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RABBITEYE BLUEBERRY, AMERICAN CRANBERRY AND LINGONBERRY BREEDING IN LATVIA
EŠA ZILEŅU, AMERIKAS DZĒRVEŅU UN BRŪKLEŅU SELEKCIJA LATVIJĀ

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Abstract
The purpose of the breeding work was to create adapted to the climatic conditions of Latvia and disease resistant cultivars of rabbiteye blueberry (*Vaccinium ashei* Reade), American cranberry (*Vaccinium macrocarpon* Ait.) and lingonberry (*Vaccinium vitis-idaea* L.). The main task was the breeding of cultivars with large berries, high productivity and different ripening time. Breeding research has been carried out in National Botanic Garden of Latvia since 1980. In the work, classic plant breeding, interspecific breeding and polyploidy breeding have been employed, and wild lingonberry clones were used. The rabbiteye blueberry cultivar 'Salaspils Izturīgā' was selected from seedlings of open pollination of the cultivar 'Tifblue' in 1993 and the cultivar 'Lielogu' was selected from the hybrid ('Delite' x 'Woodart') seedlings in 1995. From the hybrid (cranberry cultivar 'Franklin' x lingonberry) seedlings were selected the cultivar 'Dižbrūklene' in 1997, the cultivar 'Salaspils Agrās' in 1996 and the cultivar 'Tīna' in 2006. The lingonberry cultivar 'Salaspils Ražīgā' origin of the wild lingonberry clone was selected as cultivar in 1993; the cultivar 'Rubīna Lāse' was selected in 1988 from open pollination seedlings of the cultivar 'Salaspils Ražīgā', but the cultivar 'Jūlija' was selected in 1995 from open pollination seedlings of the clone 'Krasnojarska'.

Kopsavilkums
Selekcijas mērķis bija radīt Eša zileņu *Vaccinium ashei* Reade, Americas lielogu dzērveņu (*Vaccinium macrocarpon* Ait.) un brūkleņu (*Vaccinium vitis-idaea* L.) šķirnes, kas būtu piemērotas Latvijas klimatiskajiem apstākļiem un slimību izturīgas. Galvenie uzdevumi bija izveidot šķirnes ar lielām ogām, ražīgas un ar dažādiem ienākšanās laikiem. Selekcija tika veikta Nacionālajā Botāniskajā dārzā Latvijā kopš 1980. gada. Darbā tika izmantota klasiskā selekcija, starpsugu selekcija un poliploīdija, kā arī izmantoti savvaļas brūkleņu kloni. Eša zilenes šķirne 'Salaspils Izturīgā' tika izveidota no brīvas apputes 'Tifblue' sēklaudžiem 1993. gadā, bet šķirne 'Lielogu' tika atlasīta no hibrīda ('Delite' x 'Woodart') sēklaudžiem 1995. gadā. No hibrīda (dzērveņu šķirne 'Franklin' x brūklene) sēklaudžiem tika atlasīta šķirne 'Dižbrūklene' (1997.), 'Salaspils Agrās' (1996.) un 'Tīna' (2006.). Brūkleņu šķirne 'Salaspils Ražīgā' tika atlasīta no savvaļas klona 1993. gadā. Šķirne 'Rubīna Lāse' tika atlasīta 1988. gadā no šķirnes 'Salaspils Ražīgā' brīvas apputes

sēklaudžiem, bet šķirne 'Jūlija' tika atlasīta 1958. gadā no klona 'Krasnojarska' brīvas apputes sēklaudžiem.

Key words: clones, clusters, hybrid, phenological phases, pollination, resistance, upright, vine, yield.

Introduction

The abundant yields and medicinal properties of the berries of rabbiteye blueberries, American cranberries and lingonberries contribute to the popularity of these cultures. The fresh berries of rabbiteye blueberries contain 16.6 g kg^{-1} of soluble dry matter, 7.8 g kg^{-1} of glucose and fructose, to 1.4 g kg^{-1} of titrable acid, 0.001 g kg^{-1} amino acid. The rabbiteye blueberry berries are a valuable source of physiologically active and mineral substances (Ripa 1992, Ripa 1998). American cranberries are characterized by a considerable amount of biologically active substances. The content of anthocyans in fresh berries constitutes 0.604 – 0.186 g kg^{-1} and catechines 0.152 – 0.126 g kg^{-1}, and vitamin C 0.062 – 0.068 g kg^{-1}. The fresh berries contain 10.3 – 11.6 g kg^{-1} of soluble dry matter, 7.2 – 8.2 g kg^{-1} glucose and fructose, to 3.0 g kg^{-1} of titrable acid. The berries are a valuable source of pectin and mineral substances (Ripa 1980, Ripa 1996). The berries of the lingonberry contain 17.7 g kg^{-1} of soluble dry matter, 10.37 g kg^{-1} of glucose and fructose, to 2.11 g kg^{-1} of titrable acid. The lingonberry berries are a valuable source of physiologically active substances and mineral substances (Ripa 1981, Ripa *et al.* 1992).

The purpose of the breeding work was to create adapted to climatic conditions of Latvia and disease resistant cultivars of the rabbiteye blueberry (*Vaccinium ashei* Reade), the American cranberry (*Vaccinium macrocarpon* Ait.) and the lingonberry (*Vaccinium vitis-idaea* L.). The main task was the breeding of cultivars with large berries, high productivity and different ripening times.

Materials and methods

In 1983 the ripe berries of the following open pollination clones of lingonberries were gathered: 'Salaspils Ražīgā', 'Krasnojarska', and in 1986 the ripe berries of the following open pollination cultivars of rabbiteye blueberries were gathered: 'Delite', 'Tifblue'. In 1988 – 1989 the self-pollination and cross-pollination of rabbiteye blueberry cultivars was carried out. During cross-pollination the cultivar 'Woodart' was used as the pollinator. In 1987 – 1990 the cross-pollination of cranberry cultivar 'Franklin' with pollen of lingonberry clones was carried out. The lingonberry clones from the wild were distributed in 1980.

During cross-pollination the flower buds were isolated by gauze sacs. In each cultivar 30 blooms were isolated. The blooms were pollinated two days after their opening. Pollen was collected from unfolded blooms. The germination capacity of the pollen was determined in a medium consisting of 1.0 g kg^{-1} agar and 15.0 g kg^{-1} saccharose. The berries obtained from open-pollination and cross-pollination were stored in a fridge and stratified for six months at +4 °C. The seeds of hybrid (cranberry cultivar 'Franklin' x lingonberry), before sown, were soaked for 24 hours in a 0.5 g kg^{-1} solution of colchicine. The seeds were sown in acid peat (pH 3.5 – 4.5) 2 – 3 mm deep and covered with sand. In the seedling boxes the peat was constantly kept humid at an air temperature of 22 °C. A month after shoot emergence the seedlings of rabbiteye blueberries, lingonberries and hybrids (cranberry x lingonberry) were planted in acid peat at a distance of 5 x 10 cm and later replanted in a permanent place at a distance of 2 x 1 m.

The soil for planting the rabbiteye blueberry seedlings of open- and cross-pollination was sandy clay, soil reaction neutral to slightly acid (pH KCl – 6.1). The soil had a high level of organic matter (11.3 g kg^{-1}), and total nitrogen (0.3 g kg^{-1}) the level easily absorbed potassium was medium (0.01 g kg^{-1}) and that of phosphorus was high (0.024 g kg^{-1} soil), the level of replaceable calcium was 0.279 g kg^{-1} soil. The level of trace elements (copper, boron, iron) in the soil was sufficient, i.e. 0.0003, 0.0001 and 0.0040 g kg^{-1} soil, respectively. Since 1992 each spring (in May) supplementary fertilizers have been cultivated around the seedlings superphosphate 70.0 – 80.0 kg ha^{-1}, potassium sulphate 20.0 – 30.0 kg ha^{-1}. The soil for planting the lingonberry and hybrid (cranberry x lingonberry) seedlings was 20 – 30 cm thick acid sphagnum peat (pH KCl 2.3 – 2.6). The peat had a high level of organic matter (87.5 – 94.9 g kg^{-1}), and total nitrogen (1.1–1.5 g kg^{-1}), the level of easily absorbed potassium was high (0.060–0.148 g kg^{-1} soil) and that of phosphorus

was medium (0.014 – 0.017 g kg^{-1} soil), the level of replaceable calcium was 0.089 – 0.290 g kg^{-1} soil. The level of trace elements (copper, boron, iron) in the peat was sufficient, i.e. 0.0003, 0.0004 and 0.0016-0.0080 g kg^{-1} substrate, respectively. The lingonberry and hybrid (cranberry x lingonberry) plants had been grown using organic methods.
During the growing period the following qualities were determined: growth rhythm (phenological phases), the colour, shape, and quality of the berries, the yield of berries, the weight of berries, the frost and disease resistance of plants.

Results and Discussion
The rabbiteye blueberry cultivar 'Salaspils Izturīgā' was selected from seedlings of the open pollination of the cultivar 'Tifblue' in 1993.
'Salaspils Izturīgā'. Shrub: upright, vigorous, the ten years old shrub is about 1.5 m high and 1.4 m wide, open spreading, tolerates -36 °C, productive, the average yield of berries in 14 years was 3.06 kg per shrub. The leaves are small (the length 5.5 – 6.1 cm, width 2.4 – 2.7 cm), bright green, elliptic. The raceme is loose cluster, in the cluster are 7 – 37 flowers. The flowers are small, white with medium anthocyans paint. The berries are medium (the length 1.0 – 1.3 cm, diameter 1.3-1.6 cm, the weight of one berry 1.2 – 1.8 g), dark blue, good quality, round-oblate, and ripens about 22 July.


Figure 1. Rabbiteye blueberry cultivar 'Salaspils Izturīgā'

The rabbiteye blueberry cultivar 'Lielogu' was selected from hybrid ('Delite' x 'Woodart') seedlings in 1995.
'Lielogu'. Shrub: upright, vigorous, the 10 years old shrub is 1.8 m high and 1.75 m wide, very productive, the average yield of berries in 9 years was 6.05 kg per shrub, tolerates -34 °C. The leaves are medium (the length 6.6 – 7.1 cm, width 3.2 – 3.6 cm), bright green, elliptic. The flowers are medium size, white with medium anthocyans paint. The raceme is loose cluster, in the cluster are till 39 berries. The berries are large (the length 1.0 – 1.2 cm, diameter 1.5 – 1.6 cm, the weight of one berry 1.7 – 2.0 g.), aromatic, light blue, good quality, ripens about 20 July.
The vegetation period for the rabbiteye blueberry cultivars 'Salaspils Izturīgā' and 'Lielogu' started depending on the year's climatic conditions from April 14th to 28th, when the average air daily temperature was above 4.7 °C, bud swelling continued a week, after that the buds began to dehisce and green leaves appeared. In the beginning of May, when the average air daily temperature is above 10 °C and the positive temperature sum is 126 – 220 °C, the flower buds begin to swell. Depending on the vegetation period and the average air daily temperature the rabbiteye blueberry cultivars 'Salaspils Izturīgā', 'Lielogu' begin to flower from the 17th to 23rd of May and lasts 22 – 27 days. During the period of flowering the sum of positive temperatures is 220 – 550 °C. The first berries of the cultivars 'Salaspils Izturīgā' and 'Lielogu' ripen from 20th to 22nd July.

From the hybrid (cranberry cultivar 'Franklin' x lingonberry) seedlings the cultivars 'Salaspils Agrās' (in 1996), 'Dižbrūklene' (in 1997), and 'Tīna' (in 2006) were selected.
'Salaspils Agrās'. This cultivar produces large to medium berries (the length 1.5 – 1.8 cm, the diameter 1.4 – 1.8 cm, the weight of one berry – 1.2 – 2.0 g). The berries are round, dark red, ripen very early. Fine textures vines produce short uprights that are capable of good production, the average yield of berries was in 6 years 3650 kg ha^{-1}. The elliptical leaves are medium large (the length – 9 – 12 mm, the width – 3 – 5 mm), bright green. The buds of the top of uprights are vegetative-generative. The raceme is intercalary cluster, in the cluster are 1 – 9 flowers. The flowers are light red. The berries cluster is loose, in the cluster are 1 – 5 berries.
'Dižbrūklene'. The berries are exceptionally large (the length – 1.8 – 2.1 cm, the diameter – 1.4 – 2.0 cm, the weight of one berry – 1.7 – 2.4 g) blackish red, round to oval. The berries ripen very early. This productive cultivar produces coarse vines with medium high uprights, the average yield of berries in 6 years was 2810 kg ha^{-1}. The elliptical leaves are medium large (the length 10 – 11 mm, the width – 4 – 5 mm), bright green. The buds on the top of uprights are vegetative – generative. The raceme is intercalary cluster, in the cluster are 1 – 8 flowers. The flowers are light red. The berries cluster is loose; in the cluster are 1 – 6 berries.
'Tīna'. This cultivar produces red, round exceptionally large berries (the length – 1.6 – 1.8 cm, the diameter – 1.3 – 1.6 cm, the weight of one berry – 1.4 – 2.2 g). The berries ripen early. The moderately vigorous vines produce short uprights that have consistently large yield, in 6 years the average yield of berries was 4530 kg ha^{-1}. The elliptical leaves are medium large (the length – 10-11 mm, the width – 4 – 5 mm), bright green. The buds on the top of uprights are vegetative-generative. The raceme is intercalary cluster, in the cluster are 1 – 8 flowers. The flowers are light red. The berries cluster is loose; in the cluster are 1 – 6 berries.


Figure 2. Hybrid cranberry x lingonberry 'Tīna'

The vegetation period of the hybrid cultivars 'Salaspils Agrās', 'Dižbrūklene', and 'Tīna' started from 28-th April to 18-th May, when the average daily air temperature was 4.4 °C. The growth of shoots began from 11-th to 28-th of May. Buds forming the uprights were the first ones to grow. After opening of the buds the first thirty five days the uprights growth was intensive. During that time their length reached 3.0-7.0 cm.
At the end of May, when the average daily air temperature was over 10 °C and sum of positive temperatures exceeded 412 °C, the buds of the uprights began to swell and the flower buds emerged. Hybrid cultivars under trial began to flower from 14th June to 6th July and continued for 30 – 35 days. The flowering period of each flower lasted for 15 – 17 days.
The ripening of the berries depends on cultivar properties and the average daily air temperature during the vegetation period. The first berries of the very early hybrid cultivars 'Salaspils Agrās' and 'Dižbrūklene' ripened from September 5th to 11th, and of the early hybrid cultivar 'Tīna' – from September 8th to 15th.
The lingonberry cultivar 'Salaspils Ražīgā' originated from a clone found in Pļavu forestry (Talsi region), selected as cultivar in 1993 (Audriņa, 1996).

‘Salaspils Ražīgā’. Vigorously growing, upright, compact shrub (mature plant height 16 – 35 cm), with moderate plant spread (rhizome production). Leaves are dark green, medium size (length 1.6 – 2.2 cm, width 0.7 – 1.1 cm).
This cultivar has only one pronounced blooming period (middle of May – beginning of June), the second blossoming is sparse. Flowers are set in medium size clusters (2 – 12 flowers) or alone. Flowers are white or white with anthocyan paint. Berries ripen in the end of August – beginning of September. Fruit clusters are medium size (2 – 10 berries). Berries are deep red, roundish, medium size (0.21 – 0.31 g), length 0.7 – 1.1 cm, diameter 0.7 – 1.0 cm. The cultivar is productive – fruit yield of mature plants – 90 – 180 g per plant. The cultivar is winter hardy and showed relatively high resistance to “little leaf disease”.

Figure 3. Lingonberry cultivar ‘Salaspils Ražīgā’

The lingonberry cultivar ‘Rubīna Lāse’ was selected in 1988 from open pollination seedlings of ‘Salaspils Ražīga’.
‘Rubīna Lāse’. It is vigorous, upright, compact shrub with moderate plant spread. Mature plant height 20 – 30 cm. Leaves are light green, medium size (length 1.8 – 2.6 cm, width 0.8 – 1.4 cm). This cultivar has the ability to bloom twice in a season, but the second blossoming is sparse. More intensive second blossoming was observed in the years when the first blooms were damaged by frosts. The average first blossoming period is in the middle of May – beginning of June, but the second – end of July – beginning of August. Flowers are set in medium size clusters or alone. Flowers are white with anthocyan paint, larger then flowers of other cultivars. The first berry crop ripens in the beginning to middle of August, but the second crop – in the end of September – beginning of October. Fruit clusters are medium size (2 – 9 berries). Berries are very deep red, drop-like, medium size (0.30 – 0.42 g), length 1.0 – 1.3 cm, and diameter 0.8 – 1.0 cm. Berries yield 35 – 200 g per plant. The characteristic distinctive feature of ‘Rubīna Lāse’ from other lingonberry cultivars is their relatively light colour of leaves contrasting with very dark berries, and an unusual crop-like form of berries. The cultivar is winter hardy and showed high resistance to “little leaf disease” (Audriņa, 2004).
The lingonberry cultivar ‘Jūlija’ was selected in 1995 from open pollination seedlings of the clone ‘Krasnojarska’.
‘Jūlija’. It has compact, 13 – 20 cm high shrub with moderate plant spread. Leaves are dark green, medium size (length 1.7 – 2.1 cm, width 0.6 – 1.2 cm). The cultivar has only one pronounced blossoming period (middle of may-beginning of June). Flowers are set in medium size clusters (2 – 13 flowers) or alone. Flowers are white with anthocyan paint. ‘Jūlija’ is an early ripening cultivar – in the end of July to beginning of August. Berries are dark red, roundish, medium size (0.20-0.39 g), length 0.6 – 1.0 cm, and diameter 0.7 – 1.0 cm. Fruit yield 21 – 92 g per plant. This cultivar also is winter hardy, and showed high resistance to “little leaf disease’ (Audriņa, 2004).

Conclusions

The highly productive and cold resistant cultivars of rabbiteye blueberries 'Salaspils Izturīgā' and 'Lielogu' were selected.

The highly productive hybrid (cranberry cultivar 'Franklin' x lingonberry) cultivars 'Salaspils Agrās', 'Dižbrūklene', and 'Tīna' were selected. These very early and early ripening cultivars have large and very large berries.

The highly productive and disease resistant cultivars of lingonberry 'Salaspils Ražīgā', 'Rubīna Lāse' and 'Jūlija' were selected.

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VOLATILE PROFILES OF EUROPEAN BLUEBERRY: FEW MAJOR PLAYERS, BUT COMPLEX AROMA PATTERNS
EIROPAS MELLEŅU AROMĀTS: DAŽAS GALVENĀS SASTĀVDAĻAS, BET DAUDZVEIDĪGS KOPĒJAIS AROMĀTA SASTĀVS

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Abstract

As part of a project on cultivation and industrial exploitation of European Blueberry (*Vaccinium myrtillus*) started in 2008, berries from different wild populations from South, Mid and North Norway were investigated. One aspect of fruit quality analyses was to identify and describe blueberry aroma profiles. Volatiles were extracted by headspace solid-phase microextraction (HS-SPME) and analysed by gas chromatography/ mass spectrometry (GC/MS). A total of 132 potential aroma volatiles could be detected, of which 99 structures were identified based on MS database search and retention indices, also comprising aroma impact compounds not being described in blueberries earlier. Detected aliphatic and aromatic structures belonged to different chemical groups such as alkanes, acids, alcohols, aldehydes, esters, ketones and mono- and sesquiterpenes. Ten major compounds (mostly C_4-, C_6- and C_9-structures) accounted for averagely 65–75 % relative amount of all detected peaks. However, HS-SPME analyses revealed complex volatile profiles including terpenes (23 compounds, e.g. *p*-cymene, 1,8-cineole, linalool) and aromatic structures (10 compounds, e.g. benzaldehyde, ethyl benzoate, 2-phenylethyl acetate, benzyl benzoate), which contribute to the characteristic and flavourful blueberry aroma.