CRANBERRY AND BLUEBERRY PRODUCTION IN LATVIA
DZĒRVEŅU UN KRŪMMELLEŅU AUDZĒŠANAS SITUĀCIJAS IZPĒTE LATVIJĀ

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Abstract
Large cranberries (*Vaccinium macrocarpon* Ait.) and highbush blueberries (*Vaccinium corymbosum* L.) are relatively new cultures in Latvia. The first commercial cranberry plantation was established in 1985. Nowadays, the area of cranberries is approximately 100 ha which makes it the third largest in the world. The blueberry plantations compared to other European states are not so large - 170 ha. The largest part of the area of high moss peat bogs was drained and is now being used as cranberry fields – a bogs area of approximately 10 000 ha. The examination of the situation of cranberry and blueberry production started in 2007/2008. Cranberry and blueberry plantations were surveyed in all four fruit-growing areas of Latvia. The following parameters were examined: varieties and plantation sizes, the physiological status of the plants of different varieties after overwintering, growing technologies - characterisation of the soil or substrate, plantation location, growing distances; yield and yield quality. The most popular varieties of cranberries are 'Stevens', 'Bergman', 'Ben Lear', etc. The most popular cultivars of blueberries are 'Bluecrop', 'Patriot' and 'Northland'. The newest cultivars in the Latvian plantations are 'Toro', 'Rubel', 'Blue Gold', 'Hanna', 'Klara', 'Drapers' and 'Bonus'. Planting technologies of highbush blueberries: 1) mineral soil (78 % of farmers – with specific preparation of the soil before planting; 2) peat – 22 % of farmers.

Kopsavilkums
Lielogu dzērvenes (*Vaccinium macrocarpon* Ait.) un krūmmellenes (*Vaccinium corymbosum* L.) ir salīdzinoši jauni kultūraugi Latvijā. Pirmie komerciālie dzērveņu stādījumi tika ierīkoti 1985. gadā. Šobrīd dzērveņu stādījumu platības sasniedz jau 100 ha, ieņemot trešo vietu pasaulē, bet krūmmelleņu stādījumu platības ir mazākas, salīdzinoši ar citām Eiropas valstīm – 170 hektāri. Lielākā daļa augstā sūnu kūdras purvi ir nosusināti un šobrīd tiek izmantoti kā dzērveņu lauki - purvu platību aptuveni 10 000 ha. Pētījumi par dzērveņu un krūmmelleņu audzēšanu Latvijā uzsākti 2007/2008 gados. Dzērveņu un krūmmelleņu stādījumi tika apsekoti visās četrās augļkopības zonās Latvijā. Tika vērtēts: audzētās šķirnes un to audzēšanas platības, dažādu šķirņu augu fizioloģiskais stāvoklis pēc ziemošanas, audzēšanas tehnoloģijas – raksturojot augsni vai substrātu, atrašanās vieta, audzēšanas attālumi, raža un ražas kvalitāte. Visvairāk audzētākās dzērveņu šķirnes 'Stevens', 'Bergman', 'Ben Lear', u.c. Visvairāk audzētākās krūmmelleņu šķirnes – 'Bluecrop', 'Patriot', 'Northland'. Jaunākās krūmmelleņu šķirnes Latvijā ir 'Toro', 'Rubel', 'Blue Gold', 'Hanna', 'Klara', 'Drapers' and 'Bonus'. Krūmmelleņu audzēšanas tehnoloģijas:
1) minerālaugsnē–78 % saimniecībās (pirms stādīšanas augsni speciāli sagatavojot); 2) kūdrā–22% saimniecībās.

Key words: *Vaccinium macrocarpon*, *Vaccinium corymbosum*, cultivars, area, technologies

Introduction
Cranberries, as it is with highbush blueberries, can play an important role in the economy of Latvia as these berries are sought in the world market for their medical and dietary properties and they are among the best paying berries.
The Latvia's climate and the vast marshland area is the main reason why from ancient times the European or the Latvian local (*Vaccinium oxycoccus* L.) cranberries are grown in the wild. Berry plantation is not mechanized due to their morphological properties. The yield was mostly used in the local market.
The American large cranberry (*Vaccinium macrocarpon* Ait.) and highbush blueberry (*Vaccinium corymbosum L.*.) are relatively new cultures in Latvia. The first commercial cranberry plantations

were established in 1985. Nowadays, the area of the large cranberries is approximately 100 ha and that is third place in the world. The blueberry plantations compared to other European countries are not so large- about 170 ha (after Latvian Fruitgrowers Association data).
The scientific research on the European or Latvian local cranberries was started in the 70ies of the last century by the Department of Horticulture under the Faculty of Agriculture of the Latvia University of Agriculture. It was found that the advantage of these cranberries lies in the growing season, it is shorter- the beginning of flowering is about two weeks earlier, it starts already in the middle of May. Besides, they require a lower sum of the effective temperatures than the large berry cranberries. The berries are better protected from autumn frosts, the berry texture is more gentle. For this species of cranberries it is not possible to use mechanization in harvesting (Abolins and Gurtaja, 2006). Producing shoots are upright, unable to detach the berries from the plant and the berries develope unequally.
Productive wild clones were found not only in the bogs of Latvia but also in Karelia (Russia) and Estonia using both physical and chemical mutagenesis. 172 cranberry genotypes were studied. Most of them -163 genotypes had been collected in Latvia, 7 - in Estonia, 1 - in Novosibirsk and 1 - in Petrozavodsk in Russia.
The research was carried out propagating woody and softwood cuttings, investigating planting density, substrates, morphological and biological characteristics of the plant and other issues (Gronskis and Liepniece, 2004.)
Improving less productive areas of cranberry bogs with high-value varieties as well as on recovering the cranberry degraded bog areas. It was decided to continue selection in cranberry clone test conditions in order to breed crops, to test their suitability in re-cultivated bogs. It was also decided to develop elaborated technologies for the propagation and cultivation of the specific genotype.
In the breeding work, the most valuable clones were chosen. Having analyzed the organic harvest of the best cranberry genotypes, it can be concluded that the greatest number of inflorescence - 800 m^{-2} , the largest flower number 1420 m^{-2} and berry mass are calibrated with the genotype V-63583 (Gronskis and Liepniece, 2004.)
According to the length of the vegetation period, the best cranberry genotypes are divided into: medium early B-83 and V-63383; medium late V-63583, but the late is -V-21682. The highest breeding ability for grass-like cuttings is noteworthy with the genotype V – 63583 and B – 83 (Abolins.and Gurtaja, 2006).
In the recultivated cranberry bogs areas - in total 40.8 ha of land, selected in different places of Latvia, the most valuable genotype seeds were sown. The seed sowing was done by plane. Studying the recultivated cranberry areas it was found that cranberry growing was very uneven, averaging from 10 to 30 %. In some places it was associated with deep groundwater levels, sulphur spring diffluence and open places in the array as well they were destroyed by frost.
However, in a more carefully prepared place - in the Experimental Plantation of Jelgava MRS (Jelgava Forestry), sowing the seeds in the area of 1 ha, the projective cover totaled to 100 % and planting seedlings in the growing area of 0.8 ha also totaled to 100 %. The yield reached 1.7 – 2.1 t ha^{-1} in the given stands.

Materials and Methods

Climate in Latvia. The northern part of Latvia is outside the fruit zone of the temperate climate. However, nearness to the ice-free Riga Gulf Stream avoids early autumn frosts, and during the winter becomes the reason for a relatively mild climate in the western part of Latvia. The average precipitation is 560 – 850 mm, the monthly average winter temperature (January) is -2.6 to – -6.6 ^{o}C and the summer temperature (July) is +16.8 to +17.6 ^{o}C with the day length 17 – 18 hours in June. In the growth season, temperature over +5 ^{0}C lasts 180 – 200 days. The sum of the active temperatures (> 10 ^{o}C) in the vegetative period is 1800 – 2100 ^{0}C. There are 120 – 140 active cyclones and 160 – 180 anticyclones per year.
The total area of peat bogs is 6401 km^2 or 9.9 % of all the land area of Latvia, which makes recourses of peat – 1.7 - milliard t. There are more than 5000 peat deposits: 7 exceeding an area of 5000 ha; 87 with the area of 1001- 5000 ha; 109 with the area of 501 – 1000 ha. Included are 49.3 % of low grass peat bogs; 41.7 % of high moss peat bogs, 9 % others. The average depth of

deposits is 2 – 5 m, but the maximum - up to 15 metres. The largest part of the area of high moss peat bogs is drained and used for establishing cranberry fields- could in the future be approximately 10 000 ha (Abolins and Gurtaja, 2006).
Despite the greatly varying climatic conditions, the winter of 2007/2008 was more favorable for the growth and development of large cranberries and highbush blueberries, rouhg the highbush plantings could suffer from spring frosts when temperatures fell below 0ºC. In such cases, the frost did not damage plantings where surface irrigation was available. The physiological observations carried out in 2008 showed that only single twigs of highbush blueberries were frost damaged. The after effect of the damage caused by the winter of 2006/2007 caused the delayed development of single twigs that later led to the twigs dying.
An evaluation of the situation of cranberry and blueberry production started in the season of 2007/2008 within the framework of Project No. 04.1 – 25/5. Cranberry and blueberry plantations were surveyed in all fruit-growing zones of Latvia – Central, Eastern, Southern and Western zones. The following parameters were examined: the used varieties and plantation sizes, growing technologies - characterisation of soil or substrate, plantation location, growing distances, the physiological status of plants of different varieties after overwintering, yield and yield quality.
In collaboration with the researchers of the Laboratory of Plant Mineral Feeding under the Institute of Biology of the Latvia University, in the farm „Strelnieki" (Riga District, in the mineral soil, the variety 'Patriot') and Lienama Ltd (Aluksne District, in the peat bog, the variety 'Northblue'). The testing of fertilizer systems: option 1 - the basic fertilizer NPK + Mg + S, a supplementary fertilizer N; Ca; S;option 2- leaf fertilizer Vito Silva; option 3- leaf fertilizer Vito Silva + B; Cu; Mo; option 4–leaf fertilizer Vito Silva + B; Cu; Mo + Caltrac.
The research on the development of plant phenology, the physiological status of plants, yield and its quality indicators is simultaneously carried out by the Training and Research Farm of the Institute of Agrobiotechnology under the Faculty of Agriculture of the Latvia University of Agriculture (www.llu.lv) in the City of Jelgava. On this base farm, the high bush blueberry and cranberry collection is structured. The high bush blueberries are planted in the mineral soil in peat cushions distributed in furrows. The plant age-7 years, biennial seedlings were planted. Cranberries are planted in peat providing the necessary growth conditions.

Results and Discussion
The **large cranberries** (*Vaccinium macrocarpon* Ait.)**.** The most popular varieties of cranberries are 'Stevens', 'Bergman', 'Ben Lear' and others, but less popular are 'Franklin', 'Pilgrim', 'Hoves' and 'Lemynion' (Figure 1).

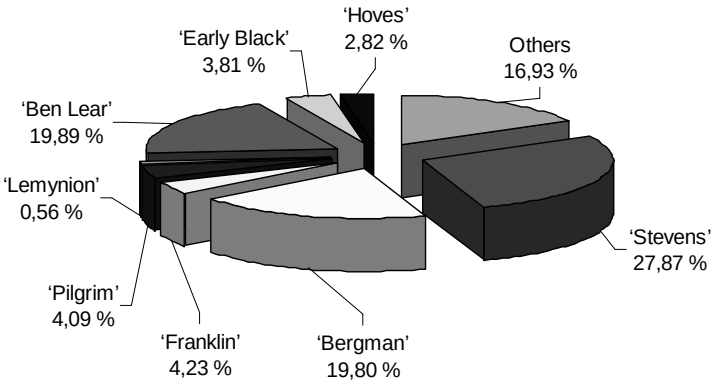

Figure 1. The division of cranberry varieties in farms, %

Due to the high costs involved to establish cranberry fields, most (65 %) of the farms are small - with 0.1 – 5.0 ha of land, but 21 % of farms – with 5.1 – 10.7 % with 10.1 – 15.0 and 7 % - with 15.1 – 20.0 ha of land (Figure 2).

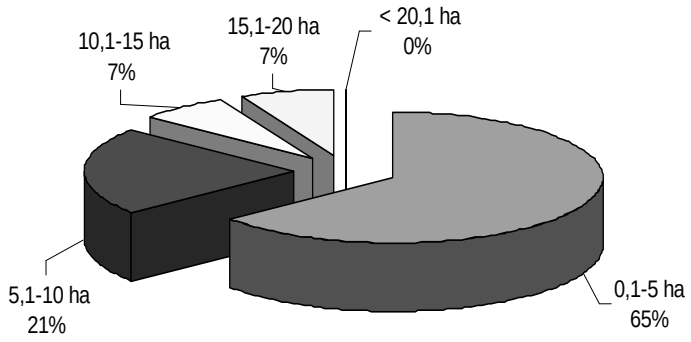

Figure 2. Farm division by cranberry plantation areas, %

There are three planting technologies for large cranberries used in Latvia.
First - in the prepared field, cranberry tendrils are evenly spread on the soil surface and imbedded in peat with a disc harrow. Cranberries are planted or seeded in straight lines. It is a widely used method with sand substrate abroad. The drawback of the method- all tendrils are not deeply the soil.
Second - imbedding tendrils by power harrow. In order not to damage the plants the speed of the power harrow should be reduced. One should not imbed them too deep or too shallow.
Third - planting by hand using a planting stick. The drawback - a laborious process, but it can be used for planting a small area.
The large cranberries unlike the local ones, start blooming later-in mid-June/early July (the local cranberries – in May/June). Thus, the harvest of the large cranberries is only affected by the late spring frosts (sprinkling should be provided). On the surveyed farms, in May maintenance work was started in the cranberry plantations-combing, tendril cutting, and in the end of June, cranberry plantations were at the flowering stage.
On the whole, in terms of weather conditions, in the second decade of September in Latvia it was cold but dry in 2008. The average air temperature of the decade was 3.7 degrees below the norm. The cold weather lasted the whole decade. During the coldest night of the decade (16 September), the first frosts were recorded -2 ºC. During the decade there was frost almost every night, during the coldest periods falling to -5 – -6 ºC.
The highest yield of 2007 was 4500 g m^{-2}. In 2008 there was a harvest of 3900 g m^{-2}. Also, 100-berry mass was higher in 2007 by an average of 180 g and in 2008. - 150 g. In the middle and eastern areas rainfall was lower.
Weed control as an essential part of cranberry management was done in two ways - by hand and by using glyphosate pesticides as a replant treatment by weed wipers on bicycle wheels.
Sand, used as a mulching material, was spread with a specially constructed spreader but there were problems with sand pH and weeds. Therefore, sanding is not popular. The farmers use high moss peat, but some -sawdust or sawdust mixed with peat especially those without a sprinkler irrigation system.
The highest cranberry harvest in the year 2007 was - 4500 g m^{-2}, but in the year 2008 – 3900 g m^{-2} (Figure 3). The large berries of cranberries (above 19 mm), were on average 1 – 2,5 %, but the main harvest was produced large berries (15-16 mm), 43 – 62 % in the year 2007 and 35 – 59 % in the year 2008, accordingly.

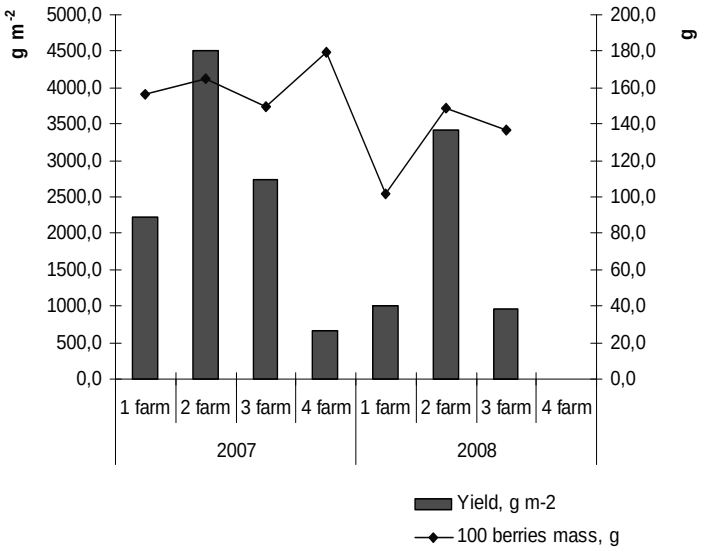

Figure 3. The average yield of the cultivar 'Stevens', g m^{-2}, and the mass of 100 berries, g (on three farms in the years 2007 and 2008).

The analysed late cranberries varieties in the autumn frost, up to 10 % of the harvest was lost in autumn frosts on the farms of the western area of Latvia.

Blueberries (*Vaccinium corymbosum* L.)**.** The most popular varieties of blueberries in Latvia are the northern highbush varieties adapted to quite cold mid-winter temperatures below -20 ºC 'Bluecrop', 'Patriot' and 'Northland' (Hancock, 2006). The newest varieties are 'Toro', 'Rubel', 'Blue Gold'.

In the collections of some farms, such varieties as 'Hanna', 'Klara', 'Drapers', 'Bonus' are starting to appear but are not popular in Latvia yet (Figure 4).

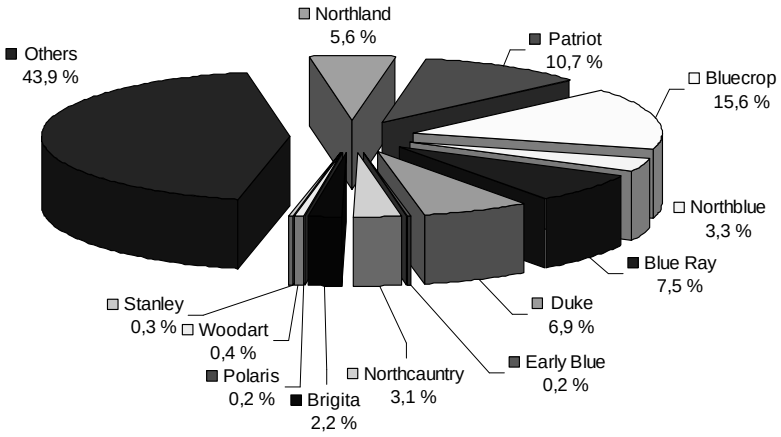

Figure 4. The division of highbush blueberry cultivars on farms, %

Like it was with cranberries, most blueberry farms - 80 % are small with 0.1 – 5.0 ha of land, but 11 % of the farms have 5.1 – 10 ha of land (Figure 5). The main reason why small farms are so many, is the high start up cost and lack of experience in highbush blueberries cultivation.

On the surveyed farms, the highbush blueberries are chosen for cultivation in one of the following ways: in mineral soil (78 % of the breeders) – the soil before planting is adequately prepared: the plants are planted in cushion peat pits (50 x 50 x 50 cm), which are filled with acidic high moss peat, some of the farmers fill the furrows with peat and chippings or sawdust (1:1).

The second option-in the peat bog (22 % of the farmers) they choose to breed highbush blueberries in worked out peat-moss bogs, planting plants on a level field or in the beds.

In less than half the surveyed farms, the highbush blueberry plantations were irrigated against frosts. Therefore, the spring frost damage was very slight. In determining soil acidity pH/KCl, in all the surveyed farms it was within the norm from 4.3 to 5.15 (Nollendorfs, 2003).
Spring maintenance includes: fertilizing, the tree crown formation, excision of the dead twigs, bed maintenance (weeding, mulching) and irrigation. As a mulching material, moss bog peat is used as well as chipping mulch. The research carried out in the year 2007 shows that incompletely mulched plantations are destroyed by frosts.

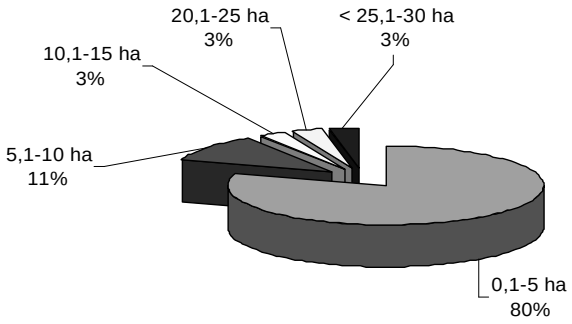

Figure 5. Farm division by the highbush blueberry plantation areas, %

Irrigation. The farms use both surface (sprinkling) and drip irrigation. Some farm irrigation is not yet available and this condition highly affects the further growth, development and production of highbush blueberries.
Fertilizers. Most farmers use soil analysis and adjust the required amount of fertilizers accordingly.
Yield, harvest and quality. The highbush blueberry varieties 'Northland' – 4.12 and 'Patriot' – 4.06 kg from a bush had the highest yields, the lowest the variety 'Chandlers' – 0.32 (Figure 6).

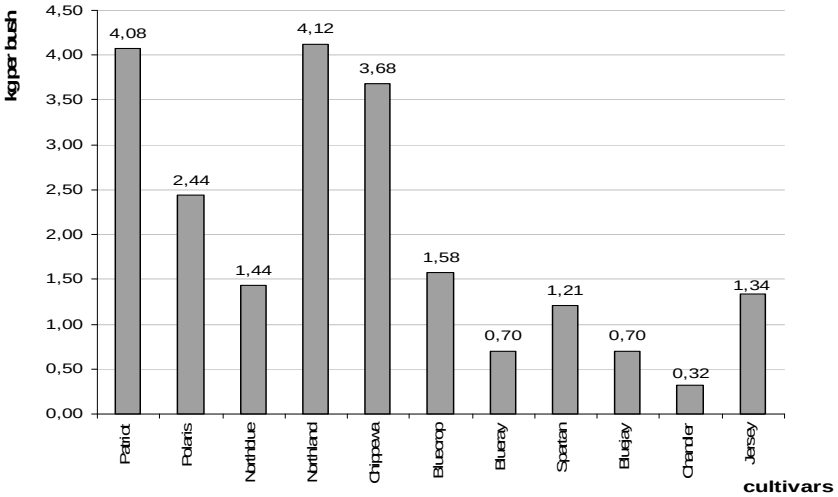

Figure 6. The average yield of highbush blueberry cultivars per bush, kg.
(Training and Research Farm of the Faculty of Agriculture under the LLU in Jelgava)

The largest 100 berry mass was achieved by the variety 'Northblue', using the supplementary fertilizer Vito Silva + B Cu Mo + Caltrac. For the variety 'Patriot', the effects of ferilizers are not essential. Depending on the fertilizer option, the variety 'Northblue' had the largest berries – the proportion of the very big berries was 2 – 7 % and of the big berries – 29 – 40 %. For the variety 'Patriot', proportion of the very big berries was on average - 5 %, but of the big berries on average – 50 % of the total number of berries. The fertilizers used did not essentially affect the berry size.

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SELECTION OF THE EUROPEAN CRANBERRY IN LITHUANIA
EIROPAS DZĒRVEŅU SELEKCIJA LIETUVĀ

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Abstract
A detailed evaluation of the morphological diversity and economical properties of the European cranberry was carried out in 2000 – 2008 in the Kaunas Botanical Garden of Vytautas Magnus University with the purpose of ascertaining the most valuable clones. The European cranberry clones were selected from the strictly protected areas of Čepkeliai, Žuvintas, and Kamanos in 1995 – 1999. These clones with distinctive morphological peculiarities were propagated and planted into acid peat (pH 3.5 – 4.0) in the field collection of the Kaunas Botanical Garden for further investigations. The results of the comprehensive evaluations of the phenotypic and genetic diversity of the European cranberry were crowned with the selection of the most valuable clones. These clones were compared with Estonian and Russian cultivars. Berry size, yield, and the amount of biologically active substances were evaluated. The selected clones are characteristic of exceptional biological and biochemical peculiarities. The five Lithuanian clones 'Amalva', 'Žuvinta', 'Vaiva', 'Vita, and 'Reda' were proposed to recieve the cultivar status.

Kopsavilkums
Novērojumi par Eiropas dzērveņu morfoloģisko daudzveidību un ekonomiskajām īpašībām tika veikti no 2000. – 2008. gadam Vitautas Magnus universitātes Kauņas botāniskajā dārzā ar mērķi noskaidrot vērtīgākos klonus. Eiropas dzērveņu kloni tika izraudzīti no īpaši aizsargājamām teritorijām Čapkeliai, Žuvintas un Kamanos, laikā no 1995. – 1999. gadam. Šie morfoloģiski atšķirīgie kloni tika pavairoti un iestādīti skābā kūdrā (pH 3.5 – 4.0) tālākai izpētei un novērojumiem kolekcijas stādījumos Kauņas botāniskajā dārzā. Pēc vispusīgiem pētījumiem par Eiropas dzērveņu fenotipisko un genotipisko daudzveidību rezultāti ir vainagojušies ar vērtīgāko klonu izlasi. Šie kloni tika salīdzināti ar Igaunijas un Krievijas dzērveņu šķirnēm. Tika vērtēts ogu lielums, raža un bioloģiski aktīvās vielas. Izvēlētajiem kloniem bija īpaši vērtīgas bioloģiskās un bioķīmiskās īpatnības. Pieci Lietuvas kloni 'Amalva', 'Žuvinta', 'Vaiva', 'Vita' and 'Reda' ir pieteiktas, lai saņemtu šķirnes statusu.

Key words: anthocyanins, cultivar, morphological diversity, phenolics, selection

Introduction
The European cranberry (*Vaccinium oxycoccos* L., syn. *Oxycoccus palustris* Pers.) belongs to the most valuable berry plants, whose natural habitats are found in moist boreal forests, ombrothrophic shagnum bogs and minerotrophic fens. This species has been intensively researched for its health properties in recent years. The cultivars of other species American cranberry (*Vaccinium macrocarpon* Aiton, syn. *Oxycoccus macrocarpus* (Aiton) Purs.) are known for their exceptional