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# BOTANICAL DESCRIPTION, CHEMICAL COMPOSITION AND MEDICINAL PROPERTIES OF *FERULA ASSA-FOETIDA*

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***Abstract.*** *This article presents an analysis of literature data on plant species belonging to the genus Ferula L. that grow in the desert, semi-desert, foothill, and mountainous regions of Uzbekistan, including their distribution, botanical description, chemical composition, and medicinal properties.*

***Keywords:*** *ferula assa-foetida, panaferol, kufestrol, zafarol, tefestrol, alkaloid, glycoside.*

## Introduction

It is important to note that since ancient times, people have used plants not only as a source of food but also as medicinal organic substances. For example, the peoples of East Asia have traditionally used tea, African peoples have used coffee and kola nuts, the peoples of Central America have used cocoa, and the peoples of South America have used mate leaves. In addition, to expel intestinal parasites from the body, African peoples have used the flowers of the kusso plant, while South American and European peoples have used fern roots.

Moreover, from ancient times in Southeast Asia-particularly in India, China, Tibet, Korea, and Arab countries-patients have been treated with medicinal plants. Abu Ali ibn Sina, in his book *The Canon of Medicine*, provided information on more than 400 plant species. In nature, there are about 500,000 species of higher plants, of which approximately 12,000 are considered medicinal. In Uzbekistan, more than 4,200 plant species are found, and over 160 of them are used as medicinal and healing plants in human medicine and partly in veterinary practice.

Kovrak belongs to the Apiaceae (umbellifer) family and is a perennial monocarpic plant that grows to a height of 100–120 cm and flowers and bears fruit only once in its lifetime. In spring, kovrak sprouts and produces only basal leaves. Over the years, its leaves gradually increase in size, while the root thickens and accumulates a large amount of nutrients. After 7–13 years of growth, the plant forms a stem and begins to flower. In the year it enters the seed-producing stage, the length of its leaves reaches 50–60 cm, and their diameter can reach up to 1 meter. It blooms in March–April, forming a yellow, compound umbel-shaped inflorescence at the tip of its generative organ. The seeds ripen in May–June. The young green leaves of kovrak, its dried hay, and its mature seeds are consumed by animals. Kovrak seeds contain 14–19% protein, 8% fat, 37–47% nitrogen-free extractive substances, and 23–27% fiber [2; pp. 21–22, 18; p. 30].

On a global scale, there are nearly 200 species of *Ferula*. In our country, more than 50 species have been identified. Many species of *Ferula* are widely used in the pharmaceutical industry as remedies for treating diseases. Furthermore, resins and essential oils are obtained from some species, while the young flowering parts of *Ferula* are also used for food purposes.

The beneficial properties of *Ferula* have been known to people since ancient times. As a result, various nations around the world have long used extracts of this medicinal plant as an anti-

tumor, antitoxic, laxative, and immunomodulatory agent. In recent years, it has also been increasingly applied in veterinary practice as an anthelmintic agent against parasitic worms.

**Purpose of the research.**

The aim of this study is to analyze the available literature data on plants belonging to the genus *Ferula* L. that are distributed in different regions of our republic.

**Degree of research development.**

In recent years, the extraction of gum (resin) from kovrak roots and its export have intensified significantly [3; pp. 114–240]. Kovrak contains biologically active substances and exhibits high pharmacological and chemotherapeutic activity. Therefore, the prospects for the use of this plant are quite broad and promising [18; p. 30]. The resin of *Ferula assa-foetida* is used at the Tashkent Pharmaceutical Plant for the production of estrogenic preparations such as panaferol, kufestrol, and zafarol, which are applied to increase egg productivity in poultry [15; 23; p. 112; 20; pp. 131–132].

It should be particularly emphasized that the kovrak plant is widely distributed in mountainous and desert regions. In the Kyzylkum deserts, the distribution area of *F. assa-foetida* and *F. foetida* alone reaches about 2 million hectares [18; p. 30]. In addition, it has been established that chemical compounds isolated from species of the genus *Ferula* L. possess hormonal properties, which led to the development of the preparation panoferol. The panoferol preparation (a complex of extracts) is used in veterinary practice to improve egg quality in poultry, prolong their egg-laying period, and prevent infertility in cattle and ewes [3; pp. 114–240].

According to many authors, stinking ferula (assafoetida) is an excellent essential oil–bearing plant and, first of all, is considered a valuable medicinal plant as well as a feed source for farm animals. Moreover, it is an industrial plant of aromatic food importance, as it contains starch and sugar substances. Based on the biologically active compounds present in kovrak, in recent years the Institute of Chemistry of the Academy of Sciences of Uzbekistan and the Tashkent Pharmaceutical Plant have produced four widely used preparations for medicine, animal husbandry, and poultry farming—tefestrol, panaferol, kufestrol, and zafarol. Among these, tefestrol is used in medicine for the treatment of gynecological diseases, while panaferol, kufestrol, and zafarol are widely applied in veterinary practice, particularly in poultry farming, to enhance reproductive activity and to prevent infertility in sheep and cattle [15; 20; pp. 131–132].

Thus, plants belonging to the genus *Ferula* L., in addition to containing the above-mentioned natural biologically active substances, also attract great interest among specialists as reserve and medicinal plants rich in terpenoids and their analogues. For this reason, studying the distribution, ontogenesis, and biomorphological characteristics of terpenoid-containing plants of this genus is of great theoretical and practical importance. A comprehensive botanical and morphological study of *Ferula* L. species, along with the compilation of cartograms of their natural resources, helps to address theoretical and practical problems of the pharmaceutical industry related to drug production and preparation. Furthermore, such studies make it possible to assess their natural resources and create opportunities for their wide application in the national economy [19].

Taking into account the multifaceted use of stinking ferula in the national economy, scientifically substantiated criteria for its rational utilization have been developed in our country. An analysis of the literature shows that 96 species of the genus *Ferula* L. [18; p. 30] have been identified within the flora of our region. It should be particularly emphasized that 28 species of *Ferula* L. growing in Central Asia are endemic. Especially important from a practical standpoint

is the identification and propagation of the natural resources of stinking ferula, as well as the endangered Bukhara sumbul listed in the Red Book.

The interest of many researchers in the terpenoids contained in stinking ferula is explained by the fact that, like other natural compounds, they exert specific effects on humans, animals, and microorganisms. In addition to their various properties, these compounds also exhibit estrogenic activity, as a result of which estrogenic agents such as panoferol and tefestrol have been isolated [9; p. 120; 10]. Panaferol, kufestrol, and zafarol preparations are widely used in veterinary practice to increase egg production in poultry and to prevent infertility in sheep and cattle. The preparation tefestrol is used in the treatment of reproductive disorders, including dysmenorrhea, ovarian hypofunction, sexual weakness, infertility, and dysfunctional uterine bleeding [11; 12; pp. 18–22; 13].

According to the studies of the author [21; p. 350], the qualitative and quantitative indicators of alkaloids in various plants vary depending on their vegetative growth stages. In addition, these indicators are significantly influenced by the region and environmental conditions in which the plant grows. The content of chemical compounds in plants, particularly complex esters, varies within wide limits depending on plant age and seasonal changes. Therefore, when collecting raw materials, special attention must be paid to periods when the concentration of these substances is highest. In the process of isolating biologically active terpenoid compounds from stinking ferula, treatment with alkaline substances is applied [27; pp. 173–178].

As noted by the author [18; p. 30], the kovrak plant constitutes about 8–10% of the feed balance of Karakul sheep and other grazing animals. During the spring season, Karakul sheep consume up to 850–1000 g of fresh green kovrak leaves daily. In practice, the dried milky latex obtained from the assafoetida root is most commonly used. The latex extracted from the assafoetida root has a bitter taste and a smell resembling a mixture of onion and garlic, although its unpleasant odor is closer to that of garlic. The taste of assafoetida resin remains in the mouth for several hours and cannot be removed by rinsing with water, alcohol, or vinegar solutions. If assafoetida is brought into a room where the temperature exceeds 22°C, its strong odor permeates the air within minutes, and even prolonged ventilation for several days cannot eliminate it [17; p. 208].

According to another author, most varieties of kovrak grow together with large grasses found in mountainous and foothill regions. The history of the distribution of kovrak is highly complex, and many positive efforts have been made to spread it widely. Historical sources indicate that stinking ferula was widely distributed in North Africa as early as the 4th century BC. However, due to intensive extraction of resin from its roots, its population gradually declined in many regions and, by the 1st century AD, it had completely disappeared in some areas. At present, its numbers are also gradually decreasing in other regions. The main reason for the decline of this plant is the unregulated collection of resin in large quantities [7; p. 29; 8; p. 117]. According to available data, stinking ferula currently grows only in the territories of Iran, Afghanistan, and Uzbekistan.

In the livestock sector of our republic, Karakul sheep breeding is considered one of the main branches. The development of this sector requires efficient use of pastures, foothills, and desert areas, improvement of their reclamation status, and cultivation of forage crops adapted to desert climates. Desert forage plants include wormwood, camelthorn, wild grasses, kovrak, and other species. In the desert regions of our republic, stinking ferula is widely distributed, covering about 2 million hectares in the Kyzylkum deserts. Under desert conditions, Karakul sheep are mainly raised and bred. In early spring, when vegetation begins to sprout, kovrak also emerges,

and sheep start feeding on it. In May, the plant produces seeds, which are also readily consumed by sheep.

Central Asia, including Uzbekistan, is characterized by extremely rich flora, with about 30% of all plant species known in the CIS growing in this region. Many of these plant species are widely used in folk medicine and veterinary practice for the treatment of various diseases [12; pp. 18–22; 26; pp. 160–162]. According to researchers, stinking ferula grows abundantly in the desert regions of our republic, occupying approximately 2 million hectares of the Kyzylkum deserts. As mentioned above, Karakul sheep are primarily raised in desert conditions, and kovrak serves as an important forage plant during early spring and seed-setting periods.

Stinking ferula belongs to the Apiaceae (Umbelliferae) family and is a perennial herbaceous plant that can reach a height of up to 1.5 meters. According to the author, after 8–9 years the plant produces an upright stem that is thick and branched in its upper part. The basal leaves are petiolate, elongated or lanceolate, and divided into three lobes, whereas the stem leaves are smaller, repeatedly pinnately dissected, and arranged alternately with sheathing bases. The flowers are arranged in compound umbel inflorescences, are five-parted, and have a whitish-yellow color [18; p. 30].

According to another source, stinking ferula blooms in March–April and forms double achene fruits in April–May. The plant *Ferula assa-foetida* grows in steppes, foothills, sandy deserts, mountain soils, and occasionally in foothill plains of Central Asia. In particular, it is widely distributed in sandy and gravelly plains and foothills of the Tashkent, Samarkand, Kashkadarya, and Surkhandarya regions; in the sandy deserts of Bukhara, Navoi, and Karakalpakstan; in the Khujand region of Tajikistan and the Samarkand massif; in Turkmenistan on the Badakhshan plain; near Kelif; in the lower Amu Darya region; around the Kyzylkum desert; and in Kazakhstan, especially around the Aris station and the city of Turkistan in the Shymkent and Jambul regions, where extensive plantations occur, and in some areas the plant forms dense stands.

…forming dense thickets [16; pp. 276–313]. According to the researcher, 96 species of kovrak (*Ferula* L.) occur in the mountains and foothills of Central Asia, of which 55 species grow in the Western Tien Shan region. Among them, 30 species contain biologically active sesquiterpene lactones, terpenoid coumarins, and complex ester compounds. Some of these substances are of great importance for pharmacological research [2; pp. 21–22].

Another author notes that studies of terpenoid compounds found in kovrak plants have shown that coumarins are present in *Scorodesma*, which is considered one of the most ancient species of kovrak, whereas all other species contain terpenoid coumarins and sesquiterpene lactones. It has also been reported that the roots of *Peucedanoides* are rich in complex esters. Biologically active substances are present in different parts of these plants, and their quantity varies depending on the developmental stage of the plant and ecological conditions [1; p. 20].

The young green leaves of stinking ferula, its hay, and its mature seeds are consumed by animals. The seeds of kovrak contain 14–19% protein, 8% fat, 37–47% nitrogen-free extractive substances, and 23–27% crude fiber [4; pp. 7–70; 6; p. 384].

**Chemical composition**

**Alkaloids** are complex organic compounds containing nitrogen. They readily dissolve in water and form salts with acids. Most alkaloids occur as crystals in their pure form, while in plants they are usually found in the form of salts. The alkaloid content of a plant varies depending on the season and developmental phase. Newly sprouted seedlings contain small amounts of alkaloids, which then gradually increase and reach a maximum during the flowering stage, after which they

slowly decrease. The first alkaloid identified was morphine, isolated from the opium poppy. Later, widely used alkaloids such as atropine, echinopsine, quinine, pilocarpine, cocaine, berberine, and reserpine were isolated from various plants. Alkaloids have a broad range of effects, primarily influencing the central nervous system and causing vasoconstriction.

**Glycosides** are complex nitrogen-free compounds consisting of a sugar component (glucose, galactose, rhamnose) and a non-sugar component (aglycone or genin). In their pure form, they are crystalline substances that readily dissolve in water and alcohol and usually have a bitter taste.

**Saponins** decompose upon hydrolysis into a carbohydrate part and an aglycone. They dissolve easily in water and alcohol and produce foam when shaken. Plants such as thermopsis, polemonium (cyanosis), primrose, and istod root have expectorant properties; kidney tea acts as a diuretic; and St. John's wort has choleretic and tonic effects. Saponins also show positive effects in cases of vascular atherosclerosis.

**Flavonoids** are widely distributed in the plant kingdom. They play an important role in complex oxidation–reduction processes and tissue respiration within plants. Isolated flavonoids occur as crystals and may be yellow, orange, red, or less commonly colorless. They mainly contain monosaccharides and, less frequently, disaccharides.

**Coumarins and furocoumarins** are natural compounds that, in their pure form, are colorless and fragrant crystals. In plants, they occur either in free form or as glycosides combined with sugars. Hundreds of coumarin compounds are known, and their content in plants ranges from 0.2% to 5%, sometimes reaching up to 10%, with higher concentrations found in roots and fruits. They are particularly common in legumes and umbelliferous plants. Spasmolytic drugs are mainly derived from furocoumarins.

**Lignans** are found in plant roots, leaves, bark, and wood, for example in juniper, sesame, and other plants, either in free form or as glycosides. They are effective in the treatment of cancerous conditions and hemorrhagic diathesis.

**Essential oils** are volatile, strongly aromatic substances composed of terpene hydrocarbons and their derivatives. They are extracted from plants by steam distillation. Essential oils are found mainly in the flowers, leaves, and fruits—and less frequently in the roots—of plants such as wormwood, yarrow, and mountain basil. Their content ranges from 0.001% to 20%, most commonly around 2–3%. More than 2,500 types of essential oils have been identified. Due to their instability, special care must be taken during the collection, drying, and storage of essential oil–bearing raw materials. Essential oil preparations exhibit anti-inflammatory, antimicrobial, and antiviral effects, influence the central nervous system and cardiovascular system, and possess stimulating, analgesic, antitussive, and blood pressure–lowering properties.

**Resins (oleoresins)** are complex organic compounds with a semi-liquid or semi-solid consistency and a chemical structure similar to essential oils. They are found in coniferous trees, birch buds, rhubarb roots, and the roots of the kovrak plant. Resins have bactericidal and anthelmintic effects.

**Organic acids** (malic, citric, oxalic, salicylic, and acetic acids) occur in seeds, fruits, roots, leaves, and stems in free form or as salts. They participate in metabolism and stimulate the activity of salivary glands, bile secretion, and pancreatic function.

**Mineral salts of inorganic acids** occur in plants in dissolved form or as oxalate crystals. They play an important role in metabolism, enzyme and hormone synthesis, blood formation, and cardiac function.

…affects cardiac activity, increases nerve fiber conductivity, and is a constituent of skeletal bones.

**Microelements** are catalysts of metabolic processes in living organisms. A number of diseases arise as a result of deficiencies of certain microelements in the body. They are components of enzymes and active organometallic compounds and act as catalysts in many biochemical processes. Microelements include cobalt, copper, zinc, nickel, lead, iodine, manganese, and others. Their content in plants is extremely low. The balance of microelements in the human and animal body is maintained through microelements supplied with food and water.

**Vitamins** are biologically active substances that are extremely important for vital functions of the organism. They play a key role in metabolism, in the assimilation of major nutrients—proteins, fats, and carbohydrates—and in the protective functions of organs and organ systems. The body requires a continuous intake of about 20 different vitamins from external sources through food.

**Starch** is a polysaccharide and an important reserve carbohydrate that accumulates in the cells of all higher plants. After biologically active substances are extracted from plants, starch remains as a ballast substance; however, it also possesses certain physiological properties, such as a protective and coating effect on the gastrointestinal tract.

**Conclusion**

Based on the analysis of the literature data presented in this article, it can be concluded that, to date, the medicinal and phytotherapeutic properties of plants belonging to the genus *Ferula* L. have been relatively well studied in human medicine, whereas their use and effects in veterinary practice remain insufficiently explored. Taking the above into account, comprehensive and in-depth studies of this medicinal plant, including investigations of its phytotherapeutic and anthelmintic effectiveness, are of great importance.

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