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QUALITY RATE DETERMINATION OF MEDICINAL PLANT RAW MATERIALS OF THE GENUS *LAMIUM* L. SPECIES OF WESTERN UKRAINE

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ABSTRACT

The aim of the work. Studying the peculiarities of the morphological and anatomical structures of leaves, stems and flowers of some *Lamium* L. species growing widely in Western Ukraine with the definition of diagnostic features of their raw materials.

Materials and Methods. The objects of the research were the air-dry and freshly harvested and fixed in a mixture of glycerin-alcohol-water (1: 1: 1) raw materials of some *Lamium* L. species. The raw material has been examined with the naked eye and with a magnifying glass (x10) in daylight. The anatomical features of plants' organs have been studied on the prepared epidermis and preparations from the surface under a microscope Delta Optical Genetic Pro (Poland). The obtained data has been recorded using schematic drawings and photographs.

Results and Discussion. The analysis of diagnostic features of *Lamium galeobdolon* plant raw material have been performed with herb of *Lamium album* L., *Lamium glaberrimum* (C. Koch) Taliev, *Lamium purpureum* L. which can be impure. The features have been established: numerous simple thin-walled 1–2–3 cellular hairs. At the base of the hairs there are weak nodular swellings of the basal cell, the base is slightly expanded and immersed in the base, which is formed by several epidermal cells. On the epidermis of the stem and leaves there are glands that have a short 2-cell stalk and 4- or 5-6-cell spherical head. Other studied species of the genus *Lamium* are characterized by the following features. *Lamium album*: multicellular and unicellular hairs, glandular hairs with a unicellular stalk and 8–12 cell head; and also with a unicellular leg and a two-, four-cell head. *Lamium purpureum*: typical are simple two-celled hairs with a coarse warty surface, head hairs and branched hairs are on the inside of the corolla tube, essential oil glands. *Lamium glaberrimum*: short two-celled with wide cavity hairs with a warty surface, tortuous epidermis of the lower side of the leaf blade and underdeveloped glands are rarely found.

Conclusion. The morphological and anatomical studies of leaves, stems, and flowers of *Lamium galeobdolon* (L.) Crantz (syn. *Galeobdolon luteum* Huds.) comparatively with the aboveground organs of *Lamium album* L., *Lamium glaberrimum* (C. Koch) Taliev, and *Lamium purpureum* L. have been conducted. The diagnostic features of raw materials of these species have been established. The obtained results will be used to develop the parameters of standardization of the studied *Lamium galeobdolon* plant raw material.

Introduction. The genus *Lamium* L. of the *Lamiaceae* Martinov (*Labiatae*) family combines according to various data from 25 to 50 species that grow in the temperate zone of the Northern Hemisphere: West and Central Asia, Transcaucasia, Mongolia, China, Japan, Korea, Northern India, and almost all territory of Europe. More than 10 species of the *Lamium* genus grow on the territory of Ukraine [1–3].

It should be noted that the *Lamiaceae* family is one of the most common and important for medicine and pharmacy. It has 7,500 species that are widespread all over the world flora and grouped into about 200 genera and 7 subfamilies. Among the *Lamiaceae* there are mountain and plain xerophytes, numerous forest and meadow mesophylls. The majority of *Lamiaceae* plants are herbs and shrubs; in the tropics and subtropics, their life form could be shrubs, trees and vines [1–6].

Chemically, *Lamium* is distinguished by the presence of different classes of chemical constituents, which we can mention hydroxycinnamic acids, terpenoids, among them iridoids and secoiridoids, flavonoids, anthocyanins, phenylpropanoids, phytoecdysteroids, benzoxazinoids, betaine. Thus, the presence of these chemicals can provide biological activities, such as antioxidant, anti-inflammatory, antimicrobial, antischistosomal, for pain relief in rheumatism and arthritis, a tonic for constipation, antinociceptive, anticancer. Most of the bioactivities of *Lamium* species are linked to their principal constituents, that is, phenolics and essential oils. Polyphenols, flavonoids, terpenes, steroidal derivatives, and ecdysteroids account for various biological activities of this species of *Lamium* [7, 8].

We have processed literary sources which provide data on species of the genus *Lamium* growing in Ukraine, according to three well-known and authoritative sources such as “Ecoflora of Ukraine” (Kyiv, 2007) [1], “Vascular Plants of Ukraine” (S. Mosyakin, Kyiv, 1999) Mosyakin [4].

In modern Botany, some issues of the taxonomy of the *Lamium* genus remain debatable [1–4]. Despite the relatively small number of species of the genus *Lamium* in the flora of Ukraine, there are discrepancies between some sets of data. Thus, the issue of including representatives of the close genera *Orvala* and *Galeobdolon* in the genus *Lamium* as a subgenus is still relevant. It should be noted that S. Mosyakin claims to the doubtfulness and inevidence of data on the growth of *L. orvala* in Ukraine. The status of *L. cupreum* and *L. montanum* is unclear, which may not be independent species, but only subspecies of *L. maculatum* and *L. galeobdolon*, respectively. *Lamium rubrum* according to the literature is a species of *Lamium maculatum* var. *rubrum* (Benth.) Briq. In this research, we are focused on the taxonomy presented in the work “Vascular plants of Ukraine”.

Information regarding the anatomical structure of the aboveground part of the plant of *Lamium galeobdolon* (L.) Crantz (syn. *Galeobdolon luteum*), according to available sources of scientific literature, is not found. Therefore, the study of the anatomical structure of leaves and flowers of *Galeobdolon luteum* is relevant.

The aim of our work was to study the morphological and anatomical structure of leaves and flowers of the genus *Lamium* L. species growing widely in Western Ukraine with the definition of diagnostic features of their raw materials.

Materials and Methods. The objects of the research have been raw materials of some *Lamium* L. species harvested during the flowering period in Ivano-Frankivsk and Zakarpattia regions in 2020 and 2021 years (Figure 1, 2). The raw material samples of *Lamium glaberrimum* (C. Koch) Taliev were obtained from the fund of the collection of medicinal plants of the Dendrological Park “Druzhba” of the Vasyl Stefanyk Precarpathian National University.

Air-dry and freshly harvested and fixed in a mixture of glycerin-alcohol-water (1: 1: 1) plant raw materials have been used for the research [9–10]. The study of features of the morphological structure of raw materials has been carried out according to the requirements of the State Pharmacopoeia of Ukraine [11]. The raw material has been examined with the naked eye and with a magnifying glass (x10) in daylight. When determining the anatomical features of plant organs have been studying the prepared epidermis and preparations from the surface under a microscope Delta Optical Genetic Pro (Poland). The obtained data has been recorded using schematic drawings and photographs taken with a digital camera Delta Optical DLT – Cam PRO 3 MP.

Figure 1. *Lamium galeobdolon* (L.) Crantz in the natural forest habitats.

A B C

Figure 2. Species of the genus *Lamium* L. in their natural habitats (phase of mass flowering): A – *Lamium glaberrimum* (C. Koch) Taliev, B – *Lamium album* L., C – *Lamium purpureum* L.

Results and Discussion. The plants of the genus *Lamium* L. are quite similar in appearance due to possessing square stems, bilabiate corolla, etc. So, it is important to research the morphological characteristics of the studied species, which makes it possible to identify the most characteristic diagnostic features.

Morphological features of *Galeobdolon luteum*. Flowering stems are up to 25 cm long, erect, and branched. Leaves are simple, entire, opposite, leaf-stalking, ovate, double-toothed, often with silvery white spots. Flowers are in six-flowered rings. Corolla is bilabiate, yellow; upper lip is oblong, the blades of the lower lip are ovate, the middle blade is larger than the lateral ones. The color of the stems is greenish-grey; the leaves are greyish-green above and the silver-grey below. The flowers are yellow. The smell is fragrant, original, and strong.

To substantiate the indicators of authenticity of raw materials, the main distinguishing features of the genus *Lamium* L. species are presented in Table 1.

Table 1
Distinctive morphological features of the genus *Lamium* L. species growing widely in Western Ukraine

Diagnostic features	Types of plants		
	Lamium glaberrimum (C. Koch) Taliev	*Lamium album* L.	*Lamium purpureum* L.
1	2	3	4
Stem	Simple, straight, quadrilateral	Simple, straight, quadrilateral	Recumbent or raised, branched, up to 30 cm, quadrangular, there is a red plaque at the top
Stem pubescence	None	Hairy	None
Leaves	Long-leaf-stalking, broadly ovate or kidney-shaped, plate 0.5–1.5 cm long, almost to the base finger-dissected; upper integumentary leaves shorter than flowers, 1–2.5 cm long, 1–2 cm wide, with a short leaf-stalk and a less deeply dissected plate	Opposite, ovate, heart-shaped, pubescent, large-sawed	Cross-opposite, soft-haired, wrinkled, with pronounced veining, the edge is unevenly zigzag, the lower leaves are leaf-stalking, ovate-cordate, the upper – ovate, almost sessile, often pinkish-purple

Продовження table 1

1	2	3	4
Inflorescence, flower	There are 4–6 flowers in false rings, bracts narrowly lanceolate, calyx inverted conical narrow-bell-shaped, corolla 3–3.5 cm long, pink, hairy on the outside	There are 6-8 flowers in rings, sitting in the axils of sharp linear bracts, irregular, bilobed, white, pubescent, on the stems are whorls in the axils of the upper leaves. Corolla is dirty-yellowish-white (up to 20 mm long), upper lip is long, heart-shaped curved, with longer lashes, much larger than the middle blade of the lower lip. The upper lip of the corolla is helmet-shaped, the lower – three-blade. Calyx is bell-shaped, with five long teeth. There are 4 stamens, anthers stamens black and purple. Pistil is with a four-part upper ovary, a long column and a two-part receiver	The flowers are purple, sometimes pink, in many-flowered axillary whorls. Calyx is bell-shaped, twice as short as the corolla, glabrous or hairy. Calyx teeth after flowering are protruding. Corolla is with a thin, long tube, dilated in the throat. Upper lip is oblong or ovoid, lower lip – with purple spots, three-blade. There are 4 stamens, ovary four-blade, four-nested, with one column and two-part receptacle
Fruit	Coenobium (four nuts)	It consists of 4 triple-face nuts, which are placed in a cup	Nuts are inverted-ovate with small white bumps, 2–2.5 mm long and 1–1.3 mm wide, almost triple-face

The anatomical features of vegetative and generative organs have been studied to identify the main peculiarities of the species of the genus *Lamium* L. The distinctive diagnostic features have been established.

Anatomical structure of the stem *Galeobdolon luteum*. Endoderm is single-row, well expressed. The epidermal cells of the stem are erect and elongated in the tangential direction. The stomata are diacytic. The stem is covered with simple multicellular hairs and scleroid shells with slit-like and branched pores that connect protoplasts and provide metabolism and synthesis of biologically active substances.

The results of studying the anatomical structure of the *Galeobdolon luteum* stem are presented on Figure 3.

Anatomical structure of the *Galeobdolon luteum* leaf blade. The leaf blade is covered with a cuticle, under which is a layer of epidermal cells. Microscopic analysis of the leaf from the surface has shown the main feature of the upper and lower epidermis. Cells of the upper and lower epidermis are with strongly tortuous and evenly thickened walls. The stomata are located on the lower epidermis (diacytic type). Along the veins, the epidermal cells are small, parenchymal, in some places their membranes are rosary-like thickened. There are two types of hairs: simple and glandular. On the lower epidermis of the leaf there is a large number of simple hairs with a pointed tip. The hairs cuticle is smooth, there are more hairs along the central vein of the leaf. The bases of the hairs are located on the stands formed by the epidermis. Essential oil glands are located on both sides of the leaf, rounded, with a translucent stalk, and radially located 6–8 secretory cells.

The results of studying the anatomical structure of the leaf *Galeobdolon luteum* are presented on Figure 4.

Anatomical structure of the petal of the *Galeobdolon luteum* flower. Examining the flower petal (Figure 5) from the surface has shown that there are elongated with straight walls of the cells of the upper and lower epidermis. The stomata of the diacytic type are located only on the lower epidermis. On the surface of the petals there are simple two-celled hairs with a warty surface, which are located along the vein and the edge, they are characterized by articular joints of cells; glandular hairs are on unicellular stalk and bicellular head; cell walls sometimes have rosary-like thickenings; essential oil glands are with 8 secretory cells or underdeveloped.

The research of the anatomical structure of leaves, flowers and stems has been carried out and established the main diagnostic features of *Lamium album* and other species (*Lamium glaberrimum*, *Lamium purpureum*) as possible impurities. *Lamium album* L. is characterized by multicellular and unicellular hairs. Some of them are rigid with thickened walls, others have a basal cell with much thickened walls and thin-walled in the distal part, around such hairs thete is the basis from the epidermal rosette consisting of 8–10 cells. The application of Stahl and Trim-Hill reagents to the micropreparation (in chloral hydrate) has resulted in crystalline spherical formations with iridoids, which are observed through the upper epidermis. Along the edge of the leaf blade there are simple thin-walled two-celled hairs with a thickening at the junction of cells and an angled terminal cell. Glandular trichomes on the epidermis of *Lamium album* are two types: glandular hairs with a unicellular stalk and 8–12 cell head; and also with a unicellular leg and a two-, four-

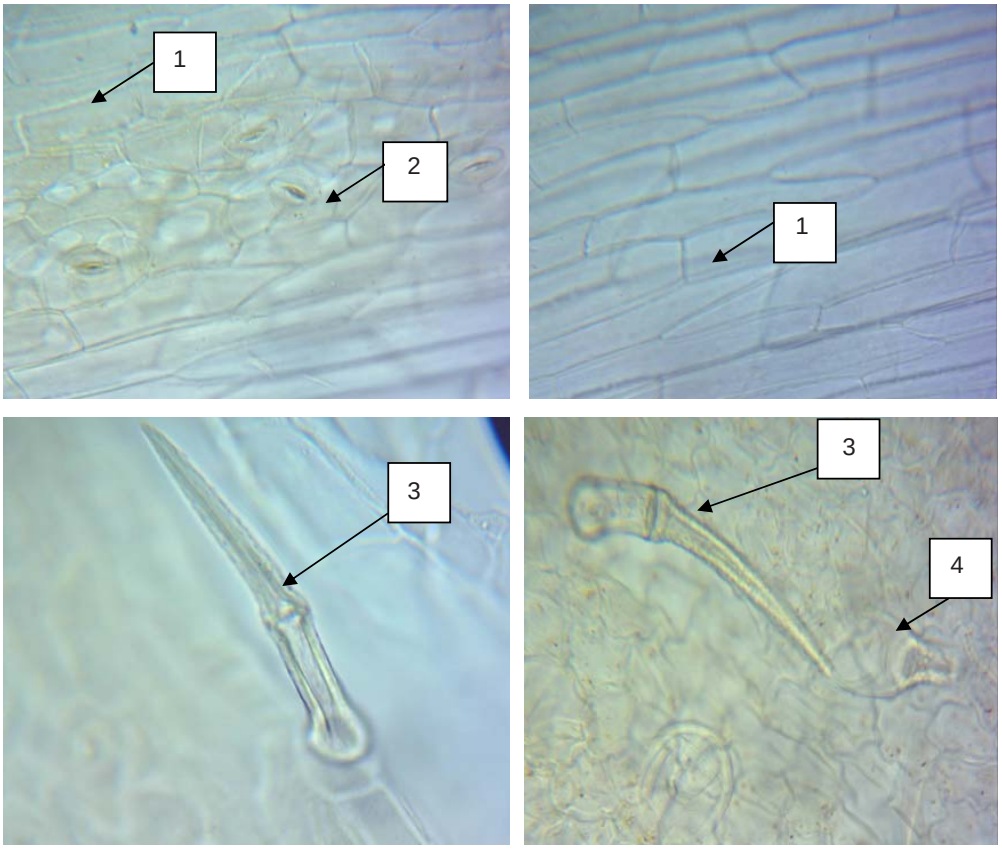

Figure 3. The anatomical structure of the *Galeobdolon luteum* stem: 1 – epidermal cells; 2 – stomata; 3 – simple hairs with a warty surface, 4 – glandular hair.

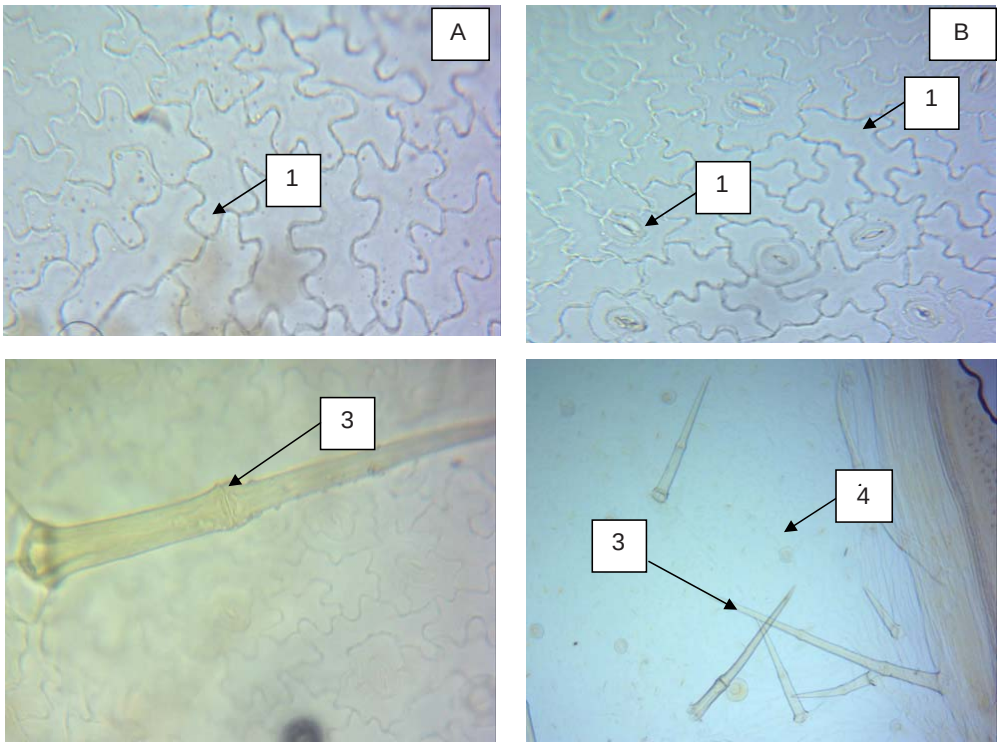

Figure 4. The anatomical structure of the *Galeobdolon luteum* leaf: A – upper epidermis; B – lower epidermis. 1 – epidermal cells, 2 – stomata of the diacytic type, 3 – simple trichome, 4 – essential oil-bearing glands.

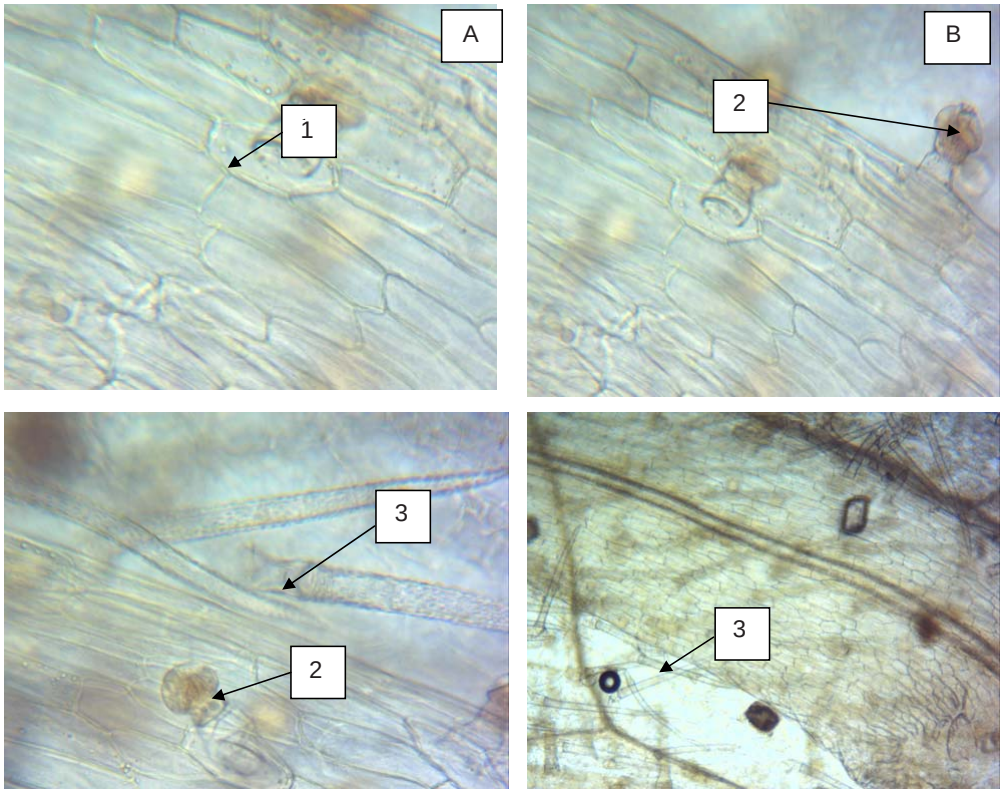

Figure 5. The anatomical structure of the *Galeobdolon luteum* flower's petal: A – upper epidermis; B – lower epidermis. 1 – epidermal cells, 2 – glandular hairs, 3 – simple hairs with a warty surface.

cell head. The lower epidermis is strongly tortuous and has more pubescence and more stomata. Inherent in the anocytic type of the stomata is the longitudinal folding of the cuticle along the vein. Examining the leaf from the surface has revealed that the epidermis of the upper side of the leaf of the *Lamium glaberrimum* is represented by cells with slightly tortuous walls, the epidermis of the lower side of the leaf is tortuous. The hairs are almost absent on both sides. The stomata are numerous, located mainly on the lower epidermis, surrounded by 3–4 stomatal cells (anomocytic type). Glands are very rare, they are on a short stalk with 4–8 secretory cells. Hairs are very rare on the vein of the leaf or more often on the veins of the calyx. The calyx of the flower is pubescent with simple two-, three-celled hairs, which have a swollen base, a wide cell at the base of the hair and narrower and heard-shaped cells with a warty surface. *Lamium purpureum* is characterized by simple hairs of two types: large simple hairs thick-walled with a coarse warty surface and thin hairs with a barely noticeable warty surface. *Lamium purpureum* is characterized by glandular hairs on a single-celled stalk and with a two-celled head. Simple hairs with articular cell division often break at the joints, even during the preparation of micropreparations, which can also be a diagnostic feature.

Conclusion. The morphological and anatomical structures of the vegetative and generative organs of *Galeobdolon luteum* have been studied as a result of the research. A systematic comparative analysis of morphological and anatomical features of *Galeobdolon luteum* have been performed with herb of *Lamium album*, *Lamium glaberrimum*, and *Lamium purpureum* which can be impurity, the basic diagnostic signs have been established: numerous simple thin-walled 1–2–3 cellular hairs. At the base of the hairs there are weak nodular swellings of the basal cell, the base is slightly expanded and immersed in the base, which is formed by several epidermal cells. On the epidermis of the stem and leaves there are glands that have a short 2-cell stalk and 4- or 5–6-cell spherical head. Other studied species of the genus *Lamium*, which can be harvested as impurities to *Galeobdolon luteum*, are characterized by the following features. *Lamium purpureum* have the typical simple two-celled hairs with a coarse warty surface, glandular hairs and branched hairs are on the inside of the corolla tube, essential oil glands. *Lamium glaberrimum* possesses the short two-celled with a wide cavity hair with a warty surface, tortuous epidermis of the lower side of the leaf blade and underdeveloped glands are rarely found. The obtained results will be used to develop the parameters of standardization of the studied plant raw material.

Conflicts of interest: authors have no conflict of interest to declare.

Конфлікт інтересів: відсутній.

ВСТАНОВЛЕННЯ ПОКАЗНИКІВ ЯКОСТІ ЛІКАРСЬКОЇ РОСЛИННОЇ СИРОВИНИ ВИДІВ РОДУ *LAMIUM* L. ЗАХІДНОГО РЕГІОНУ УКРАЇНИ

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Мета роботи. Вивчення морфолого-анатомічної будови листків, стебел та квіток видів роду *Lamium* L., що зростають у дикорослому стані в західному регіоні України, з визначенням діагностичних ознак сировини.
Матеріали і методи. Об'єктами дослідження була сировина видів роду *Lamium* L. заготовлена під час цвітіння. Використовували повітряно-суху та свіжозібрану і фіксовану у суміші гліцерин-спирт-вода (1:1:1) рослинну сировину. Вивчення ознак морфологічної будови сировини проводили за вимогами ДФУ. Сировину розглядали неозброєним оком та за допомогою лупи (х10) при денному освітленні. При визначенні анатомічних ознак органів рослин вивчали на відпрепарованій епідермі та препаратах з поверхні під мікроскопом Delta Optical Genetic Pro (Польща). Отримані дані фіксували за допомогою схематичних рисунків та фотографій.
Результати й обговорення. Проведено порівняльний аналіз діагностичних ознак сировини зеленчука жовтого з травою глухої кропиви білої, глухої кропиви голої, глухої кропиви пурпурової, які можуть бути домішками. Встановлено такі ознаки: численні прості тонкостінні 1–2–3-клітинні волоски; біля основи волосків є слабкі вузлуваті здуття базальної клітини, основа злегка розширена і занурена в основу, яку утворюють декілька епідермальних клітин; на епідермі стебла і листя зустрічаються залозки, які мають коротку 2-клітинну ніжку і 4- або 5–6-клітинну кулясту головку. Для інших досліджуваних видів роду *Lamium* характерні такі ознаки: для глухої кропиви білої характерні багатоклітинні та одноклітинні волоски, залозисті волоски з одноклітинною ніжкою і 8–12-клітинною головкою, а також з одноклітинною ніжкою і дво-, 4-клітинною головкою; для глухої кропиви пурпурової типові прості двоклітинні волоски з грубобородавчастою поверхнею, головчасті волоски та розгалужені волоски на внутрішній стороні трубочки віночка квітки, ефіроолійні залозки; для глухої кропиви голої: рідко розташовані короткі двоклітинні з широкою порожниною волоски з бородавчастою поверхнею, звивистостінна епідерма нижньої сторони листової пластинки та недорозвинуті залозки.
Висновки. Проведено морфолого-анатомічне вивчення листків, стебел та квіток *Lamium galeobdolon* (L.) Crantz (син. *Galeobdolon luteum* Huds.), зроблено порівняння їх морфологічної будови з органами глухої кропиви білої, глухої кропиви голої та глухої кропиви пурпурової. Встановлено діагностичні ознаки сировини цих видів. Отримані результати будуть використані для розробки параметрів стандартизації рослинної сировини *Lamium galeobdolon*.

Ключові слова: морфологічні ознаки; анатомічні ознаки; трава; листки; квітки; *Lamium galeobdolon*.

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