


## Morphological and Micromorphological Investigations of *Bidens frondosa* L. from Flora of Krasnodar Region, Russia

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### Abstract

Complex morphological and micromorphological studies have been made about bootjack bur (*Bidens frondosa*) growing on the territory of the Krasnodar region. The lamina is of dorsoventral type. The conduction system has fasciations, three closed collateral bundles, are present near the vein. The leaf is of amphistomatic type, stomatal apparatus are present in a small amount. Anticlinal walls of the main cells of the epidermis are strongly flexuose. The lower epidermis if compared to the upper one has a large number of stomatal apparatus of anisocytic type. The trichomes are leggy, represented by multicellular hairs of different shapes and lengths. Micromorphological capabilities of bootjack bur's transverse section of the caulis and leafstalk have been studied. Received micromorphological data is a fragment of complex pharmacognostic studies of the *Bidens* kind. For acquiring the anti-allergic medication in the future, it is necessary to make pharma-technological studies and come up with the necessary medical form in the shape of thick extract and also make pharmacological studies in acquiring this medical form.

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## INTRODUCTION

The bootjack bur (*Bidens frondosa*) is not popular among medicinal plants, as there is a sufficient number of pharmacopoeial representatives. In countries worldwide, *B. frondosa* is actively used as a medicinal plant, but it is not accepted officially in Russia<sup>1</sup>. As for the distribution of this species, it is worth noting that it belongs to a hazardous invasive species, spreading almost across all continents. And in this regard, problems with the raw material mass of this type will not be present. There is a question about the toxicity of this species, but in the previous work, it is possible to trace several studies on the absence of toxicity of this species<sup>2</sup>.

Many authors indicate that this species' distribution can be attributed to the group of invasive species. This type is quite polymorphic, including more than 25 varieties. In addition to the high amplitude of variation in morphological characteristics of achenes, there is also variability in the number of chromosomes in the natural range<sup>3</sup>. Typically, *B. frondosa* has 2n=48 chromosomes. However, specimens with 2n=24 and 36 chromosomes have been recorded naturally. The biological features of this species in the conditions of invasion are studied. In addition to the formation of many seeds, invasive species may differ from native species of the same genus in the rate of passing through various stages of ontogenesis and other biomorphological features<sup>4</sup>.

*Bidens frondosa* grows in floodplains, along the banks of reservoirs, along Railways, in ruderal places, and fields. It spreads easily and spreads quickly, especially along rivers. The ways of the settlement are diverse: hydrochory, epizoochory, and

anthropochory. The latter distribution methods are possible because the seeds are equipped with prongs that easily cling to the hair of animals and people's clothing. It is also distributed by railroad transport. In North America's natural growth conditions, the roots and leaves of *B. frondosa* are used for arrhythmia and colds. The plant has antispasmodic, diaphoretic, wound healing, and diuretic effects. Another study revealed the highest content of polysaccharides and flavonoids is observed through natural drying and at a drying temperature of 40°C with forced ventilation<sup>5</sup>.

As for the chemical structure of species of the genus *Bidens*, it is known that in alcohol extracts of the grass of *Bidens tripartita* and *B. frondosa*, the main component is luteolin-*O*-7-glucopyranoside. The similarity of the component structure of alcohol extracts from the grass of *B. tripartita* and *B. frondosa* has been noted; this suggests that the *B. frondosa* herb can be considered an additional source of medicinal plant raw materials<sup>6,7</sup>. As for the pharmacological activity of this species, the following types of pharmacological activity can be found in several works, including expectorant action of the roots and seeds of *B. frondosa*, as a diuretic action in the treatment of prostatitis, antibacterial activity in gastritis, diarrhea, colitis, enterocolitis. Decoctions are used as an anti-allergic agent in the treatment of dermatitis. The antibacterial and antioxidant effect is due to the presence of essential oil, which has an inhibitory effect against *Staphylococcus aureus*, *Listeria monocytogenes*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Salmonella enteritidis*, and *Enterobacter aerogenes*<sup>8,9</sup>.

As for the species of the genus *Bidens*, according to the flora, the genus has 36 species, among which the main distribution is associated with the Northern hemisphere. Among the species that grow on the territory of the Russian Federation, the following can be noted: *Bidens alausensis* Kunth., *B. alba* (L.) DC., *B. aurea* (Aiton) Sherff., *B. bipinnata* L., *B. cernua* L., *B. chilensis* DC., *B. connata* H.L. Muhl. ex Willd., *B. coronata* (L.) Fisch. ex Steud., *B. ferulifolia* Jacq., *B. frondosa* L., *B. hirsuta* Nutt., *B. hispida* Kunth., *B. kamtschatica* Vassilcz., *B. leucantha* (L.) Willd. ex Walp., *B. leucanthema* (L.) Willd., *B. maximowicziana* Oetting., *B. melanocarpa* Wiegand., *B. minor* (Wimm. & Grab.) Worosch., *B. montaubani* Phil., *B. odorata* Cav., *B. orientalis* Velen., *B. parviflora* Willd., *B. pilosa* L., *B. radiata* Thuill., *B. reflexa* Link., *B. scandicina* Kunth., *B. sweetiana* Banfi, Galasso & Bartolucci, *B. taquetii* H. Lev. & Vaniot, *B. trichosperma* (Michx.) Britton, and *B. tripartita* L. This work provides information about the morphological, chemical, and anatomical structure of *B. frondosa*. We want to compare this species with the official medicinal plant *B. tripartita* and provide the data from the experimental part. Thus, we aim to draw attention to a little-known, unexplored, and undervalued type of *B. frondosa*.

## MATERIALS AND METHODS

### Materials

The material used in this study was *B. frondosa* and *B. tripartita* (as comparison) obtained from the Krasnodar Region, Russia, and determined at the Department of Pharmacognosy, Botany and Technology of Phytopreparations, Pyatigorsk Medical and Pharmaceutical Institute, Volgograd State Medical University, Russia. The equipment used includes a digital camera and light microscope.

### Methods

#### Morphological studies

Morphological studies were carried out with the same procedure as our previous preliminary study<sup>10</sup>. Parameters observed included examination of the anatomical structure of *B. frondosa*, which was then compared with *B. tripartita*.

#### Micromorphological studies

Micromorphological studies were carried out with the same procedure as our previous preliminary study<sup>10</sup>. The anatomical structure was observed for the upper and lower epidermis, transverse slices on the leaf lamina, and stem of *B. frondosa*.

## RESULTS AND DISCUSSION

### Morphological studies

*Bidens frondosa* is an annual herbaceous plant up to 150 cm tall, shoots erect, branching, and almost naked. The leaves have divided lamina, usually 3-5 divided. The lateral lobe has stems 3-5 mm long. The final lobe of the leaf is longer than the

lateral one, with a stem 10-15 mm long. Leaf lobes are lanceolate or oblong-lanceolate, pointed, coarsely toothed. Leaf arrangement is the opposite.

*Bidens frondosa* has inflorescences-baskets, rarely single, often collected in aggregate botryoidic inflorescences in the form of non-conic corymbose panicles. The wrapper is two-rowed: the outer row is represented by about eight spatulate or back-lanceolate to linear herbaceous, usually ciliated along the edge; the inner row of 6-12 almost membranous leaflets is oblong-ovate. A characteristic feature of the type - the number of leaves of the basket wrapper is less than 10. False-tongued flowers with a Golden-yellow tongue are usually absent, rarely in the number of 1-3 or more. Tubular flowers in 20-60 or more, with Corolla orange (**Figure 1**). Only two morphological features correlate between *B. frondosa* and *B. tripartita*: brown achenes have straight or slightly deviated awns, and yellowish achenes are provided with strongly deviated awns. Other features are not correlated and can be combined differently, as shown in **Table I**.



**Figure 1.** Morphological traits of *B. frondosa*

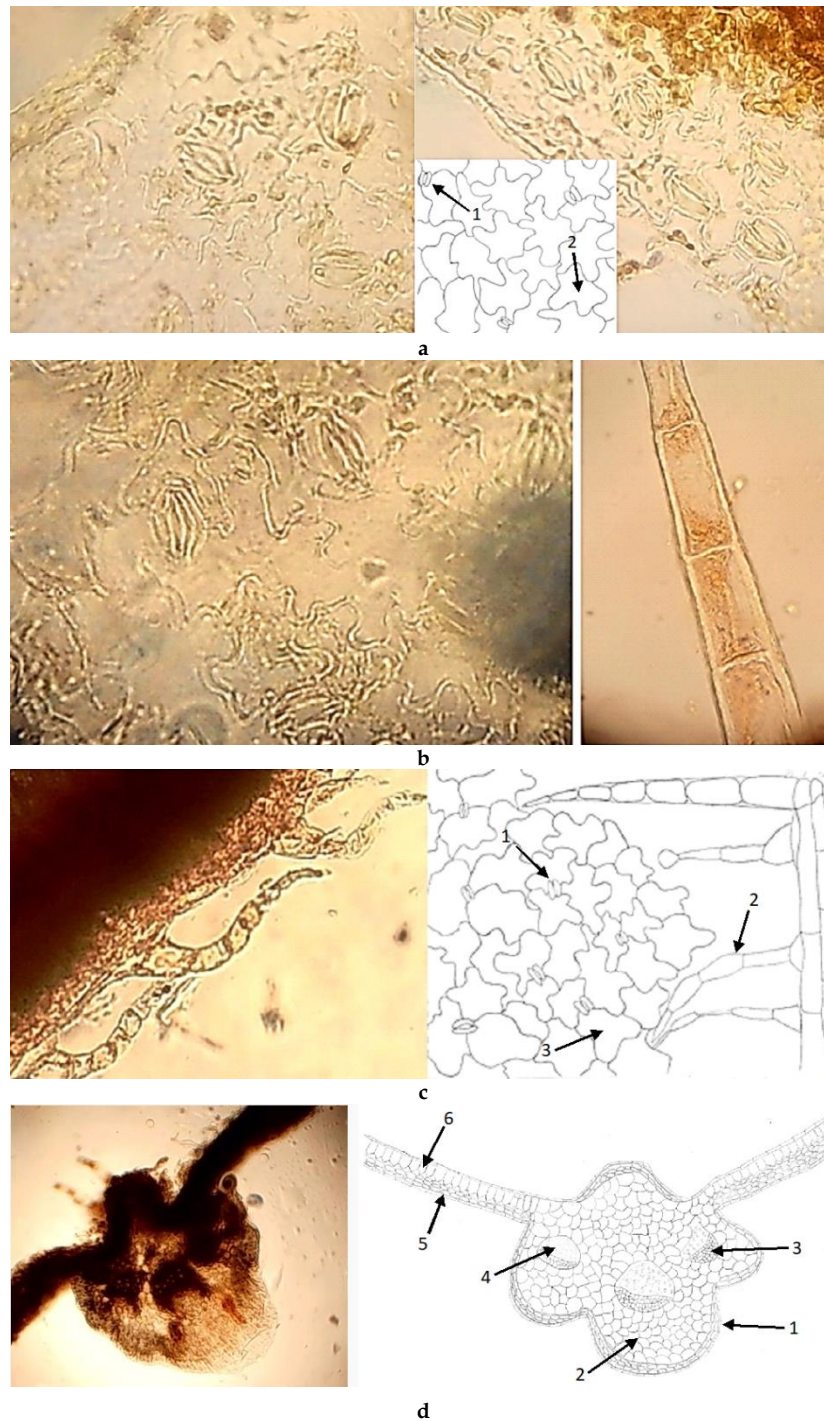
**Table I.** Morphological comparison between *B. frondosa* and *B. tripartita*

Plant's organs	Morphological traits	
	<i>Bidens tripartita</i>	<i>Bidens frondosa</i>
Stem	Erect, up to 100 cm high, branched, with opposite branches	Erect, up to 180 cm high, more or less branched, the branches are also opposite
Leaf	Short-stemmed, leaf blade oblong-elliptical, whole edge, rounded base, acute tip, veining pinnate-reticulate, leaf-opposite	Petiolate, leaf blade lanceolate-ovate, saw-toothed edge, wedge-shaped base, pointed tip, pinnate-reticulate venation, opposite leaf arrangement
Anthodium	Erect, 6-12 mm in diameter	Not tall, usually solitary, rarely in pairs, threes or corymbose panicles on stalks 1-8 cm long
Bract	Filmy, equal in length to the flowers and achenes	Filmy, equal in length to the flowers and achenes
Flowers	Tubular, bisexual	Tubular, bisexual; false-Lingual flowers are usually absent, rarely in the number of 1-3 or more, with a Golden-yellow tongue.
Seed pod	Obovate, wedge-shaped, flattened, with two serrated spines	From blackish to straw-brown, flattened, obovate to wedge-shaped, external up to 7 mm long, internal - up to 10 mm, on the edges with upward-pointing tooth-like hairs



*Anatomical structure of lamina*

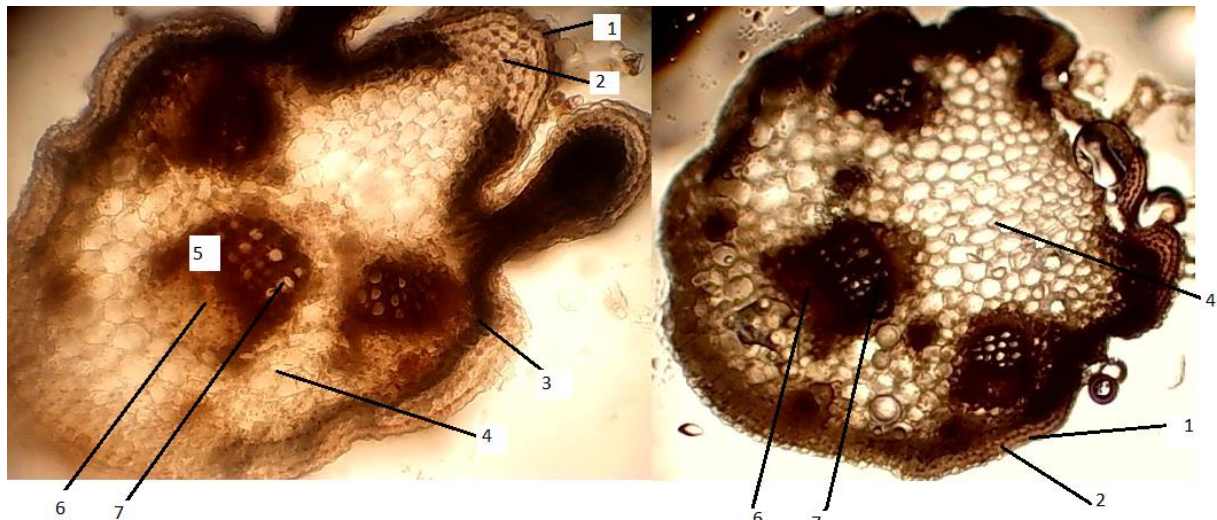
The lamina of *B. frondosa* is dorsoventral type. The epidermis represents the integumentary tissue. The palisade mesophyll is in a single layer under the upper epidermis, and the spongy mesophyll occupies the main section space. The conducting system has a beam structure and three closed collateral beams in the vein area. Sclerenchyma is absent. Rarely there are outgrowths of the upper epidermis, represented by multicellular hairs. The leaf of *B. frondosa* is of amphistomatic type, stomatal instruments are present in small amounts, and there are no trichomes. The anticline walls of the main cells of the epidermis are enormously convoluted. The lower epidermis, in contrast to the upper one, has many stomatal anisocytosis-type devices. Multicellular hairs of various shapes and lengths represent well-developed trichomes (Figure 2).



**Figure 2.** The anatomical structure of lamina of *B. frondosa*. a: upper epidermis (1-stomatal apparatus; 2-main cells); b: the lower epidermis (1-stomatal apparatus; 2-trichome; 3-main cells), c and d: transverse section of lamina (1-epidermis; 2-pap; 3-phloem; 4-xylem; 5-spongy mesophyll, 6-palisade mesophyll)

#### Anatomical structure of transverse section of stem

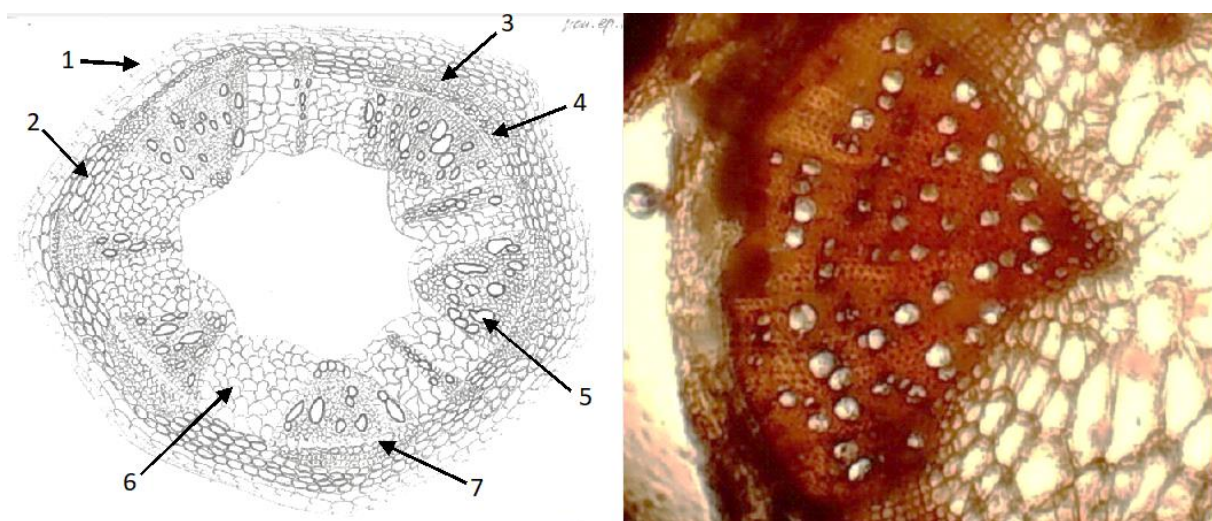
The leaf stalk of *B. frondosa* on the transverse has a wing-shaped form. The integumentary tissue is represented by the epidermis. Conducting the system of the beam type, we made a series of cross-sections of the petiole in the upper, middle, and lower parts. We observe three collateral bundles in the upper and middle parts and the lower section-3 large bundles and six small collateral bundles. There are trichomes, multicellular hairs of different lengths, concentrated mainly on the adaxial side of the petiole in the recessed area (**Figure 3**).



**Figure 3.** The anatomical structure of lamina of *B. frondosa* on a transverse section. (1-epidermis; 2-collenchyma; 3-sclerenchyma; 4-parenchyma; 5-conducting bundle; 6-phloem; 7-xylem)

#### Anatomical structure of transverse section of lamina

The stem on the transverse section of *B. frondosa* stem has a cylindrical shape. In the center of the incision, the stem is hollow. The integumentary tissue is primarily represented by the epidermis. The bark is represented by collenchyma, chlorenchyma, and parenchyma. Collenchyma is located immediately under the epidermis in 2-3 layers. The endodermis is not expressed. The central cylinder contains pericyclic sclerenchyma, phloem, cambium, and xylem. The sclerenchyma is adjacent only to the phloem part. The phloem is represented by sieve-like elements. The xylem is formed by vessels and lignified parenchyma. Fragments of conducting beams have a triangular shape. The vessels are located centripetally. The interstitial parenchyma forms additional conducting collateral bundles due to the activity of the interstitial cambium (**Figure 4**).



**Figure 4.** The anatomical structure of stem of *B. frondosa* on a transverse section. (1-epidermis; 2-collenchyma; 3-sclerenchyma; 4-parenchyma; 5-conducting bundle; 6-phloem; 7-xylem)



## CONCLUSION

Morphological and micromorphological data obtained from *B. frondosa* are fragments of a pharmacognostic study of the *Bidens* species complex. For further research, it is planned to conduct pharmacological research to get anti-allergic drugs from *B. frondosa* by testing and developing dosage forms from these plants.

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None.

## AUTHORS' CONTRIBUTION

All authors have an equal contribution in carrying out this study.

## DATA AVAILABILITY

None.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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