

Morphologo-anatomical features of the fruits of the *Ligusticum sinense*

Naida Nadezhda Michailovna
Doctor of Biological Sciences, Full Professor
Saint-Petersburg State Agrarian University

Abstract. The experience of using medicinal plants in China goes back several millennia, about 12000 plant species are used in traditional Chinese medicine (TCM), of which 300 species of medicinal plants are grown in culture.

The study of medicinal plants from traditional Chinese medicine will make it possible to rationally select species for their introduction and cultivation in Russia, as well as increase the arsenal of medicinal plants and preparations based on them.

Within the framework of cooperation between the St. Petersburg State Agrarian University and the Scientific Research Institute of Industrial Crops of the Sichuan Academy of Agricultural Sciences (Chengdu, People's Republic of China), seeds (mericarpies) of Chinese ligusticum were obtained. Types of ligusticum are used in traditional medicine of the East and in medicine in Western Europe. They are used for hypertension, coronary heart disease, they have analgesic, antirheumatic, sedative, antiseptic effects, improve blood circulation.

The aim of our research was to study the morphological and anatomical features of the fruits of Chinese ligusticum (*Ligusticum sinense* Oliver, *Apiaceae*). The morphology and anatomy of fetuses were studied using live material and material fixed in acetoalcohol.

The fruit of the Chinese ligusticum is elliptical, two-seeded, splitting into two mericarps (parts of the fruit), the seed is not released from the pericarp. Mericarps are brown in color, not compressed from the back, the dorsal side is convex with three well-defined ribs and two lateral ones. Conductive bundles pass through the ribs; in ripe fruits, they are almost invisible. In the hollows between the dorsal ribs there are 1-2 essential oil tubules, on the lateral side - 2-3, on the ventral side - 2-4. Pericarp parenchyma cells in mature fruits are compressed and crumpled. The non-lignified endocarp of the seed coat is well preserved.

Studies have revealed specific morphological and anatomical features of the fruits of *Ligusticum sinense*, distinguishing them from other species of the genus *Ligusticum*. Further studies of Chinese ligusticum will make it possible to judge the prospects for its introduction, cultivation and use in Russia.

Keywords: ligusticum, medicinal plants, fruit, seed, rib, mericarp, pericarp, essential oil tubule

Introduction

From year to year, interest in medicinal plants is growing, both in Russia and around the world. To satisfy the need of medicine for medicinal plant raw materials, some types of plants are collected in nature, others are grown in culture. However, the natural reserves of many types of medicinal plants are under threat of destruction, all this leads to a decrease in the biological diversity of plants. Anthropogenic impact has a detrimental effect on the state of plant resources. Some plant species do not tolerate trampling and suffer from uncontrolled harvesting, especially in suburban forests. Many types of medicinal plants have the status of protected and endangered.

It is quite obvious that the problem of conservation of medicinal plants, the threat of destruction of their natural resources, as well as rapid climate change lead to an understanding of the need to search for new species and forms of medicinal plants and cultivate them in the soil and climatic zones of the Russian Federation. This problem is relevant not only for Russia, but also for other countries. According to Chinese researchers from the Sichuan TCM Research Center, they organized expeditions to Tibet and identified rare species of medicinal plants used in traditional Chinese medicine. Methods of conservation of rare species are being developed, as well as technologies for their cultivation in culture [1]. The cultivation of medicinal plants has a number of advantages, the main ones being the achievement of high yield, quality and uniformity of raw materials, its environmental safety, the use of mechanization means, simultaneous and fast harvesting, etc. [2]. As you know, the experience of using medicinal plants in China goes back several millennia, about 12000 plant species are used in traditional Chinese medicine (TCM), of which 300 species of medicinal plants are grown in culture. Therefore, the study of medicinal plants from traditional Chinese medicine will allow us to rationally select species for their introduction and cultivation in Russia and will increase the arsenal of medicinal plants, which, ultimately, will contribute to expanding the range of herbal medicines.

Within the framework of cooperation of the St. Petersburg State Agrarian University with the Scientific Research Institute of Industrial Crops of the Sichuan Academy of Agricultural Sciences (Chengdu, People's Republic of China), seeds (mericarpies) of a medicinal plant [3] were obtained, used in traditional Chinese medicine - Chinese ligusticum from family of celery *Apiaceae*.

Types of ligusticum are used in folk medicine and as food plants. So, Scottish ligusticum, which grows in the European part of the Russian Federation, the Far East and Alaska, is eaten as a vegetable plant. Ligustikum arafe - an endemic of the Western Transcaucasia, has a fragrant rhizome, from which a powder is prepared for flavoring tobacco. Ligusticum Wallich, or Wallich, (*Ligusticum wallichii*=*Ligusticum chuanxiong* Hort.), A related species - Chinese

ligusticum (*L. sinense*) and zheholensky ligusticum (*L. jeholense*) are used in traditional Chinese medicine (TCM) and in medicine in Western Europe. The medicinal raw materials are the rhizomes and roots of these plants. Wallich ligusticum rhizomes contain essential oil with numerous components, alkaloids and organic acids (ferulic). Preparations from rhizomes are used for hypertension, coronary heart disease, they have an analgesic effect, improve blood circulation. The roots and rhizomes of Chinese ligusticum have antirheumatic, sedative, antiseptic and diaphoretic effects [4, 5].

Chinese Ligusticum - *Ligusticum sinense* Oliver is a perennial herb 80-100 cm high. In the soil it has a short, branched rhizome. Under natural conditions, it is distributed in East Asia (China, Japan), grows in forests at an altitude of 3000 m above sea level, occurs in shrub thickets, in meadows, slopes, along river banks. Loves wet places and shade. This species is cultivated in East Asia and Europe. It is not yet grown in Russia [6].

Purpose of the study - to study the morphological and anatomical features of the fruits of Chinese ligusticum to identify diagnostic signs.

Materials, methods and objects of research

The object of the study were seeds (mericarps) of *Ligusticum sinense* sample from Sichuan province (China). The morphology and anatomy of fetuses were studied using live material and material fixed in acetoalcohol. To soften the fruits, a mixture of ethyl alcohol, glycerin and water (1:1:1) was used. Temporary preparations were prepared according to generally accepted methods. The study of objects was carried out using a binocular and a microscope.

Research results

The Chinese ligusticum has a specialized, non-opening, fractional fruit, which, when ripe, decays into 2 mericarp (half-fruit). It is formed from the lower ovary, in shape - elliptical or ovoid, two-seeded, the seed is not released from the pericarp. Mericarps are light to dark brown in color, their length is 2.4-3.1 mm, width is 1.0-1.3 mm, they are not compressed from the back, the dorsal side is convex with three well-defined ribs and two lateral, no wings. The ribs are primary, almost equal, rounded, the marginal ribs are located at the width of the lateral ones; in some mericarpi, additional ribs appear on the dorsal side. The ventral side has a protruding keel. At the apex there is a noticeable spout 1.0–1.2 mm long (fig. 1).



Fig. 1. Mericarps of the *Ligusticum sinense*

The mass of 1000 seeds (mericarp) is 1.76 g. Conductive bundles pass through the ribs; in ripe fruits they are almost invisible. In the hollows between the dorsal ribs there are 1-2 essential oil tubules, on the lateral side - 2-3, on the ventral side - 2-4 (fig. 2). Costal essential oil tubules are not visible.

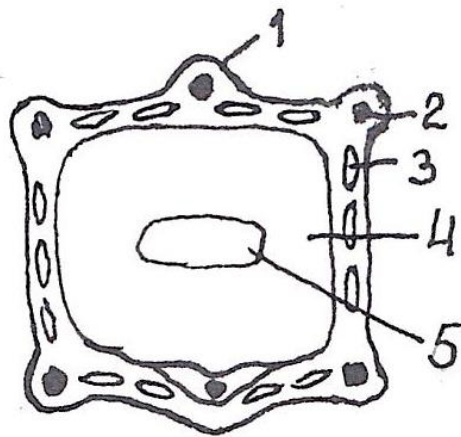


Fig. 2. Cross-section of the mericarp of the *Ligusticum sinense* (diagram): 1-the rib of the dorsal side; 2 – the conducting bundle; 3 – the essential oil channel; 4-the endosperm; 5 – the embryo

The anatomical study of the mericarps showed that in mature fruits the cells of the pericarp parenchyma are crumpled (fig. 3) and filled with tannins. The exocarp is covered with a finely folded cuticle, its cells are almost isodiametric with beaded lateral walls.

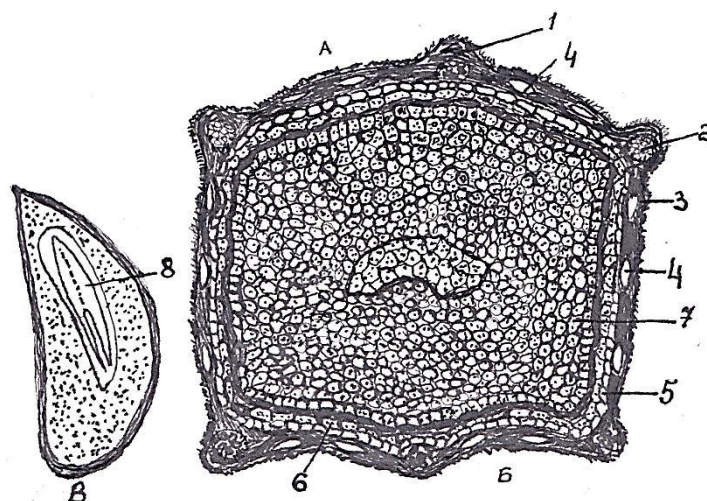


Fig. 3. Cross section of the mericarp of the *Ligusticum sinense*: A – dorsal side of the mericarp; B – abdominal side; C – longitudinal section of the mericarp; 1 – rib ; 2 – conducting bundle; 3 – exocarp; 4 – essential oil channel in the mesocarp; 5 – endocarp; 6 – seed peel; 7 – endosperm; 8 – embryo

The mesocarp consists of 4-6 layers of parenchymal cells, there are no crystals in the cells, the essential oil tubules are fusiform (fig. 4). The endocarp is not lignified, remains in mature fruits and is represented by large cells. Like all representatives of the celery family, the seed coat is poorly developed, tightly pressed against the endocarp. Inside the seed lies a powerful endosperm, the cells of which are filled with oil, aleurone grains, and calcium oxalate crystals. On the ventral side, the endosperm is flat or slightly convex.

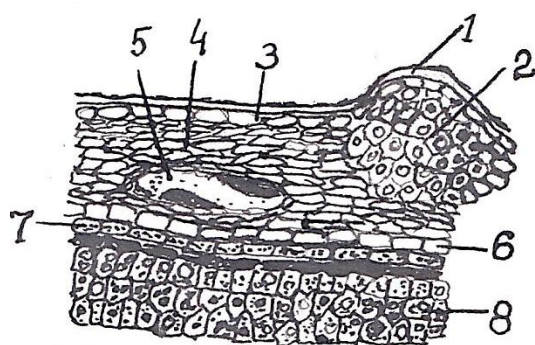


Fig. 4. Cross-section of the mericarp of the *Ligusticum sinense* (fragment): 1 – cuticle; 2 – conducting bundle; 3 – exocarp; 4 – mesocarp; 5 – essential oil channel; 6 – endocarp; 7 – seed peel; 8 – endosperm

A comparative analysis of our data and the material contained in the literature [7, 8] shows both the general similarity and uniformity of the structure of fruits in the species of the

genus *Ligusticum*, and differences in morphometric and anatomical details. Distinctive features of the mericarpia of Chinese *ligusticum* are their relatively small size (2.4-3.1 mm), in the cross section of the mericarp they are almost square, not compressed from the back, have small rounded ribs, the number of tubules varies depending on the size of the mericarp, it is preserved in mature fruits endocarp and seed coat, secondary rib formation noted.

Conclusion. The studies carried out have revealed specific morphological and anatomical features of the fruits of *Ligusticum sinense*, distinguishing them from other species of the genus *Ligusticum* and capable of serving as diagnostic signs. Further study of Chinese *ligusticum* will reveal the prospect of its introduction, cultivation and use in Russia.

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