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MORPHO-ANATOMIC INVESTIGATION OF VEGETATIVE ORGANS OF WATER AVENS (*GEUM RIVALE* L.)

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ABSTRACT: Species of *Geum* L. genus (avens) of *Rosaceae* L. family belong to perspective sources of medicinal plant raw material for obtaining medicines with the anti-microbic and anti-inflammatory action. They are characterized by such an important feature as the presence of biologically active substances, particularly the polyphenol compounds. According to the aim of present work, morphologic and anatomic investigation of leaves, stems, rhisomes with roots of *Geum rivale* L. of *Rosaceae* L. family has been carried out. In order to obtain the data by scientific investigation, the morphologic and anatomic methods of analysis of medicinal plants have been used. In the process of our investigation the diagnostic features of vegetative organs have been determined. The results of morpho-anatomic features can be used in developing analytic and regulatory records intended for incorporation of the additional sources of medicinal herbal raw materials in the practical field. Research of anatomical structure of aboveground and underground parts of *G. rivale* L with the identification of diagnostic features may be needed during the development of the relevant sections of quality control methods.

INTRODUCTION: According to the data of the World Health Organization, a trend of more complex medical use of raw materials and pharmaceuticals with herbal origin is being reported at the present time¹. Therefore, the research of Ukraine's flora, study of its raw materials base, its application in medicine as well as identification of medicinal herbal raw materials have theoretical and practical significance. Both the necessity of the complex utilization of herbs and presence of sufficient raw materials base explain the interest in the research of *Geum rivale* (wateravens), one of Ukraine's flora representatives².

The presence of polyphenol compounds, polysaccharides, amino acids, fatty acid and micro elements in *G. Rivale* plants defines its variable pharmacological action. Phyto remedies obtained from this plant are taken for diarrhea, dysentery, fever and as a sedative remedy. Due to hemostatic, astringent and anti-inflammatory properties, folk-medicine considers herbal infusion of water avens rhizomes and roots to be a good remedy for treatment of gastrointestinal tract disorders, hemorrhoid, gynecological disorders and internal bleedings^{3,4}. In order to identify the raw materials by macro- and microscopic criteria and to compose the Quality Control Techniques on their base, the morphologic and anatomic study of shoots, rhizomes and roots of *G. rivale* L. has been carried out.

MATERIAL AND METHODS:

Raw materials *G. Rivale* harvested in 2011 – 2012 with in the Kharkiv region area, Ukraine, have been

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used for the macro- and microscopic studies. Fresh, fixed and dry materials have been studied. The herbs have been softened and discolored with 3% alkaline solution where it has been necessary. Studies have been conducted by conventional techniques⁵⁻¹⁰. Microscopes MBR-1, MBU-6 and VV-2610 with magnification of 800X200 and X400 have been used. Micro sections have been photographed with Canon "Digital IXUS700" and Canon "LH-DC50" digital cameras. Photographs have been processed with Adobe Photoshop CS6 Extended software.

RESULTS AND DISCUSSION:

Morphological study of *Geum rivale* water avens (*G. rivale* L.) is a perennial herbaceous plant 25–75 cm high (Fig. 1 A); creeping rhizomes are multi headed, 6–16 cm long, 1.5–2 cm wide, stiff, xyloid, horizontal, sometimes with base so fradical leaves, non uniform lyrugate on the outside, with non-

uniform breakage (Fig. 1 B, C), 6–12 cm long and 0.5cm width ready complementary roots grow away from the rhizome. The color of breakage is light-brown. Stem 1-3, is erect, dark-red on top, leaned, pilose, glandular; radical leave sare macropodous, fragmentary-lyrate-pinnatelypartite, with 2–3 pairs of small obovate duplicidentate locules on each side; stem leaves are micropodous, trifid, with small ovoid stipules.

All leaves are pubescent with accumbent fuzz on the both sides. Flower 2-3, is drooping, actinomorphic, bell-shaped, calyx with hypanthium is brown red, glandular-pilose, with erect ovoid lanceolate calyx lobe leaning to petals; outer calyx lobes are small, linear; petals are reddish or yellow-white with brown-red fibers, torus is slightly elevated, significantly pubescent; fruits are coarse-haired, hair serect and leaned.

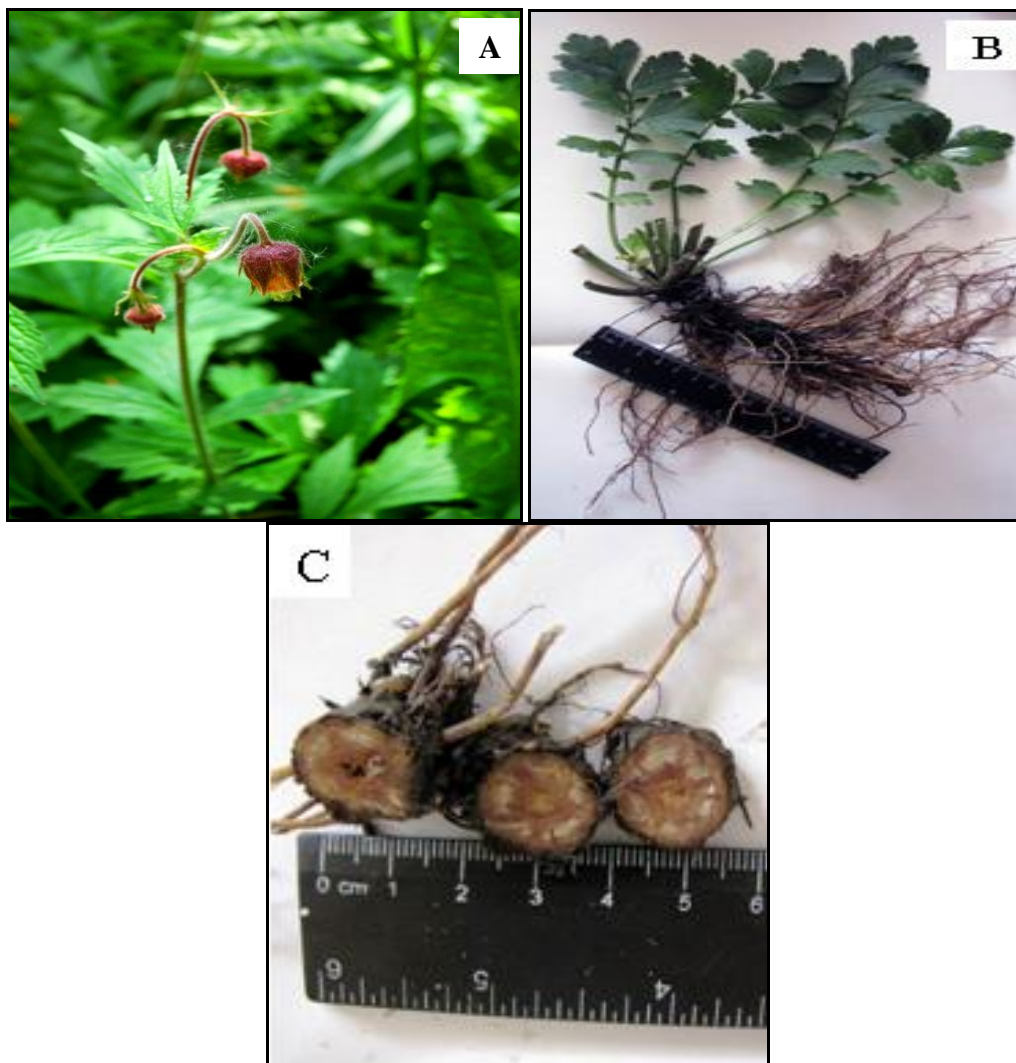


FIG. 1. *GEUM RIVALE* L. A – GENERAL VIEW; B RHIZOME WITH ROOTS; C – RHIZOME IN SECTION

Anatomic study of *Geum rivale* Leaf:

Lamina is amphistomatic, rang in from in completely dorsiventral to nearly isolateral by structure. Palisade mesophyll is weakly

differentiated, single- or double - layered, consist sof slightly elongated cells, spongy mesophyllis 3–4-layered, loosely packed. Druses occur in leaf mesophyll (**Fig. 2**).

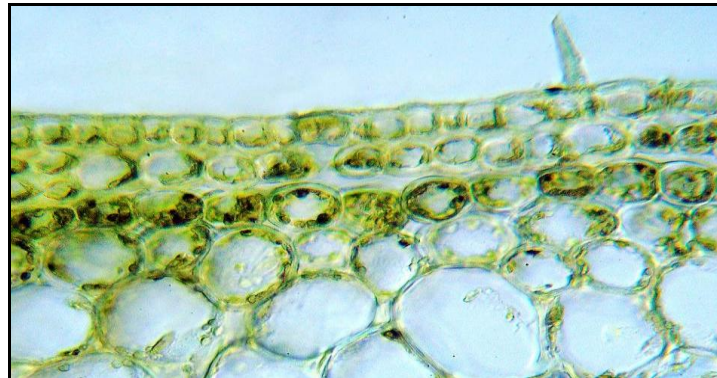


FIG. 2. CROSS SECTION FRAGMENT OF *G. RIVALE* L. LAMINA

Midrib with one U-shaped vascular bundle significantly protrudes from the lower side of the leaf. Epidermis over veins has simple and glandular trichomes. Edge of the lamina is reinforced by collenchyma. Epidermis basic cells of ventral and dorsal sides of the lamina are parenchymal, polygonal, with even or slightly flexuose membrane. Stomas occur only on the lower

epidermis. The stomatal apparatus is of anomocytic type. There are simple and glandular trichomes, (**Fig. 3 A, 3 B; 4**), located along the edge and above the veins over the who low surface of lamina, however the midrib is much more pubescent, since epidermis cells are elongated and have straight porous walls over it.

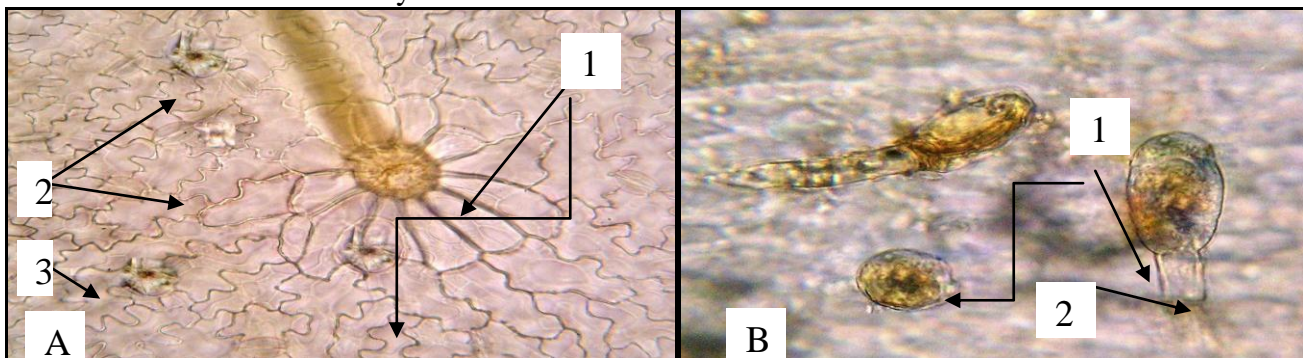


FIG. 3 A – FRAGMENT OF *G. RIVALE* L. LEAF EPIDERMIS ON THE LOWER SIDE: 1 – ROSETTE OF CELLS AROUND SIMPLE TRICHOME; 2 – CELLS WITH DRUSES; 3 – STOMAS; B – GLANULAR HAIRS: 1 – HEAD; 2 – STALK



FIG. 4. SIMPLE HAIRS OF *G. RIVALE* L.

Rosette cells around simple hairs differ from basic cells (**Fig. 3 A**). They are larger, and have more even and thick walls, folded cuticle. Simple covering hairs (**Fig. 3 A; 4**) are unicellular, thick-walled, with incrassate porous membrane, which consists of 12 or sometimes 14 cells. Depending on the formation stage and location on the leaf, the hairs differ in length and shape, presence or absence of living content, wall in rassation extent and its chemical composition. Young out growth sare living, conical-oblong protrude or slightly

dent. Hairs in the formation stage are more oblong, spini form and erect. Formed and mature hairs are dead, long, gradually tapering to sharp apex; their membranes are significantly incrassated, flaky, typically without a cavity. Hairs along the lamina are directed upwards. Glandular hairs (**Fig. 3 B**) have oblong, cylindrical stalk of 2-3 cells and oblong, elliptic unicellular head with yellowish secretion. They are erector leaned and mostly occur above the veins, typically on the upper epidermis.



FIG. 5. A – LEAFSTALK OF *G. RIVALE* L; B – EPIDERMIS FRAGMENT

The groove and two side wings are observable on ad axial surface of the leafstalk. One or 3–4 conductive bundles are located along the centre, angular collenchyma, and 1–3 small bundles are in the wings (**Fig. 5 A**). Large druses are occasionally found in large cell parenchyma. Epidermis of leafstalk (**Fig. 5 B**) consists of prosenchymal wedge-pointed basic cells, sparse stomas with narrow guard cells and 3–4 subsidiary cells. Leafstalk is sparsely pubescent with trichomes typical for all aboveground organs.

Stem: Densely pubescent stem gradually increases in diameter from apex to its base (from 1.5 to 4 mm). The shape of stem cross section is almost rounded, without distinct ribs. Epidermis consists of narrow prosenchymal cells with simple unicellular and glandular trichomas (**Fig. 6. 1**). Primary cortex consists of 2–3 lamellar collenchymas layers, 3–4 chlorenchyma layers, with starch grains and druses stored in its cells (**fig. 6. 2**). Central cylinder has transitional bundle structure; nodes are 3-lacunar. Pith occupies the most significant area of the stem section (**Fig. 6. 8**); its cells are large, globular, with porous membranes. Cells of the central part of the pith are destroyed in the lower stem zone, the cavity is formed. Conductive bundles are open and

bicollateral. Vessels mostly have simple perforation.

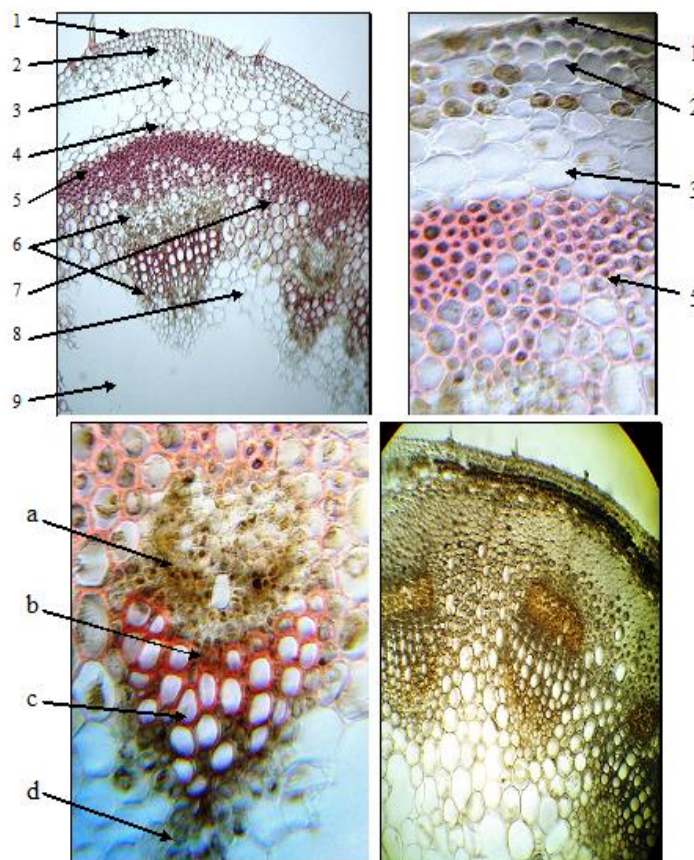


FIG. 6. FRAGMENT OF *G. RIVALE* L. STEM CROSS SECTION MAGNIFICATION: (10x10), (10x40), (7x40)

- 1 – Epidermis with stomas and simple hairs,
- 2 – Collenchyma,
- 3 – Cortex parenchyma,
- 4 – Endoderm,
- 5 – Sclerenchyma,

Rhizome: Rhizome has bundle structure (Fig. 7), covered with periderm, which consists of flat-sided thin-walled cells of dark-brown colour, arranged into roof-tile-like structure. Multi layered storage parenchyma is observed in primary cortex, endodermis ulterior. (Fig. 7. 2, 3). Conductive bundles of the central cylinder are open and bicollateral

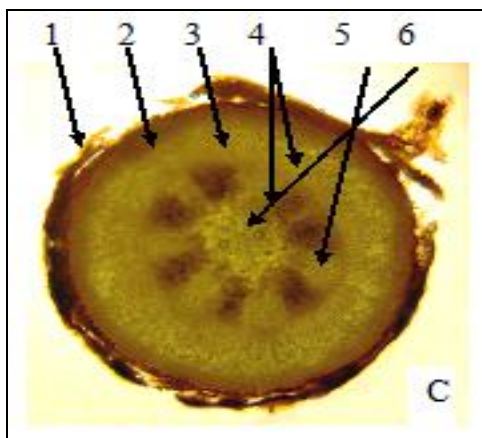
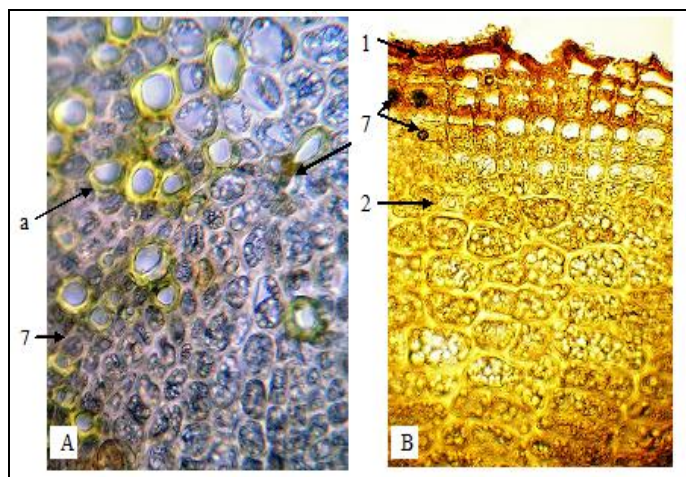


FIG. 7. CROSS SECTION (C) AND FRAGMENTS (A, B) OF *G. RIVALE L.* RHIZOME

- 1 – Periderm; 2 – Cortex Parenchyma with Starch Grains;
- 3 – Endoderm; 4 – Open Bicollateral Bundle; A – Wood Vessels;
- 5 – Pith Rays; 6 – Pith

Phloemic elements are represented by thin-walled cells. Boundary of cambium is not always clearly expressed. The wood is of diffuse-porous type. Vessels are broad, 15.0–26.0 μm in diameter, rounded, gathered in to small radial groups of 4–6, up to 8. Mottled (porous), helical, cancel late or scalar form vessels are more typical. They are

- 6 – Open bicollateral conductive bundles:
- a – outer phloem, b – Cambium, c – Xylem, d – Inner phloem,
- 7 – Inter fascicular sclerified parenchyma,
- 8 – Pith with druses and starch grains,
- 9 – Cavity.

adjacent to small sections of libriform, which creates non continuous radial lines and has the properties of anatomic organization inherent to a rhizome.

Broad pith rays of thin-walled parenchyma pass between radial lines of conductive and mechanical tissues. Pith occupies large volume and consists of large-cell thin-walled parenchyma with large quantity of elongated idioblastic cells with brown secretion. Intrinsic inclusions in the form of starch grain 2.0–4.0 μm in diameter and idioblastic cells with druses are located in the cortex parenchyma, phloem, pith rays and pith (Fig. 7).

Root

The roots have secondary bundle structure. (Fig. 8). Primary cortex is broad, separated from the central cylinder with slightly visible endoderm.

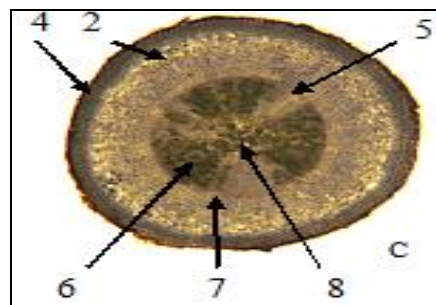
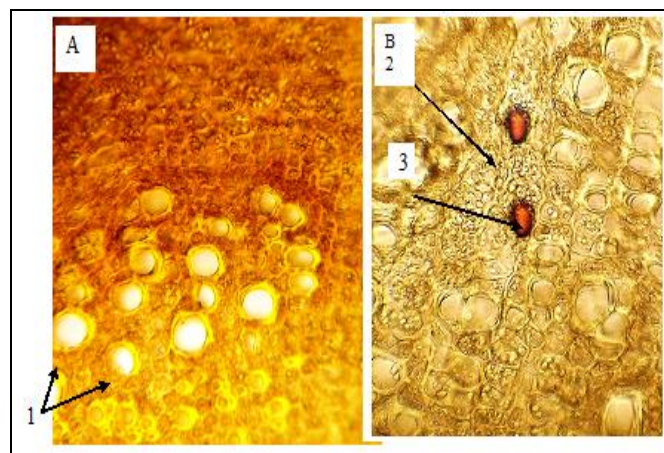


FIG. 8. ROOT OF *G. RIVALE L.*A, B – FRAGMENTS; C – CROSS SECTION (10x40)

- 1 – Vessels of The Wood; 2 – Storage Parenchyma With Starch Grains; 3 – Secretory Storages; 4 – Periderm; 5 – Pith Rays; 6 – Bicollateral Conductive Bundle; 7 – Cambium; 8 – Primary Xylem;

Sieve tubes are large and sparse. The basis of phloem is comprised of phloem parenchyma, the cells of which are small, dense, elongated along the root; there are no mechanical elements. Cambium ring and embryonic elements of the phloem and xylem formed by it consist of 6–8 cell layers.

The largest section of the root is comprised of secondary xylem, which is divided into irregular parts by pith rays. These parts have the same width as the pith rays. Wide pith rays separate three conductive bundles. Inclusions in the form of secretory storages, starch grains and idioblastic cells with druses are occasionally found. Primary xylem is located in the center of the root (**Fig. 8. 8**).

CONCLUSIONS: Morpho-anatomic study of leaves, stems and rhizomes with roots of *Geum rivale* has been conducted for the first time. Morpho-anatomic diagnostic properties of stem, leaves, and rhizomes with roots of *G. Rivale* are important and necessary to identify medicinal herbal raw materials. Studied morpho-anatomical properties will be used in composing documentation on quality control techniques of medicinal herbal raw materials.

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