APPROACHES TO BIOTECHNOLOGY OF *VACCINIUM* CULTIVATION FROM MYCOLOGICAL VIEWPOINT AND VALUE FOR MEDICINE

Yukhnenko M.D., Andrianova T.V.
National Aviation University, Kyiv
Scientific advisor – Andrianova T.V., Cand.Sc.(Biology), Assoc. Prof.

Berries producing plants of the genus *Vaccinium* are well known and have long been used as a food and medicinal plants. They are classified in the family Ericaceae and numbers about 500 species through the world. Native for the territory of Ukraine are small-fruited cranberries (*Vaccinium microcarpum*), bilberries (*V. myrtillus*), marsh cranberries (*V. oxycoccos*), blueberries (*V. uliginosum*) and lingonberries (*V. vitis-idaea*). Some species of *Vaccinium* are cultivated on plantations and introduction of alien species, as large cranberry (*V. macrocarpon*) from North America, take place.

Plants of the genus *Vaccinium* are of boreal origin and are generally grown on naturally acidic soils, with optimal pH of 4-5.5, though pH of 2.5-6.5 is acceptable, with high organic matter content and sufficient amount of moisture in the soil. These plants do not tolerate alkaline soils, which cause a complete cessation of growth and death. The ability of *Vaccinium* to grow on acidic soils is due to symbiosis with fungi in the form of mycorrhiza, when plant species is engaged in mutualistic relationships with fungus that colonize the roots. A single plant species can have several to hundred species of associated mycorrhizal fungi. Members of the Ericaceae family have ericoid mycorrhizas (type of endomycorrhizas) when fungus penetrates the root epidermal cells and form coils within them. Up to 150 species of Ascomycota and some species of Basidiomycota took part in that mutualistic relations. During the interaction is enhanced nutrient uptake, plants receive from fungi an additional amount of water and minerals which are in difficult to assimilate forms in the soil, and the fungi receive organic substances in return. Seedlings of this plant family could be obtained by micropropagation. However, when plants are transferred from *in vitro* conditions to *ex vitro* conditions, certain difficulties arise, including the problem of extracting nutrients from the soil by microclones due to the absence of certain fungal associates in their roots. It had been proposed to add mycorrhizal fungi into the soil before growing the microclones, but the method did not always successful. Besides, mycorrhizas could “work” only under the acidic environment. A number of ericoid mycorrhizal fungi are associated with plant species of *Vaccinium*, such as: *Botryosphaeria dothidea*, *Chaetomium globosum*, *Gaeumannomyces caricis*, *Oidiodendron majus*, *Pezicula ericae*, *Phialocephala fortinii*, *Trichoderma virens*, *Umbelopsis isabelline*, species of *Lachnum*, *Leptosphaeria*, *Phoma*, *Phomopsis*, *Pleospora* and *etc.* Currently, the mycorrhizal component and its influence on the yield and quality of the plants are being actively studied [1-2]. Besides, the species of endophytic fungi, symbiotic ones, found growing within and between plant cells of different organs, were revealed in the tissues of *Vaccinium* species. They numbered about 260 genera [2]. As associated phytopathogenic fungi of *Vaccinium* plants were identified about 25 species of Ascomycota and Basidiomycota in Ukraine. Amongst them are

Exobasidium vaccinii, E. vaccinii-uliginosi, Mycosphaerella myrtillina, Myzothyrium leptideum, etc. Recently, in 2020, has been found new for country territories fungi of *Coleophoma empetri, Colletotrichum acutatum* and *Phomopsis vaccinii* in plantations of *V. macrocarpon* in Volyn oblast [in print]. Thus, the potential of fungal influence on growth and fructification of *Vaccinium* species is rather high.

Berry fruits of *Vaccinium* species are rich in many medicinally useful substances that are important for biotechnologies. *V. oxycoccos*, *V. uliginosum* and *V. vitis-idaea* contain glucose and fructose, many organic acids (citric, malic, benzoic, tartaric, salicylic, oxalic, acetic, pyruvic, glyoxylic) that help in uric acid salts excretion. Pectins are also present, they form insoluble complex compounds (chelates) with heavy and toxic metals that are indigestible and can help in their excretion. Chelates are used in treatment of radiation impact and regulate intestinal functions as antibacterial compounds. Multi-action phenolic compounds of *Vaccinium* species include anthocyanins, leuco-anthocyanins, catechins, flavonols and phenolic acids. Besides, berries are full of vitamins C, B, E, K1 and provitamin A. All parts of *V. vitis-idaea* contain triterpenoids (ursolic and oleic acids) which can act as the adrenal hormone; there are also present significant amounts of arbutin, tannins and betaine which has anti-atherosclerotic, lipotropic and anti-ulcer effects and is also known for *V. uliginosum*. Berries of *V. uliginosum* are rich in substances of P-vitamin action that reduce permeability and strengthen blood capillaries. They have unique ability to relieve allergies caused by different drugs and almost never cause allergic reactions. Those berries are included in the diet of children with diathesis.

The latest biotechnologies should improve the biochemical composition and plant raw material quality. For the cultivation and reproduction of *Vaccinium* species nowadays are applied methods of: seed propagation, propagation by tissue culture, clonal micropropagation, propagation through somatic embryogenesis, reproduction by shoots with part of the roots and roots segments, reproduction by cuttings and reproduction of blueberries by layering [1,4]. Developments are underway to introduce innovative technologies for the accelerated production of planting material of *Vaccinium*: the use of zeatin, as a plant growth hormone (1–2 mg/l); induction of the meristem and biomass growth by red-blue LED light; application of decontamination agents (timentin and cefotaxime antibiotics in dosage up to 1000 mg/l) for elimination of *Agrobacterium* overgrowth without inhibition of plants; application of herbicide glufosinate as an effective selectable marker for transformed plants [3].

References:

1. Курлович Т.В. Брусника, голубика, клюква, черника. М.: Издательский Дом МСП, 2005. 128 с.

2. Yang H., Zhao X., Liu C., *et al.* Diversity and characteristics of colonization of root-associated fungi of *Vaccinium uliginosum*. *Scientific Reports*. 2018. Vol. 8(1). P. 9657.

3. Cappai F., Garcia A., Cullen R., *et al.* Advancements in low-chill blueberry *Vaccinium corymbosum* L. Tissue Culture Practices. *Plants.* 2020. Vol. 9(11). P. 1624.

4. Debnath S.C. Propagation of *Vaccinium in vitro. International Journal of Fruit Science.* 2007. Vol. 6 (2). P. 47–71.