetes, and display anti-inflammatory activity. Regarding Tc occurrence,

while Tp reach high concentrations in most seed oils, T3 compounds are restricted to a few botanical families. In addition, the amounts of Tc are lower in fruits and vegetables than in seed oils because of the lower concentration of lipids.

Phytosterols are bioactive isoprenoids occurring in plants. More than 150 phytosterols have been found so far. Among them, β -sitosterol, campesterol and stigmasterol are dominant compounds, representing 65, 30, and 3%, respectively, of the dietary phytosterol intake. Phytosterols have cholesterol-lowering effects. They are found in plants either as esters or as free alcohols both of which are beneficial to health as the hydrolysis of the esters occurs in the digestive system. The nutritional value of such compounds is connected to the inhibition of the absorption of cholesterol, and to the reabsorption of cholesterol excreted to the bile during the enterohepatic cycle, leading to lower values of total serum cholesterol and LDL-cholesterol. St (campesterol, β -sitosterol and stigmasterol) show antitumor actions, especially on those of colon, breast, and prostate. Their mode of action is connected to cancer cell growth inhibition, and to the promotion of cancer cell apoptosis. Sq is a 30-carbon isoprenoid and the biosynthetic precursor of steroids both in plants and animals, which is metabolized to St in plant cells. Although no report was found about its antitumor actions in humans, in rodents Sq inhibits induced tumorigenesis, and can reduce free radical oxidative damage to the skin. The primary application of Sq in cancer therapy seems to be as potentiating agent for anticancer drugs. Promising results were obtained when Sq was tested in combination with antitumor agents. Moreover, animal experimentation suggested the protective effect of Sq against cardiovascular heart disease, explained by its ability to inhibit the isoprenaline-induced lipid peroxidation.

The composition of the essential oil of borage medicinal herb was determined: at least 60 components, of which 40 were identified, belonging to hydrocarbons, alcohols, complex ethers, ketones, aldehydes. The main components of the essential oil were diisooctyl phthalate (14.60%), hexahydrofarnesylacetone (13.84%), dibutyl phthalate (6.83%), diisobutyl phthalate (6.68%), heptacosane (5.87%), phytol (5.28 %).

3.6. The study of microelement composition of *Borage «Alba» variety herb.*

Study of qualitative and quantitative elements was performed using the method of atomic emission spectrophotometry.

Samples were evaporated to craters of graphite electrodes in the discharge the arc alternating current power at 16 and 60 seconds of exposition.

As a source of excitation of spectra using IBC-28.

The spectra were recorded on film using a spectrograph DFS-8 diffraction grating 600 str / mm and threelens lighting slit.

Conducted photometry line of spectra at wavelengths from 240 to 347 nm in the samples compared with standard samples of mixture of mineral elements with mikrophotometr MF-4.

The results of elemental analysis of *Borage «Alba» variety herb* shown in Table 3.7.

Table 3.7.

The results of elemental analysis of *Borage «Alba» variety herb*

Element	The quantitative contents (mg/100 g)
Macroelements	
Potassium (K)	7350
Sodium (Na)	1350
Calcium (Ca)	1850
Phosphorus (P)	170
Magnesium (Mg)	710
Silicon (Si)	1080
Microelements	
Iron (Fe)	150
Manganese (Mn)	30
Aluminium (Al)	6
Lead (Pb)	<0,01

Strontium (Sr)	0,3
Nickel (Ni)	0,03
Molybdenum (Mo)	<0,03
Copper (Cu)	8
Chromium (Cr)	<0.03
Cobalt (Co)	<0.01
Cadmium (Cd)	<0.01
Arsenic (As)	<0.01
Surma (Sb)	<0.01

Detected 6 macro – (K, Na, Ca, P, Mg, Si,) and 9 microelements (Fe, Mn, Al, Pb, Sr, Ni, Mo, Cu, Cr). Potassium and calcium a contents in most higher Potassium was the major mineral element, reaching an even higher proportion than either fat or starch. Borage had also adequate levels of iron.

Based on the amount needed, mineral elements are usually classified into two groups: macroelements and microelements. Macroelements consist of elements in large supply, while microelements are usually only needed in trace amount.

Calcium (Ca): Calcium functions as a cofactor with many enzymes and is particularly important in cell wall synthesis. Calcium deficiency may result in shoot tip necrosis. Calcium used in plant tissue culture is mostly in the forms of calcium chloride and calcium nitrate in a concentration of 1-3 mM.

Magnesium (Mg): Magnesium is critical for enzyme functioning, and an integral component of chlorophyll molecule. Magnesium is also a cation in plant to balance negative ions. The most used form of magnesium in plant tissue culture is magnesium sulfate in a concentration of 1-3 mM.

Phosphorus (P): Phosphorus is an integral part of nucleic acids and other structural compounds in plants. Phosphorus is supplied in culture media as phosphate (PO₄⁻) in a form of sodium or potassium hydrogen phosphate at 1-3 mM.

Potassium (K): Potassium is major positive ion in plants to balance negative ions. The amount of potassium needed in a plant tissue culture medium varies

depending on the plant species. Usually it is supplied at 20-30 mM in correlation with that of nitrate.

Iron (Fe): Iron is required for chlorophyll synthesis as well as in many oxidation/ reduction reactions. Iron usually present in media at 1 μ M. Since iron forms insoluble compounds in alkaline pH, being unavailable to plant in culture, medium pH is critical for iron supply. Fe-EDTA is often used in culture media and enable iron to be available to cultures over a wider pH range than other agents.

The natural pattern of uptake of minerals such as Potassium (K), Magnesium (Mg), Sodium (Na) and Calcium (Ca) varies during the course of the growing season. The dry matter of young rapidly growing grass, especially in the spring, has a high K content which declines as the season progresses, whilst the concentration of other minerals increases through the summer.

Heavy metals are one of the most important abiotic stresses which can have detrimental effects on the growth, metabolic pathways, and physiological and biochemical characteristics of plants. Today, the accumulation of heavy metals in agricultural lands has an increasing trend that can affect the production and quality of agricultural products as well as human health. Among heavy metals, cadmium (Cd) is one of the most important worldwide environmental pollutants. It can rapidly be taken up by plants and accumulates in plant tissues, and easily enter the food chain; so this heavy metal is a serious threat to humans, animals, plants, and environmental sustainability.

Conclusions

1. The primary chemical constituents of Borage leaves and flowers include mucilage, tannin, saponins, essential oil, alkaloid (pyrrolizidine), vitamin C, calcium and potassium
2. By steam distillation was obtained the essential oil from *Borage «Alba» variety* herb and recalculated its quantitative content, it was 0,25 %.
3. Was determined the physical-chemical properties of *Borage «Alba» variety* essential oil: refraction index, solubility, colour and transparency, odour, taste.
4. By use chromat-mass-spectrometric method in essential oil identified 9 compounds. Dominated in quantitative content are miristicine, squalen and apiole.
5. Detected 6 macro – (K, Na, Ca, P, Mg, Si,) and 9 microelements (Fe, Mn, Al, Pb, Sr, Ni, Mo, Cu, Cr).

GENERAL CONCLUSIONS

1. *Borago officinalis* is an important medicinal plant of medeterrian region. Borage is an annual plant that grows wild in the Mediterranean countries and has been cultivated elsewhere. The primary chemical constituents of Borage leaves and flowers include mucilage, tannin, saponins, essential oil, alkaloid (pyrrolizidine), vitamin C, calcium and potassium. The plant reported to contain essential fatty acids, linoleic acid and gamma-linolenic acid.

2. Literature survey reveals that Borage acts as a restorative agent on the adrenal cortex; in other words, it is believed to revive and renew the adrenal glands after a medical treatment of cortisone or steroids. There is a growing need for remedies that will aid the main system of medication i.e. allopathic system of medication, therefore its urgent need to do research on medicinal plants such as *Borago officinalis* to explore their medicinal value for the sake of mankind. It's suggested that the research work on *Borago officinalis* related to activities such as Cardiovascular, Anti-inflammatroy, gastrointestinal disorders may be explored.

3. Qualitative composition BAC of Borage «Alba» variety herb was carried out. For investigations used qualitative chemical reactions and chromatographic methods. In herbal drugs was determined presens of polysaccharides, simple phenols, coumarins, flavonoids, hydroxycinnamic acids, tannic compounds, saponins, alkaloids. The composition of mineral elements was study.

4. Quantitative content of essential oil was established. For tye essential oil some physical chemical characteristics was study.

5. Taking into account the results of phytochemical screening, it is possible to draw conclusions about the future prospects of using the herb of Borage «Alba» variety.

Since the raw material has a high content of squalene, it can be suggested to use the lipophilic fraction as a substance for the manufacture of an antimicrobial, antifungal agent for external use.

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National University of Pharmacy

Faculty for foreign citizens' education
Department pharmacognosy

Level of higher education master

Specialty 226 Pharmacy, industrial pharmacy
Educational program Pharmacy

APPROVED
The Head of Department
pharmacognosy
Olga MALA_____

28 of September 2022

**ASSIGNMENT
FOR QUALIFICATION WORK
OF AN APPLICANT FOR HIGHER EDUCATION**

Azikou HAJAR

1. Topic of qualification work: «Pharmacognostic study of the Borage «Alba» variety », supervisor of qualification work: Victoria MASHTALER, PhD, PhD, assoc. prof.

approved by order of NUPh from «6» of February 2023 № 35

2. Deadline for submission of qualification work by the applicant for higher education: October 2022.

3. Outgoing data for qualification work: The qualification work is devoted to the phytochemical study of the herb of Borage «Alba» variety. The qualitative composition of biologically active substances of raw materials was established and their quantitative content was determined

4. Contents of the settlement and explanatory note (list of questions that need to be developed): to collect information sources on the botanical characteristics, chemical composition, biological properties, and medicinal use of raw materials of representatives of the Borage «Alba» variety. To conduct a phytochemical study of the qualitative composition of the main groups of biologically active substances of raw materials representatives of the Borage «Alba» variety, chromatographic analysis, to determine the quantitative content of the main groups of biologically active substances and the main numerical indicators of medicinal plant raw materials of representatives of the Borage «Alba» variety.

5. List of graphic material (with exact indication of the required drawings):
Tables 11 , pictures 19.

6. Consultants of chapters of qualification work

Chapters	Name, SURNAME, position of consultant	Signature, date	
		assignment was issued	assignment was received
1	Victoria MASHTALER, PhD, assoc. prof., associate professor of higher education institution of department pharmacognosy	9.2022-10.2022	9.2022-10.2022
2	Victoria MASHTALER, PhD, assoc. prof., associate professor of higher education institution of department pharmacognosy	10.2022-11.2022	10.2022-11.2022
3	Victoria MASHTALER, PhD, assoc. prof., associate professor of higher education institution of department pharmacognosy	11.2022-12.2022	11.2022-12.2022
4	Victoria MASHTALER, PhD, assoc. prof., associate professor of higher education institution of department pharmacognosy	1.2023	1.2023

7. Date of issue of the assignment: «28» of September 2022

CALENDAR PLAN

№ 3/II	Name of stages of qualification work	Deadline for the stages of qualification work	Notes
1	Writing a review on a given issue	October-December 2022	done
2	Conducted of qualitative identification of phenolic compounds	January 2023	done
3	Conducted of qualitative identification of polysaccharides, alkaloids, iridoids	February 2023	done
4	Conducted of quantitative study of fatty acids and essential oil	March 2023	done
5	Preparation of a master's manuscript for official defense	May 2023	done

An applicant of higher education

_____ Azikou HAJAR

Supervisor of qualification work

_____ Victoria MASHTALER,

ВИСНОВОК

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

№ 116416 від «15 » червня 2023 р.

Проаналізувавши випускну кваліфікаційну роботу за магістерським рівнем здобувача вищої освіти денної форми навчання Азіку Хажар, 5 курсу, _____ групи, спеціальності 226 Фармація, промислова фармація, на тему: «Фармакогностичне дослідження трави огіркової трави сорту «Альба»/ Pharmacognostic study of the Borage «Alba» variety», Комісія з академічної доброчесності дійшла висновку, що робота, представлена до Екзаменаційної комісії для захисту, виконана самостійно і не містить елементів академічного плагіату (копіляції).

Голова комісії,
професор



Інна ВЛАДИМИРОВА

2%

31%

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 фармакогнозії				
Азіку Хажар	Фармакогностичне дослідження трави огіркової трави сорту «Альба»	Pharmacognostic study of the Borage «Alba» variety	доцент Машталер В.В.	проф. Перехода Л.О.

Підстава: подання декана згода ректора

Ректор

Вірно. Секретар



REVIEW

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

Azikou HAJAR

on the topic: « Pharmacognostic study of the Borage «Alba» variety »

Relevance of the topic. The therapeutic use of medicinal plants in human health is an ancient practice, historically constructed on the common-sense knowledge that articulates culture and health, since these aspects do not occur isolatedly, but are inserted in a certain historical context.

Practical value of conclusions, recommendations and their validity. The author conducted an in-depth literature search, which made it possible to compile a fairly complete review of the literature on medicinal plant materials of representatives of the Borage «Alba» variety. The results of the study determine the practical significance of the work. The collector performed a significant amount of experimental work, established the qualitative composition and quantitative content of the main groups of biologically active compounds, established the main numerical indicators of representatives of the Borage «Alba» variety.

Assessment of work. The work was performed at a high scientific level, the performer showed himself as a disciplined, erudite person. All conclusions are logical, the work is well illustrated and structured

General conclusion and recommendations on admission to defend. The results of the completed qualification work have a certain scientific and practical significance, which allows recommending the work for submission to the Examination Commission of the National Pharmaceutical University

Scientific supervisor

Viktoria MASHTALER

«7th» of April 2023

REVIEW

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

Pharmacy, industrial pharmacy

Azikou HAJAR

on the topic: « Pharmacognostic study of the Borage «Alba» variety »

Relevance of the topic. According to WHO, about 85% of the world population uses phytotherapeutic medicines for therapeutic purposes. Alternative methods have been used more, because of the lack of credibility in allopathic medicine and the low cost of phytotherapy. The growing use of medicinal plants by the population is due to low cost and easy access

Theoretical level of work. The qualification work was performed at the appropriate theoretical level. The content of the work fully corresponds to the task of the qualification work and fully discloses the topic. A person with a higher education has processed a large amount of scientific literature at a fairly high theoretical level

Author's suggestions on the research topic. The conducted research made it possible to develop a number of specific proposals that are of practical importance for increasing the effectiveness of the comprehensive research of medicinal plant raw materials.

Practical value of conclusions, recommendations and their validity. The obtained results can be used in practical activities for the pharmacognostic study of medicinal plant raw materials. The material of the qualification work is presented methodically correctly, consistently, logically, which indicates the validity of the obtained results, the author's ability to use literature and summarize literary and experimental data.

Disadvantages of work. Among the shortcomings, it is possible to note imprecise expressions, spelling mistakes, which are sometimes found in the text

General conclusion and assessment of the work. This work meets the requirements for qualifying works and can be recommended for defense at the Examination Commission of the National Pharmaceutical University

Reviewer

prof. Lina PEREKHODA

«10th» of April 2023

МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ
НАЦІОНАЛЬНИЙ ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ

ВИТЯГ З ПРОТОКОЛУ № 13
засідання кафедри фармакогнозії

«19» квітня 2023 року
м. Харків

засідання кафедри
фармакогнозії
(назва кафедри)

Голова: завідувач кафедри, канд. фарм. наук, доцент Мала О.С.

Секретар: канд. фарм. наук, ас. Комісаренко М. А.

Присутні: доц. Мала О.С., проф. Кошовий О.М., проф. Гонтова Т.М.,
проф. Ковальова А. М., проф. Криворучко О. В., доц. Машталер В. В.,
доц. Бородіна Н. В., доц. Демешко О. В., ас. Гончаров О. В., доц. Очкур О. В.,
ас. Комісаренко М. А.

ПОРЯДОК ДЕННИЙ:

1. Представлення кваліфікаційних робіт до захисту в Екзаменаційній комісії НФаУ.

1. СЛУХАЛИ: Про представлення до захисту в Екзаменаційній комісії кваліфікаційної роботи на тему «Фармакогностичне дослідження трави огіркової трави сорту «Альба» здобувача вищої освіти Азіку Хажар

Науковий керівник: доц. Виктория МАШТАЛЕР

Рецензент: проф. Лина ПЕРЕХОДА

В обговоренні кваліфікаційної роботи брали участь: зав. каф. доц. Мала О.С., проф. Кошовий О.М., проф. Криворучко О.В., доц. Бородіна Н.В., доц. Демешко О.В., доц. Очкур О.В., ас. Гончаров О.В.

1. УХВАЛИЛИ: Рекомендувати до захисту кваліфікаційну роботу здобувача вищої освіти Азіку Хажар на тему «Фармакогностичне дослідження трави огіркової трави сорту «Альба» до захисту у Екзаменаційній комісії.

Голова

Завідувач кафедри

Ольга МАЛА

(підпис)

Секретар

асистент

Микола КОМІСАРЕНКО

(підпис)

НАЦІОНАЛЬНИЙ ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ

**ПОДАННЯ
ГОЛОВІ ЕКЗАМЕНАЦІЙНОЇ КОМІСІЇ
ЩОДО ЗАХИСТУ КВАЛІФІКАЦІЙНОЇ РОБОТИ**

Направляється здобувач вищої освіти Азіку Хажар до захисту кваліфікаційної роботи за галуззю знань 22 Охорона здоров'я спеціальністю 226 Фармація, промислова фармація освітньою програмою Фармація на тему: «Фармакогностичне дослідження трави огіркової трави сорту «Альба».

Кваліфікаційна робота і рецензія додаються.

Декан факультету _____ / Світлана КАЛАЙЧЕВА /

Висновок керівника кваліфікаційної роботи

Здобувач вищої освіти Азіку Хажар процесі виконання кваліфікаційної роботи освоїв і використал на практиці різні методи фармакогностичного аналізу досліджуваної сировини.

Отримані результати досліджень за актуальністю, науковим та практичним значенням відповідають вимогам, які висуваються до кваліфікаційних робіт, тому представлена робота може бути рекомендована до публічного захисту у Екзаменаційну комісію Національного фармацевтичного університету

Керівник кваліфікаційної роботи

Вікторія МАШТАЛЕР

«05» квітня 2023 р

Висновок кафедри про кваліфікаційну роботу

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

Завідувач(ка) кафедри
фармакогнозії

Ольга МАЛА

«19» квітня 2023 року

Qualification work was defended
of Examination commission on
« 17 » of June 2023

With the grade _____

Head of the State Examination commission,
DPharmSc, Professor

_____ / Oleh SHPYCHAK /