

## **Isolation and use in pharmacy of biologically active substances of clubmoss club-shaped (*Lycopodium clavatum* L.)**

*Lycopodium clavatum* L. is an evergreen perennial herbaceous spore plant with creeping stems of the Lycopodium family. The stems are densely covered with small leaves and take root at the points of connection with the soil. Elongated legs in the form of spikelets grow at the end of the twigs.

The plant is 30 to 50 cm high with small roots and highly branching creeping stems 1 to 3 m long. All mosses are characterized by dichotomous branching of shoots. In the case of equal dichotomy, all shoots occupy a vertical position, and the roots are located in a bunch at the base of the main shoot. With unequally dichotomous branching, the shoots are divided into creeping and erect (hence the name club moss-quicksand) applies to all species. The roots extend from the horizontal stems at small intervals, allowing them to grow along the soil over long distances, sometimes creating an almost continuous cover. Lateral roots emerge from the creeping shoots and live from two to five years. In a young plant emerging from a zygote, the primordia of the shoot and root arise simultaneously as a result of the dichotomization of the growth point of the embryo. The formation of the embryo on the gametophyte is preceded by the development of a large haustorium, which displaces the first root sideways, and only on this basis do some authors call the roots of club mosses adventitious. During ontogeny, new roots arise only from the meristem of the shoot apex; when it is dichotomized, the shoot and the root arise simultaneously as the rudiments of two equivalent organs [1].

Vertical branches with sporophylls, at a height of 5(10)–15(30) cm above the ground, have fewer leaves than horizontal ones. The leaves are 3–5 mm long and 0.7–1 mm wide, with a midrib, linear or linear-lanceolate, directed obliquely upward, elongated into a long white hair-like spine, densely covering the stems. Sporangia are collected in spore-bearing spikelets (strobili) at the tops of the stems. The spikelets sit on long, erect, single leafy stalks. Each plant has two to five spikelets. Numerous spores, in the form of a tiny loose pale yellow powder, ripen in June–August. The plant, at first glance, may resemble the growth of coniferous trees. It reproduces by spores and vegetatively, by rooting creeping shoots [2].

The plant contains carbohydrates (sucrose), triterpenoids, steroids, alkaloids (0.12%, including lycopodine, clavatoxin, nicotine), flavonoids. The shoots contain carotenoids, including  $\beta$ -carotene and lutein, and triterpenoids. Flavonoids are found in the leaves. The spores contain carotenoids, phenolcarboxylic acids (dihydrocaffeic acid, vanillic acid, ferulic acid) and their derivatives, fatty oil (40–50%, containing acids: hexadecenic, myristic, palmitic,

stearic, dihydroxystearic, azelaic; glycerides), lipids (4%) [3].

The herb is used in homeopathy and folk medicine — when crushed into powder, it is sprinkled on wounds, and an infusion is drunk from it for diseases of the bladder, liver, respiratory tract, urinary incontinence, stomach pain, and inflammatory processes of the gastrointestinal tract. The infusion and decoction are used as a sedative, analgesic, antispasmodic, for hydrophobia, anti-inflammatory for rheumatism, neuralgia, diuretic for stranguria, anuria, enuresis, cystitis, urolithiasis, bladder spasms, nephritis, female diseases, contraceptive, obstetrical, normalizing regulation, increasing appetite, for diseases of the stomach, intestines, dyspepsia, gastritis, colitis, diarrhea, flatulence, hepatitis, cholestasis, cholecystitis, cholelithiasis, spleen diseases, metabolic disorders, diathesis, diaphoresis, gout, respiratory diseases, influenza, antipyretic, for arthritis; externally — for eczema, furunculosis, scrofulosis, ringworm, wound healing, for alopecia; baths and lotions — for muscle cramps in the limbs. In homeopathy, spores are used for varicose veins, hypertension, rheumatous arthritis, neuralgia, including cranial nerve, headache, otitis media, hemorrhoids, anti-inflammatory, stomach hypofunction, gastric ulcer, dyspepsia, stomach colic with nausea, flatulence, liver failure, liver cirrhosis, cholelithiasis, diuretic — for bladder diseases, metabolic disorders, prostate diseases, pneumonia, bronchitis, rickets, dermatopathy, scrofulosis, rashes, eczema, acne, calluses, warts, alopecia [4]. Spores in folk medicine in the form of a decoction are used as an anti-inflammatory, hemostatic, antirheumatic, antispasmodic, anticonvulsant, analgesic for neuralgia, toothache; diuretic for acute cystitis, urolithiasis, dysuria, choleric for liver diseases, gastritis, enterocolitis, fixative for diarrhea, enveloping, hygroscopic, emollient, antiseptic, anthelmintic; externally as baby powder, for diaper rash in adults, for psoriasis, wounds, burns, erysipelas, weeping dermatoses, rashes, scabies, varicose nodes, alopecia; in the form of an ointment — for furunculosis, ulcers [5]. The stems of club moss can be used to dye fabrics blue. In optics, spores are used to study and demonstrate diffraction phenomena.

The extraction of biologically active substances from substances of club-moss club-shaped was carried out with ethyl alcohol under statistical and dynamic conditions with particle sizes of 5–7 mm (fraction 1) and particle sizes of 0.5–1 mm (fraction 2). The efficiency of extraction depending on the extraction frequency, extraction time and other parameters was also studied.

### References

1. *Srivastava S., Singh A.P., Rawat A.K.S.* A HPTLC method for the identification of ferulic acid from *Lycopodium clavatum* // Asian Pacific Journal of Tropical Biomedicine. — 2012. — Vol. 2, No 1. — P. S12–S14.  
<https://www.sciencedirect.com/science/article/abs/pii/S222116911260121X>
2. *Pereira A.V., Rebeca K., Lera J.L., Pavanelli W.R.* Safety and efficacy of *Lycopodium clavatum* 200dH in *Toxoplasma gondii* infected mice // European Journal of Integrative Medicine. — 2016. — Vol. 8, No 4. — P. 540–545.  
<https://www.sciencedirect.com/science/article/abs/pii/S187638201630021X>
3. *Orhan I., Küpeli E., Şener B., Yesilada E.* Appraisal of anti-inflammatory potential

- of the clubmoss, *Lycopodium clavatum* L. // Journal of Ethnopharmacology. — 2007. — Vol. 109, No 1. — P. 146–150. <https://doi.org/10.1016/j.jep.2006.07.018>
4. *Svensson M.E., Johannesson H., Engström P.* The LAMB1 gene from the clubmoss, *Lycopodium annotinum*, is a divergent MADS-box gene, expressed specifically in sporogenic structures // Gene. — 2000. — Vol. 253, No 1. — P. 31–43. [https://doi.org/10.1016/S0378-1119\(00\)00243-2](https://doi.org/10.1016/S0378-1119(00)00243-2)
  5. *Aagaard S.M.D., Greilhuber J., Zhang X.-C., Niklas Wikström N.* Occurrence and evolutionary origins of polyploids in the clubmoss genus *Diphasiastrum* (Lycopodiaceae) // Molecular Phylogenetics and Evolution. — 2009. — Vol. 52, No 3. — P. 746–754. <https://doi.org/10.1016/j.ympev.2009.05.004>