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Toward the technology of large cranberry fruit storage through declining the fungal rots

Introduction of the new species and cultivars of *Vaccinium* in the Ukrainian Polyssia resulted in migration of pathogens that are associated with the berry-plants. It is currently totally reported 30 species of fungi on the genus representatives in Ukraine [1, 5]. Beside the natural thickets of *Vaccinium microcarpum*, *V. myrtillus*, *V. oxycoccos*, *V. uliginosum* and *V. vitis-idaea*, the introduced from the North America large cranberry *V. macrocarpon* is cultivated on exhausted peat bog plantations. All those plants are the host substrata for fungi of different taxonomic groups and trophics which could infect several related plant species and cause diseases with yield losses, affecting stems, leaves, flowers and berries. Environmental changes of the recent decade also influenced fructifications of the berry plants and development of their associated fungi by higher average temperatures and droughts. Investigations of *Vaccinium* pathogenic fungi and other associated ones could assist in development of advanced technologies for their cultivation and to prevent storage losses of introduced promising species of *V. macrocarpon*, especially.

Study of fungal invasions and storage rots of cultivated large cranberry on experimental plots of commercial plantations in Rivno and Volyn' oblasts were fulfilled during 2019–2020. Cultivars Wilcox, Bergman, Stevens were assayed on fungal infections. Berries of the cultivar Wilcox, as more commercially promising one, were selected for the final step of investigations. Harvest losses were recorded during berries storage period as a result of the pathogenic fungi infections. Storage conditions were modified: on the final step of study the plant material received post-harvest treatment by cold and hot water in different variants, with subsequent drying by warm air. It was examined preservation of the fruits collected in autumn and early winter, percentages of different types of fungal rots development were estimated. Isolation and cultivation of fungal cultures were carried out on PDA, in the dark, at 25°C, for 14–20 days. Identification of fungi was based on morphology observed in plant material and isolated cultures, mechanisms of spore production and morphological characteristics of spores.

Most of studies on pathogenic fungi affecting *V. macrocarpon* were carried out in countries with commercial plantations as of the North America, or such countries as Belarus, Latvia, Lithuania, etc. (Table 1). About 20 fungal species were registered [2–4]. Examination of fungi that could be responsible in development of fruit rot disease complex of cul-

tivated large cranberry was listed *Allantophomopsis cytisporea*, *Botrytis cinerea*, *Coleophoma empetri*, *Discosia artocreas*, *Fusicoccum putrefaciens*, *Pestalotia vaccinii*, *Phomopsis vaccinii*, *Phyllosticta elongate* and *Physalospora vaccinii* in Latvia. The experimental sites of Belarus with subsequent yield storage revealed the presence of *A. lunata*, *Aspergillus flavus*, *B. cinerea*, *Cladosporium sp.*, *Monilinia oxycocci*, *Myxothyrium leptideum*, *P. vaccinii* and *Phyllosticta ampelicida*, though some other fungi had been present in the field. Our study demonstrated less abundant infections of the large cranberry fruits in Ukraine. During the storage of *V. macrocarpon* were identified fruit-associated fungi of *Alternaria sp.*, *B. cinerea*, *C. empetri*, *Colletotrichum acutatum* and *P. vaccinii*, which developed in the tissues. Registered species of *C. empetri*, *C. acutatum* and *P. vaccinii* are known as pathogens that cause field rots, and *C. empetri* is only associated with a storage rot of fruits. Thus, the fungi that cause fruit infections have been invading plants, first of all in the field, and then they are progressing during the storage. The fungicides should be applied on various stages of cultivation as they could prevent development of large invasions.

Table 1. Fungi that cause fruit rots in some countries with commercial plantations of *Vaccinium macrocarpon*

Name of the fungus	Country			
	USA	Latvia	Belarus	Ukraine
Allantophomopsis cytisporea (Fr.) Petr.	+	+		
Allantophomopsis lunata (Shear) Crous & Carris	+		+	
Alternaria sp.	+			+
Aspergillus flavus Link	+		+	+
Botrytis cinerea Pers.	+	+	+	+
Cladosporium sp.			+	
Coleophoma empetri (Rostr.) Petr.	+	+		+
Colletotrichum acutatum J.H.Simmonds	+			+
Discosia artocreas (Tode) Fr.	+	+		
Fusicoccum putrefaciens Shear	+	+		
Monilinia oxycocci (Woronin) Honey	+		+	
Myxothyrium leptideum (Fr.) Bubák & Kabát	+		+	
Pestalotia vaccinii (Shear) Guba		+	+	
Phomopsis vaccinii Shear, N.E.Stevens & H.F.Bain	+	+	+	+
Phyllosticta ampelicida (Engelm.) Aa			+	
Phyllosticta elongata Weid.		+		
Physalospora vaccinii (Shear) Arx & E.Müll.	+	+		

Cranberry rots were observed in the fruit harvests of different years and during the whole storage period. Large cranberry fruit damage was 8.3 % when the material was stored under the temperature of 2–8°C for the first month and 26.8 % damage was observed in three months period. The additional post-harvest cleaning of cranberries revealed crucial for the storage of fresh fruits. Affected fruits constituted 4.3 % of the total number ones, that had been treated with water and dried by air flow at 45°C, in a month storage, and 8.3 % of the total number ones in three-month period of storage. Fruits cleaned by water jets at a temperature of 45°C and air-dried at a temperature of 45°C had a great reduce in the number of fungal invasions and fruit rots. Those observations were supported by isolation of fungi from fruit surfaces in pure cultures. At the same time, did not all surface fungi isolated during the study have been invading berries during the long-term indoors storage. That is due to the fact that present in the berries organic acids inhibit the growth of fungi.

Further method development of large cranberries processing for the effective fruit storage is planned. This will help improve the technology of maintaining high quality of the berries yield. Various methods of fruits post-harvest cleaning are rather important as they could prevent development of hemibiotrophic and saprotrophic fungi on berries surfaces and disease development.

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