UDC 581.4:615.322
DOI https://doi.org/10.32782/2226-2008-2025-2-15

B. V. Prystupa http://orcid.org/0000-0002-9100-0860
S. I. Bogatu http://orcid.org/0000-0002-7979-8232
L. V. Eberle http://orcid.org/0000-0002-3466-8653
Ya. V. Rozhkovsky http://orcid.org/0000-0002-3650-9701
D. A. Vorobyov https://orcid.org/0009-0006-8972-6220

PHARMACOLOGICAL AND PHARMACOGNOSTIC ANALYSIS OF PLANTS OF THE GENUS STELLARIA

Odesa National Medical University, Odesa, Ukraine

UDC 581.4:615.322

B. V. Prystupa, S. I. Bogatu, L. V. Eberle, Ya. V. Rozhkovsky, D. A. Vorobyov
PHARMACOLOGICAL AND PHARMACOGNOSTIC ANALYSIS OF PLANTS OF THE GENUS STELLARIA
Odesa National Medical University, Odesa, Ukraine

Introduction. The study of medicinal plants remains a crucial area of scientific research due to their long-standing use as safe and effective therapeutic agents. Plants of the genus *Stellaria* are particularly significant, given their historical application in traditional medicine for addressing inflammatory conditions, skin infections, gastrointestinal disorders, bronchitis, asthma, and obesity.

The purpose. To analyze scientific data from sources such as PubMed and Google Scholar, summarizing the botanical characteristics, chemical composition, and medicinal properties of *Stellaria* species.

Materials and methods. A literature search (2014–2024) using relevant keywords identified over 3,000 publications. After removing duplicates and applying predefined criteria, 60 sources were selected for analysis. Non-pharmacological studies, mechanistic research, editorials, commentaries, and conference abstracts were excluded.

Results. Plants of the *Stellaria* genus are characterized by a rich chemical composition, which includes flavonoids, saponins, alkaloids, phenolic compounds, tannins, and triterpenoids. These bioactive components account for a wide range of pharmacological activities, including anti-inflammatory, antioxidant, antimicrobial, antidiabetic, anxiolytic, antifungal, and antiparasitic properties.

Despite their extensive traditional use and diverse chemical profile, the therapeutic potential of *Stellaria* species remains underexplored. This article summarizes the available scientific data on the botanical characteristics, pharmacochemical composition, and pharmacological activity of plants from this genus and highlights the need for further research to expand their application in modern medicine.

Keywords: Stellaria media, Stellaria nemorum, Stellaria holostea, Stellaria graminea, Caryophyllaceae family.

УДК 581.4:615.322

Б. В. Приступа, С. І. Богату, Л. В. Еберле, Я. В. Рожковський, Д. А. Воробйов
ФАРМАКОЛОГІЧНИЙ ТА ФАРМАКОГНОСТИЧНИЙ АНАЛІЗ РОСЛИН РОДУ STELLARIA
Одеський національний медичний університет, Одеса, Україна

Оглядова стаття присвячена дослідженню ботанічної характеристики, фармакохімічного складу та фармакологічної дії рослин роду *Stellaria*. Представники цього роду мають довгу історію використання в народній медицині для лікування різноманітних захворювань, включно із запальними процесами, шкірними інфекціями, шлунково-кишковими розладами, бронхітами, астмою та ожирінням.

Рослини роду *Stellaria* характеризуються багатим хімічним складом, до якого входять флавоноїди, сапоніни, алкалоїди, фенольні сполуки, дубильні речовини та тритерпеноїди. Ці біоактивні компоненти забезпечують широкий спектр фармакологічної активності, зокрема протизапальні, антиоксидантні, антимікробні, антидіабетичні, анксіолітичні, антигрибкові та антипаразитарні властивості.

Ключові слова: Stellaria media, Stellaria nemorum, Stellaria holostea, Stellaria graminea, Зірочник.

Introduction. The study of medicinal plants is an extremely important area of scientific research, since they have long been used as a safe and effective means of treatment [1–3]. According to the recommendations of the World Health Organization, phytotherapy is considered an alternative method for the treatment of a wide range of diseases, including inflammatory processes, cardiovascular diseases, diabetes, and others [4]. Due to their low level of side effects, medicinal plants have gained widespread popularity in various countries around the world [5–7].

One of the promising plant genera is *Stellaria*, which is commonly found in regions with temperate and cold climates [8].

Given their extensive use in folk and traditional medicine, these plants are applied for the treatment of gastrointestinal disorders, respiratory diseases, as well as for reducing swelling and accelerating bone healing. The bioactive compounds of *Stellaria* species, such as saponins, alkaloids, fatty acids, and other components [9–11], exhibit significant pharmacological activities, including anti-inflammatory [12], antioxidant [13], antimicrobial, anti-hematoma, anxiolytic properties [14, 15], as well as the ability to combat diabetes mellitus [16].

Despite their numerous beneficial properties, the phytochemical composition and mechanisms of action of these

plants remain insufficiently studied that creates a need for further scientific research. *Stellaria* has significant potential for the development of new phytopreparations that can contribute to improving health and treating various diseases. Further research on this plant will open new prospects in medicine and the pharmaceutical industry.

The aim of the study is to conduct an analysis of scientific sources and data from authoritative databases such as PubMed and Google Scholar to summarize information on the botanical characteristics, chemical composition, and medicinal properties of *Stellaria* species.

Materials and methods of the study. The literature search was implemented using relevant keywords and their combinations related to the research topic, including: *Stellaria*, *Stellaria media*, anti-inflammatory, antioxidant, antimicrobial, pharmacological activity, secondary metabolites, flavonoids, saponins, ethnopharmacology, and medicinal plants. The analysis covered the period from 2014 to 2024. Over 3,000 publications were identified during the search. After removing duplicates, additional selection was carried out according to predefined criteria. A total of 60 sources were selected for further systematic analysis. Publications that were not related to pharmacological topics, as well as mechanistic studies, editorial articles, short commentaries, and conference abstracts, were excluded from consideration.

Research results and discussion

Botanical characteristics of the genus Stellaria

Stellaria is a genus of annual herbaceous plants belonging to the *Caryophyllaceae* family. It comprises approximately 120 to 190 species, depending on the classification system. These plants are characterized by creeping stems that can grow up to 30 cm in length, oval pointed leaves, and small white star-shaped flowers.

During the summer period, they can germinate several times, even after drying, and bloom continuously. A single plant can produce up to 25,000 seeds, facilitating its active spread [17].

Stellaria media is widely distributed in fields, gardens, and orchards across Ukraine, including steppe zones, mountainous regions, urban areas, and agricultural fields. It infests various crops, including cereals, perennial grasses, vegetable beds, and fallow lands. The plant thrives best in shaded areas, such as potato fields, cucumber beds, and greenhouses with tomatoes and peppers [18].

Stellaria media has a broad geographical distribution, occurring in various parts of the world, including Asia, North America, Africa, and Europe. This species can be found in coastal areas, rocky and gravelly shores, and as a weed in cultivated fields and wastelands. It propagates both by seeds (self-seeding) and vegetatively, through rooting at leaf nodes along the stem. Its shallow fibrous root system allows for easy manual removal [19–21].

Botanical analysis of *Stellaria media* raw materials is crucial for accurate identification of its morphological characteristics and differentiation from other species. As a representative of the *Caryophyllaceae* family, *Stellaria* exhibits distinctive traits – thin, creeping stems, small oval leaves, the presence of fine hairs growing along one side of the stem and white flowers forming umbel-like inflorescences.

Special attention is given to characteristics such as leaf shape and size, flower structure, and the morphology of fruits and seeds, which are key to differentiating *Stellaria media* from closely related species. These aspects are critical for the proper collection of medicinal raw materials, ensuring high pharmaceutical quality and enhanced therapeutic efficacy [22].

In the studied plants *Stellaria motuoensis*, the stem is weak, succulent, pale green, slightly swollen, covered with hairs that change sides at the places of leaf attachment. On the transverse section of the stem, thick-walled epidermal cells, collenchyma, 2–3 layers of pigmented cells, endoderm and annularly arranged vascular bundles are revealed. In young stems, the core consists of parenchymatous cells of a round or oval shape, and in mature stems it turns into a hollow slit [23].

The leaves of *Stellaria* are opposite, pale green, succulent, entire, and generally almost glabrous, sometimes ciliate at the base. Lower leaves are ovate or broadly ovate, measuring 3–20 mm in length, petiolate, with a pointed apex and a truncated or rounded base. Upper leaves can reach up to 25 mm in length, are broadly elliptical or ovate, and sessile. A cross-section of the leaf reveals the upper and lower epidermis with a distinct cuticle and anomocytic stomata. The mesophyll consists of a single-layered palisade parenchyma and 3–4 layers of spongy parenchyma with intercellular spaces. The vascular bundle has an arc shape, surrounded by a compact layer of parenchymal cells, with xylem directed toward the upper epidermis and phloem toward the lower epidermis [24].

The flowers of *Stellaria* are white, small, star-shaped, hermaphroditic, and arranged in terminal dichasia. The flower diameter ranges from 3.0 to 6.5 mm. The sepals are ovate-lanceolate, 3–5 mm long, with a narrow membranous margin and glandular hairs. The petals are deeply cleft, usually shorter than the sepals, while the stamens have reddish-purple anthers. The plant forms an ovoid-elongated capsule fruit, 5–7 mm long, which splits into six segments. The seeds are small, reddish-brown, 0.8–1.3 mm in diameter, covered with rounded or conical tubercles, with an air-dry mass of 0.67 mg [25].

The root system is shallow and fibrous, consisting of a thin taproot with a fragile texture, allowing for easy manual removal. In the powdered plant material, rosette and prismatic calcium oxalate crystals, epidermal fragments, and leaf blade elements have been identified. Thick-walled fibers, trichomes, diacytic stomata, and vessels of annular and spiral types are present in the powdered material [26].

Stellaria media demonstrates high adaptability due to its specific anatomical structure, ensuring efficient nutrient transport and mechanical stability. It thrives in various ecological conditions, particularly in moist, shaded areas where it reproduces both by seeds and vegetatively. Whereas the other species mentioned – such as *Stellaria nemorum, Stellaria holostea, Stellaria graminea, Stellaria uchiyamana, Stellaria dichotoma*, and *Stellaria alsine* – either belong to distinct evolutionary lineages or fall outside the core *Stellaria* genus entirely. For example, *Stellaria nemorum* and *Stellaria holostea* are not closely related to the American *Stellaria* species and are excluded from the core genus based on molecular data. *Stellaria*

graminea and its close relatives form a separate clade with narrower leaves and more prominent petals, while *Stellaria uchiyamana* and *Stellaria dichotoma* represent parallel evolutionary developments rather than true genetic affinity.

A particularly notable case is *Stellaria alsine*, which was revealed to be polyphyletic – some specimens cluster with European taxa, while others align with species from Asia and North America. This suggests that similar morphology has evolved independently in different lineages, underlining the role of parallel evolution within the genus. In contrast to *Stellaria media*, these species reflect the complex phylogenetic structure of *Stellaria* and challenge traditional classifications based solely on morphology [27].

The study by Wan and Liu (2017) offers a detailed comparative analysis of pollen morphology across 60species and four varieties of *Stellaria*, using scanning electron microscopy. This large-scale sampling enabled, for the first time, a comprehensive characterization of pollen types within the genus, revealing both shared traits and significant morphological diversity. The results showed that pollen grains are predominantly spheroidal or spheroidal-polyhedral, ranging in size from 21.36 to 38.38 μm, and are pantoporate with 10–22 pores. Ornamentation of the exine surface was classified into three main types: microechinate-perforate, microechinate-punctate, and microechinate-punctate-perforate.

Among the analyzed species, *Stellaria uchiyamana* stood out by lacking granules on the operculum of the pores – a unique trait not observed in the other taxa studied. This feature, alongside specific trichome morphology and scandent growth, further distinguishes it from related species. In addition, the study highlights the morphological similarity between *Stellaria* and the monotypic genus *Myosoton* (commonly known as *Myosoton aquaticum*). The nearly identical pollen structure between these genera supports previous molecular data and taxonomic treatments that advocate for merging *Myosoton* into *Stellaria*. Thus, the findings not only clarify internal variation within *Stellaria* but also strengthen phylogenetic links between closely related taxa, contributing to a more natural classification of the group [28].

Phytochemical Characterization of the Genus Stellaria

Phytochemical analysis of extracts and fractions from various parts of *Stellaria media* allowed the identification of approximately 50 biologically active metabolites. During the study of chemical components, various crude and purified fractions obtained through bioanalysis were used. The majority of registered metabolites belong to phenolic compounds and saponins. Previous phytochemical studies of ethanol, ethyl acetate, methanol, chloroform, and aqueous extracts confirmed the presence of alkaloids, saponins, cardiac glycosides, fatty acids, tannins, terpenoids, and phenolic compounds. Meanwhile, phlobatannins and anthraquinones were not detected [29, 30]. The gas chromatography-mass spectrometry (GC-MS) method enabled the identification five compounds as apigenin 6-C-beta-D-galactopyranosyl-8-C-alpha-L-arabinopyranoside, apigenin 6-C-alpha-L-arabinopyranosyl-8-C-beta-D-galactopyranoside, apigenin 6-C-beta-D-galactopyranosyl-8-C-beta-L-arabinopyranoside, apigenin 6-C-beta-D-glucopyranosyl-8-C-beta-D-galactopyranoside, apigenin 6, 8-di-C-alpha-L-arabinopyranoside [31]. The study of the chemical composition of the aerial part of *Stellaria media* led to the identification of three new compounds: 1 – (2,4,5,7-tetramethyloctane), 2 – (6-methylheptyl-3'-hydroxy-2'-methylpropanoate), and 3 – (2,2,4-trimethyloctan-3-one). Their structures were elucidated using spectroscopic methods such as ^{1}H NMR, ^{13}C NMR, mass spectrometry, UV, and IR analysis [32].

The flavonoid composition of *Stellaria nemorum* and *Stellaria holostea* was studied in detail, revealing both novel and known compounds. In *Stellaria nemorum*, researchers identified one new C-glycosylflavone – 6-C-[(α-arabinopyranosyl)-(1→2)-O-β-xylopyranosyl]apigenin, and four previously known C-glycosides (schaftoside, vicenin-3, and related apigenin derivatives). These flavonoids were isolated for the first time from this species, enriching phytochemical knowledge of *Stellaria nemorum,* which had not been previously studied in this context.

In *Stellaria holostea*, five known flavonoids were identified, including schaftoside, isoorientin, orientin, diosmetin-6-C-β-glucopyranoside, and 3,5,7-trihydroxy-3′,5′-dimethoxyflavone – the last three being reported for the first time in this plant. The presence of both apigenin and luteolin derivatives supports the trend observed in other *Stellaria* species, indicating that flavone C-glycosides are common and potentially characteristic secondary metabolites in the genus. Although the crude extracts of both species showed antibacterial activity against *Staphylococcus aureus*, none of the isolated flavonoids exhibited significant bioactivity, suggesting that the observed effects may result from synergistic interactions or other components in the extracts [33].

Leaf extracts of *Stellaria media*, analyzed by GC-MS, revealed valuable dietary supplements primarily classified as lipids, including fatty acid esters (e.g., methyl stearate, hexacosanyl palmitate), phytosterols (β-sitosterol), waxy hydrocarbons (e.g., 6,7-dimethylheptacosane, triaicontanoic acid, hentriacontane), and long-chain alcohols such as tricontanol and pentacosanol [34]. These compounds are typically associated with plant stress responses and may vary depending on environmental conditions.

The leaves of *Stellaria* plants also contain trace amounts of essential microelements such as zinc and nickel [35], likely reflecting adaptive accumulation under stress. However, no data were provided regarding the presence of other minerals or heavy metals, which highlights the need for further phytochemical and environmental assessments. They are also rich in essential amino acids such as glycine, alanine, lysine, thymine, uracil, aspartic and glutamic acids, serine, proline, thymidine, tyrosine, histidine, γ-aminobutyric acid, and threonine [36]. The analysis of *Stellaria dichotoma* medicinal raw materials at the age of three years revealed mature morphological traits, the highest methanol extract content (32.44%), and the peak accumulation of total sterols (2.33 $g \cdot kg^{-1}$) and total flavonoids (2.22 $g \cdot kg^{-1}$) [36]. A total of 1,586 metabolites were identified, classified into 13 major classes and over 50 sub-classes, including lipids (331), organic acids and derivatives (327), organoheterocyclic compounds (201), phenylpropanoids and polyketides (170), and benzenoids (168). These classes exhibited significant variability in con-

tent depending on the plant's age. In particular, lipids predominated in younger plants (1–2 years), while alkaloids, benzenoids, and phenolic compounds were more abundant at 3–5 years of growth.

Furthermore, cluster analysis demonstrated that 3-year-old *Stellaria dichotoma* showed the highest diversity and abundance of secondary metabolites, including rutin, cucurbitacin E, and isorhamnetin-3-O-glucoside. This highlights the third year as the optimal harvest time, combining high yield and peak biochemical content. These findings justify the preference for harvesting at three years and support the selection of metabolic biomarkers for quality evaluation. [37]. Phytochemical analysis of *Stellaria dichotoma* extracts confirmed the presence of a significant diversity of secondary metabolites. A total of 10 compounds were isolated from root extracts, including flavonoids, phenolic compounds, and terpenoids. Among them, luteolin (6.3 mg/kg), apigenin (7.9 mg/kg), and chrysin (11.3 mg/kg) were the most abundant flavonoids. In total, seven flavonoids were identified, six of which were reported from this species for the first time, suggesting a notable accumulation of these bioactive compounds in *Stellaria dichotoma* var. *lanceolata* [38, 39]. Important mineral elements identified in *Stellaria media* include nickel, zinc, copper, sodium, cobalt, magnesium, iron, manganese, as well as traces of cadmium and mercury [40].

The practice of using Stellaria genus plants in folk and official medicine

A decoction of *Stellaria media* leaves is widely used in traditional medicine across various countries. In regions of Asia and tropical Africa, this decoction is employed to treat acute gastrointestinal and respiratory diseases. Dried leaves are often processed into tablets, powders, or infusions used for treating skin infections, limb edema, heart diseases, hyperthyroidism, and hemorrhoids [41]. In India, the decoction is used to treat deep wounds, stop bleeding, and reduce tumors. Crushed plant parts (leaves, stems, roots) are applied as compresses for the treatment of sprains and swelling. The entire plant finds application in the treatment of asthma, bronchitis and lung diseases [42].

The decoction of *Stellaria media* also has moisturizing and soothing properties, making it suitable for relieving skin itching, alleviating menstrual pain, and treating scabies [43]. A mixture of different plant parts (leaves, stems, flowers, and roots) is often used to regulate psychological disorders [44].

The pharmacological efficacy of *Stellaria* species is attributed to the presence of several biologically active compounds, including flavonoids (apigenin, luteolin, chrysin, orientin), phytosterols (e.g., β-sitosterol), saponins, and polyphenolic acids. These compounds are responsible for the plant's anti-inflammatory, antioxidant, antimicrobial, antidiabetic, anxiolytic, and antileishmanial effects, as confirmed in pharmacological and ethnobotanical studies [34–36, 38, 39].

Among the tested Mongolian medicinal plants, *Stellaria dichotoma* exhibited moderate antifungal activity, particularly against *Candida* spp. (MIC_{50} = 97 μg/mL), but was less effective against *Malassezia furfur* and *dermatophytes* (MIC_{50} > 256 μg/mL). The highest activity was recorded in the methanol extract of *Scutellaria scordifolia* (MIC_{50} = 22–64 μg/mL). Chemical analysis by HPTLC identified rutin in *Stellaria dichotoma* and *Hyoscyamus niger*, and flavones such as apigenin and luteolin in *Stellaria scordifolia*, which are likely responsible for the antifungal effect. Thus, while *Stellaria dichotoma* shows potential, its antifungal efficacy is lower compared to other species tested, and further studies are needed to confirm its therapeutic relevance against fungal infections [45].

The antimicrobial activity of *Stellaria media* leaf extracts (aqueous, methanolic, and ethanolic) was evaluated against a range of bacterial strains, including *Escherichia coli, Staphylococcus epidermidis, Staphylococcus aureus,* and *Klebsiella pneumoniae*. The extracts effectively inhibited the growth of both gram-positive and gram-negative bacteria, with the strongest effects observed against the aforementioned species. Additionally, peptides such as genpro-SmAMP2 and the β-actin gene product from *Stellaria media* demonstrated significant inhibitory activity against bacterial isolates, while Sm-AMP-X showed antifungal effects against phytopathogenic fungi [46].

Studies of the antimicrobial activity of crude extracts of *Stellaria nemorum* and *Stellaria holostea*, revealed their effectiveness against *Staphylococcus aureus*, whereas none of the individual isolated compounds showed antimicrobial activity [33].

An ethanolic extract of *Stellaria media*, studied in Bangladesh in 2019, demonstrated hypoglycemic and hypolipidemic effects on mice, particularly reducing fasting blood sugar and cholesterol levels. Other studies have explored the anti-inflammatory properties of methanolic leaf extracts in animal models, showing significant inflammation reduction after administering various doses of the extract [47].

The hypolipidemic and antidiabetic potential of *Stellaria media* extracts was also demonstrated in mice with alloxan-induced diabetes. Alcoholic extracts significantly reduced blood sugar levels, serum transaminases, and HbA1c (–48.4%), inhibited pancreatic β-glucosidase and α-amylase activity, decreased liver and adipose tissue weight, and improved triglyceride and cholesterol levels [48].

Experiments with methanolic leaf extracts of *Stellaria alsine* revealed pronounced anti-inflammatory properties. In tests on rats with different body weights (100 mg/kg, 300 mg/kg, and 500 mg/kg), a significant reduction in inflammation was observed. The efficacy was assessed using paw inflammation models induced by formalin and protein after oral administration of the extract, indomethacin (5 mg/kg), and distilled water (10 mg/kg). Additionally, the extract significantly suppressed paw edema caused by egg protein ($p < 0.05$) [49, 50].

Bioactive screening of the methanol extract *Stellaria media* allowed the isolation of compounds 6-methylheptyl-3'-hydroxy-2'-methylpropanoate and 2,2,4-trimethyloctan-3-one, which demonstrated significant anti-obesity and anti-inflammatory effects [32].

The extract of *Stellaria dichotoma* lanceolata demonstrates a significant anti-inflammatory effect in response to *Mycobacterium abscessus* infection, while showing no modulatory effect on inflammation caused by *Toxoplasma gondii*. Infection with M. abscessus activates the NF-κB and MAPK signaling pathways in macrophages, leading

to the production of pro-inflammatory cytokines (TNF-α and IL-6) and reactive oxygen species (ROS). Pretreatment with *Stellaria dichotoma* var. *lanceolata* effectively suppresses these inflammatory mediators and intracellular ROS levels. In contrast, herbal extracts from *Bupleurum chinense* and *Bupleurum falcatum* not only failed to inhibit this response but in some cases enhanced inflammation by further activating these signaling pathways.

Moreover, oral administration of *Stellaria dichotoma var. lanceolata* in mice infected with *M. abscessus* significantly reduced lethality and attenuated TNF-α expression in the lungs and spleen, despite not directly reducing bacterial load. These results indicate the potential of *Stellaria dichotoma* var. *lanceolata* as a promising therapeutic agent targeting excessive inflammation associated with mycobacterial infections, rather than acting as an antimicrobial per se [51].

Recent studies have identified that oligosaccharides extracted from *Stellaria dichotoma* var. *lanceolata* can bind to galectin-3 and significantly alleviate the symptoms of colitis. Specifically, Zhao et al. demonstrated that these oligosaccharides exhibit selective affinity for galectin-3, a β-galactoside-binding lectin involved in inflammation and fibrosis. Oral administration of the isolated compounds significantly reduced colonic inflammation and improved histopathological parameters in a murine model of colitis. These results suggest that oligosaccharides from *Stellaria dichotoma* var. *lanceolata* may hold therapeutic promise as anti-inflammatory agents targeting galectin-3 pathways [52].

Additionally, in a separate study by Ma et al., a group of flavonoids and other secondary metabolites from *Stellaria dichotoma* var. *lanceolata* were identified as potential ligands for anti-anxiety activity sites. These findings underscore the pharmacological relevance of oligosaccharides and polyphenolic compounds in modulating inflammation and neurological responses [53].

The inhibition of enzymatic activities (hyaluronidase, lipoxygenase, collagenase) by aqueous and ethanolic extracts of *Stellaria media* was analyzed *in vitro*. The ethanolic extract exhibited significant antioxidant activity, scavenging radicals at 50% concentrations of 132.8 μg/mL (H_2O_2), 16.5 μg/mL ($NO\cdot$), and 11.9 μg/mL ($ONOO^-$). At the same time, the aqueous extract was more effective against superoxide anions. The primary bioactive metabolite of the extracts was identified as apigenin [54].

Research demonstrated that flavonoids in aqueous leaf extracts of *Stelaria media* enhance antioxidant activity. This activity was evaluated on human skin cells after ultraviolet irradiation, showing a significant reduction in intracellular ROS. In a rat model (Sprague-Dawley, 25 mg/kg/day), an alcohol-based leaf extract noticeably mitigated spermatogenesis disorders caused by dichlorvos and improved the condition of vital organs [55].

The antiparasitic potential of alcoholic extracts of *Stellaria media* was evaluated against *Leishmania tropica*. Methanolic and ethyl acetate extracts significantly inhibited parasite growth, with activity levels of 185.9 μg/mL and 36.4 μg/mL, respectively [56].

Conclusions. Recent literature confirms that the *Stellaria* genus is a rich source of diverse bioactive compounds, particularly flavonoids (apigenin, luteolin, chrysin), saponins, sterols (β-sitosterol), and polyphenolic acids. Among the species, *Stellaria media, Stellaria dichotoma,* and *Stellaria alsine* have received the most attention over the past decade. These species have demonstrated a broad spectrum of pharmacological activities, including antioxidant, anti-inflammatory, antimicrobial, antidiabetic, anxiolytic, antiparasitic, and anti-obesity effects.

Notable phytochemical advances include the identification of over 50 metabolites in *Stellaria media*, 1586 classified metabolites in *Stellaria dichotoma*, and several new flavonoids isolated from *Stellaria nemorum* and *Stellaria holostea*. Pharmacological studies have shown that *Stellaria dichotoma* var. *lanceolata* reduces inflammatory markers in mycobacterial infection models, while *Stellaria media* extracts exhibit antileishmanial effects, anxiolytic activity comparable to diazepam, and hypoglycemic properties in diabetic mice. These findings support the integration of *Stellaria* species into evidence-based phytotherapy and highlight the genus as a promising target for future drug development.

BIBLIOGRAPHY

1. Li Z, Wang H, Feng L, et al. Metabolomic Analysis Reveals the Metabolic Diversity of Wild and Cultivated Stellaria Radix (Stellaria dichotoma L. var. lanceolata Bge.). *Plants (Basel).* 2023 Feb 9; 12(4): 775. DOI: 10.3390/plants12040775.
2. Aleem A, Aslam B, Alim MB, Hussain A, Faisal MN, Sindhu ZU. Phytochemical analysis and gastroprotective effect of Stellaria media (L.) Vill. methanolic extract on piroxicam-induced gastric ulcer in Wistar rats. *Pak J Pharm Sci*. 2023 Sep; 36(5): 1425–1434. PMID: 37869918.
3. Demján V, Sója A, Kiss T, et al. Stellaria media tea protects against diabetes-induced cardiac dysfunction in rats without affecting glucose tolerance. *J Tradit Complement Med*. 2021 Aug 10; 12(3): 250–259. DOI: 10.1016/j.jtcme.2021.08.003.
4. World Health Organization. Global Report on Diabetes. Geneva: World Health Organization. 21 April 2016. 88 p. Available from: https://www.who.int/publications/i/item/9789241565257.
5. Kumar R, Singh AK, Gupta A, Bishayee A, Pandey AK. Therapeutic potential of Aloe vera-A miracle gift of nature. *Phytomedicine.* 2019; 60: 152996. DOI: 10.1016/j.phymed.2019.152996.
6. Sharma UK, Kumar R, Ganguly R, Gupta A, Sharma AK. An active component of Cinnamon provides protection against food colour induced oxidative stress and hepatotoxicity in albino Wistar rats. *Vegetos.* 2018; 31: 123–129. DOI: 10.5958/2229-4473.2018.00063.0.
7. Sharples MT, Bentz PC, Manzitto-Tripp EA. Evolution of apetaly in the cosmopolitan genus Stellaria. *Am J Bot.* 2021 May; 108(5): 869–882. DOI: 10.1002/ajb2.1650. Epub 2021 May 12. PMID: 33982285.
8. Li Z, Yang Y, Feng L, et al. The combined effects of climate, soil, and rhizospheric microorganisms determine the quality and suitable production zones of Stellaria dichotoma L. var. lanceolata Bge. in China. *Chem. Biol. Technol. Agric.* 2024; 11: 185. https://doi.org/10.1186/s40538-024-00697-4.

9. Iboroma M, Orlu EE, Ebere N, Obulor A. Androgenic and antioxidant activity of Stellaria media on rat following sub-chronic exposure to dichlorvos. *IOSR J. Pharm. Biol. Sci*. 2018; 13(6): 38–46. DOI: 10.9790/3008-1306013846.
10. Mv M, Vm V, Ma O. Research of phenolic compounds of ruta graveolens L. and Stellaria media (L.) Vill. *Asian Journal of Pharmaceutical and Clinical Research*. 2018; 11(9): 152–6. DOI: 10.22159/ajpcr.2018.v11i9.25920.
11. Zhou Li, et al. Physiological mechanisms of salt and drought induced stress effects on root biomass and secondary metabolites in Stellaria dichotoma. *International Journal of Agriculture and Biology*. 2019; 22(6): 1285–1292. URL: https://www.cabidigitallibrary.org/DOI/full/10.5555/20203271253.
12. Lin Dong, Xirong Zhou, Jiahua Ma, Hao Zhou, Xueyan Fu. "Chemical constituents of Stellaria dichotoma var. lanceolata and their anti-inflammatory effect on lipopolysaccharide-stimulated RAW 264.7 cells." *Chemistry of Natural Compounds.* 2021; 57: 158–162. DOI: https://doi.org/10.1007/s10600-021-03306-0.
13. Cusumano G, Flores GA, Cetiz MV, et al. Small Steps to the Big Picture for Health-Promoting Applications Through the Use of Chickweed (Stellaria media): In Vitro, In Silico, and Pharmacological Network Approaches. *Food Sci Nutr*. 2024 Oct 3; 12(11): 9295–9313. DOI: 10.1002/fsn3.4505. PMID: 39620022.
14. Arora D, Sharma A. Anxiolytic constituents from Stellaria media Linn. *World J Pharm Res*. 2019; 8(3): 1379–93. DOI: 10.20959/wjpr20193-14412. URL: https://wjpr.s3.ap-south-1.amazonaws.com/article_issue/1551608913.pdf.
15. Ma M, Quan H, Chen S, Fu X, Zang L, Dong L. The Anxiolytic Effect of Polysaccharides from Stellariae Radix through Monoamine Neurotransmitters, HPA Axis, and ECS/ERK/CREB/BDNF Signaling Pathway in Stress-induced Male Rats. *Brain Res Bull*. 2023 Oct 15; 203: 110768. DOI: 10.1016/j.brainresbull.2023.110768. Epub 2023 Sep 21. PMID: 37739234.
16. Lahlou R, Carvalho F, Pereira M, Lopes J, Silva L. Overview of Ethnobotanical–Pharmacological Studies Carried Out on Medicinal Plants from the Serra da Estrela Natural Park: Focus on Their Antidiabetic Potential. *Pharmaceutics*. 2024; 16(4): 454. https://doi.org/10.3390/pharmaceutics16040454.
17. Bencheikh N, Elachouri M, Bussmann RW. Stellaria media (L.) Vill. Caryophyllaceae. *Ethnobotany of Northern Africa and Levant*. 2024; 1959–1963. DOI: 10.1007/978-3-031-43105-0_197.
18. Yushchuk Ye. Ekoloho-biolohichni osoblyvosti adventyvnykh roslyn Kryvorizhzhya. *Ecological Bulletin of Kryvorizhzhya*. 2015; 1: 32–33 (in Ukrainian). DOI: 10.31812/ecobulletinkrd.v1i0.6309.
19. Native Plant Trust. Stellaria media (Common Chickweed). *Go Botany*. Available from: https://gobotany.nativeplanttrust.org/species/stellaria/media/. Access date: [2025.20.01.]
20. Manzoor R, Zafar M, Yaqoob T, et al. Micromorphological Sculptural Diversity in Foliar Epidermis and Trichomes Features among Invasive Species. *Microsc Microanal.* 2023 Jul 25; 29(4): 1531–1555. DOI: 10.1093/micmic/ozad063. PMID: 37488823.
21. Lepsi M, Lepsi P, Koutecky P, Lucanova M, Koutecka E, Kaplan Z. Stellaria ruderalis, a new species in the Stellaria media group from central Europe. *Preslia* 2019; 91: 391–420. DOI: 10.23855/preslia.2019.391.
22. Li Z. Comparative anatomy of Myosoton aquaticum and Stellaria media and its systematic significance. *Pakistan Journal of Botany*. 2016; 48.4: 1527–1535. ISSN 0556-3321.
23. Li M, Tian C, Song Y, Ju W, Pathak ML, Xu B. Stellaria motuoensis (Caryophyllaceae), a new species from Xizang, China. *Nordic Journal of Botany.* 2022; 2022(9): e03683. DOI: 10.1111/njb.03683.
24. Sharples MT, Tripp EA. Phylogenetic relationships within and delimitation of the cosmopolitan flowering plant genus Stellaria L. (Caryophyllaceae): core stars and fallen stars. *Syst. Bot*. 2019; 44: 857–876. DOI: 10.1600/036364419X15710776741440.
25. Wang WQ, Su ZW, Ma ZH. Comprehensive molecular and morphological analysis of Brachystemma calycinum and Stellaria ovatifolia in the tribe Alsineae (Caryophyllaceae). *PhytoKeys*. 2023 Feb 22; 220: 1–16. DOI: 10.3897/phytokeys.220.96126.
26. Satish C, Rawat DS. Morphological and Anatomical Properties of Himalayan Herb Stellaria Webbiana. *International Journal of Environment*. 2016; 5 (2): 26–35. DOI: https://doi.org/10.3126/ije.v5i2.15003.
27. Sharples MT. Taxonomic observations within Stellaria (Caryophyllaceae): Insights from ecology, geography, morphology, and phylogeny suggest widespread parallelism in starworts and erode previous infrageneric classifications. *Systematic Botany*. 2019 Nov 14; 44(4): 877–86. DOI: 10.1600/036364419X15710776741459.
28. Wan C, Liu J. The morphology and systematics of the pollen of Stellaria. *Palynology*. 2017; 41(4): 533–546. DOI: 10.1080/01916122.2017.1298540.
29. Miere FG, Ganea M, Teodorescu AG, Horvath T, Hanga-Farcas A, Csaba N, et al. Characterization in Terms of Phytochemical Content and Medicinal Potential of the Stellaria media Plant Extract. *Pharmacophore*. 2023; 14(1): 45–55. DOI: 10.51847/qfiILPQ13P.
30. Oladeji OS, Oyebamiji AK. Stellaria media (L.) Vill.- A plant with immense therapeutic potentials: phytochemistry and pharmacology. *Heliyon.* 2020 Jun 7; 6(6): e04150. DOI: 10.1016/j.heliyon.2020.e04150.
31. Dong Q, Huang Y, Qiao SY Studies on chemical constituents of Stellaria media: China. *J. Chin. Mater*. 2007; 32(11): 1048–1051. PMID: 17672340.
32. Arora D, Sharma A Isolation and characterization of the chemical constituents of Stellaria media Linn. *Int J. Pharm. Sci. Res.* 2014; 5(9): 3669–3673. DOI: http://dx.doi.org/10.13040/IJPSR.0975-8232.5(9).3669-73.
33. Ancheeva E, Daletos G, Muharini R, Lin WH, Teslov L, Proksch P. Flavonoids from Stellaria nemorum and Stellaria holostea. *Natural Product Communications*. 2015; 10(3): 437–440. DOI: 10.1177/1934578X1501000315.
34. Pande A, Shukla YN, Tripathi AK. Lipids constituents from Stellaria media. *Phytochemistry*. 1995; 39: 709–711. DOI: 10.1016/0031-9422(94)00935-M.
35. Salinitro M, van der Ent A, Tognacchini A, Tassoni A. "Stress responses and nickel and zinc accumulation in different accessions of Stellaria media (L.) Vill. in response to solution pH variation in hydroponic culture." *Plant Physiology and Biochemistry*. 2020; 148: 133–141. DOI: https://doi.org/10.1016/j.plaphy.2020.01.012.

36. Dziągwa-Becker M, Kalitowska M, Oleszek A. Influence of selected soil parameters on amino acid profile in Stellaria media. *Polish Journal of Agronomy* 2016; 27: 32–37. DOI: 10.26114/pja.iung.292.2016.27.04.
37. Li Z, Feng L, Wang H, et al. The Impact of Growth Years on the Medicinal Material Characteristics and Metabolites of Stellaria dichotoma L. var. lanceolata Bge. Reveals the Optimal Harvest Age. *Plants (Basel).* 2023 Jun 12; 12(12): 2286. DOI: 10.3390/plants12122286.
38. Zhang G, Yun X, Gao Y. Phytochemical Constituents from Stellaria dichotoma var. lanceolata. *Chem Nat Compd.* 2019; 55: 135–137. DOI: https://doi.org/10.1007/s10600-019-02635-5.
39. Zhang G, Zheng J, Yun, X. et al. Flavonoids from Stellaria dichotoma var. lanceolata. *Chem Nat Compd*. 2019; 55: 110–111. DOI: https://doi.org/10.1007/s10600-019-02626-6.
40. Singh R, Mansi C, Ekta SC. Stellaria media Linn.: A comprehensive review highlights the nutritional, phytochemistry, and pharmacological activities. *Journal of Herbmed Pharmacology* 2022; 11.3: 330–338. DOI: 10.34172/jhp.2022.38.
41. Bussmann R.W, Batsatsashvili K, Kikvidze Z, et al. Ethnobotany of Mountain Regions: Far Eastern Europe. In: Batsatsashvili K, Kikvidze Z, Bussmann R.W. (eds) Ethnobotany of the Mountain Regions of Far Eastern Europe: Ural, Northern Caucasus, Turkey, and Iran. Cham: Springer International Publishing; 2019; 1: 1–41. https://doi.org/10.1007/978-3-319-77088-8_1-1.
42. Chandra, S, Rawat, DS. Medicinal plants of the family Caryophyllaceae: a review of ethno-medicinal uses and pharmacological properties. *Integrative Medicine Research*. 2015; 4(3): 123–131. DOI: https://doi.org/10.1016/j.imr.2015.06.004.
43. Mahibalan S, Stephen M, Nethran RT, Khan R, Begum S. Dermal wound healing potency of single alkaloid (betaine) versus standardized crude alkaloid enriched-ointment of Evolvulus alsinoides. *Pharm Biol.* 2016 Dec; 54(12): 2851–2856. DOI: 10.1080/13880209.2016.1185636.
44. Arora D, Sharma A. Validation of a hptlc- densitometry method for the quantitative determination of anxiolytic constituents in Stellaria media Linn. *Frontier Journal of Pharmaceutical Sciences and Research*. 2019; 2(2): 47–51. URL: https://frontierjournals.org/index.php/fjpsr/article/view/12.
45. Giordani C, Simonetti G, Natsagdorj D, et al. Antifungal activity of Mongolian medicinal plant extracts. *Nat Prod Res.* 2020 Feb; 34(4): 449–455. DOI: 10.1080/14786419.2019.1610960.
46. Komakhin RA, Vysotskii DA, Shukurov RR, et al. Novel strong promoter of antimicrobial peptides gene pro-SmAMP2 from chickweed (Stellaria media). BMC Biotechnol. 2016 May 18; 16(1): 43. DOI: 10.1186/s12896-016-0273-x. PMID: 27189173;PMCID: PMC4870781.
47. Ahmad W, Ahmad M, Khan R. Stellaria media attenuates the hyperglycemia and hyperlipidemia in alloxan-induced diabetic rat. *Bangladesh J. Pharmacol.* 2019; 14: 80–86. DOI: https://doi.org/10.3329/bjp.v14i2.39847.
48. El Barky A, Hussein AS, Alm-Eldeen A, Hafez AY, Mohamed T. Saponins and their potential role in Diabetes mellitus. *Diabetes Manag*. 2017; 7: 148–158. Available from: https://api.semanticscholar.org/CorpusID:2948300.
49. Kim CK, Yu S, Lee M. Molecular networking-guided isolation strategy of a new C-glycosyl flavone rotamer from Stellaria alsine and evaluation of anti-inflammatory and antioxidant activities. *Metabolomics.* 2023; 19(79). DOI: https://doi.org/10.1007/s11306-023-02042-6.
50. Budovsky A, Yarmolinsky L, Ben-Shabat S. Effect of medicinal plants on wound healing. *Wound Repair Regen*. 2015 Mar-Apr; 23(2): 171–83. DOI: 10.1111/wrr.12274.
51. Bae SJ, Choi JW, Park BJ, et al. Protective effects of a traditional herbal extract from Stellaria dichotoma var. lanceolata against Mycobacterium abscessus infections. *PLoS One.* 2018 Nov 19; 13(11): e0207696. DOI: 10.1371/journal.pone.0207696. PMID: 30452471;PMCID: PMC6242687.
52. Zhao Z, Wu J, Xu X, et al. Oligosaccharides from Stellaria dichotoma L. var. lanceolate bind to galectin-3 and ameliorate effects of colitis. *Carbohydr Polym*. 2024 Dec 1; 345: 122551. DOI: 10.1016/j.carbpol.2024.122551. Epub 2024 Jul 30. PMID: 39227094.
53. Ma, M, Zhan, M, Mo, X. et al. Chemical Constituents and Anti-Anxiety Active Sites from Stellaria dichotoma var. lanceolata. *Chem Nat Compd*. 2024; 60: 798–802. DOI: https://doi.org/10.1007/s10600-024-04448-7.
54. Rogowska M, Parzonko A, Bazylko A. In vitro antioxidant and anti-inflammatory activity, and determination of chemical composition of aqueous and ethanolic extracts of Stellaria media herb. *Planta Med*. 2015; 81: 35. URL: https://api.semanticscholar.org/CorpusID:89575327.
55. Rogowska M, Lenart M, Ziaja M, Parzonko A, Bazylko A. Chemical composition, antioxidative and enzyme inhibition activities of chickweed herb (Stellaria media L, Vill.) ethanolic and aqueous extracts. *Ind. Crop. Prod*. 2017; 97: 448–454. DOI: https://doi.org/10.1016/j.indcrop.2016.12.058.
56. Gervazoni LFO, Barcellos GB, Ferreira-Paes T, Almeida-Amaral EE. Use of natural products in leishmaniasis chemotherapy: an overview. *Frontiers in chemistry.* 2020; 8: 579891. DOI: https://doi.org/10.3389/fchem.2020.579891.

Надійшла до редакції 01.02.2025.
Прийнята до друку 15.05.2025.
Електронна адреса для листування bodernet@meta.ua