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Some biological properties and fruit quality parameters of new sweet cherry cultivars and perspective selections

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Abstract. Twelve Estonian sweet cherry cultivars: 'Anu', 'Arthur' (control), 'Elle', 'Ene', 'Irma', 'Kaspar', 'Mupi', 'Tontu', 'Elo', 'Jaago', 'Taki', 'Tiki' and two selections: Polli 2–1 and Polli 4–13 as well as two introduced cultivars 'Iputj' (Russia) and 'Jurgita' (Lithuania) were evaluated for yield, ripening time, fruit weight and biochemical characteristics during 2007–2009 at the Polli Horticultural Research Centre. Results showed that the earliest ripening among the all studied genotypes was 'Elo' (16.06), while the latest one was Polli 2–1 (29.07). Average of the three years yields ranged from 6.0 kg per tree for cultivar 'Jurgita' to 20.1 kg per tree for cultivar 'Arthur'. The largest fruits showed cultivars 'Iputj' (6.5 g) and 'Jurgita' (6.0 g), followed by 'Arthur', 'Anu' and 'Mupi' while the smallest fruits showed 'Elo' (3.2 g). The average °Brix value in fruit juice varied by the genotypes from 14.6 ('Tiki') to 19.6 ('Anu'), average of all the genotypes was 17.1. The average total acids content ranged from 0.50% in 'Iputj' to 0.75% in 'Ene' while the total sugar content ranged from 7.7% in 'Jurgita' to 11.2% in 'Arthur'. The ascorbic acid content ranged from 13.8 mg 100 g^{-1} in 'Jaago' to 24.8 mg 100 g^{-1} in 'Anu'. The sugar:acid ratio was considerably high in 'Iputj', 'Kaspar', 'Arthur', 'Anu' and 'Mupi' (from 17.9 to 20.3). The most attractive were fruits of the cultivars 'Iputj', 'Jurgita', 'Mupi' and 'Arthur' (from 4.7 to 4.8 points).

Key words: *P. avium*, ripening time, yield, fruit weight, fruit biochemical content

INTRODUCTION

Sweet cherry is an interesting and increasingly popular fruit species in Estonia, growing mainly in home gardens and in single commercial farms. The growing of sweet cherry in Estonia is limited by cold winters, which are characterized by considerable fluctuations of temperature and sharp changes in weather conditions. Research work with cherries is concentrated at the Polli Research Centre of the Institute of Agricultural and Environmental Sciences. The primary breeding goals included: winter hardiness, high yield, improvements in fruit size and quality and moderate or compact growth habit (Kask & Jänes, 1998). In the latest decade the breeding goal has also been gaining of early and late ripening cultivars to extend the marketing period. New cultivars registered in the Estonian Variety Register during last two years include the sweet cherries 'Arthur', 'Johan', 'Meelika', 'Norri', 'Polli rubiin', 'Elle', 'Karmel', Piret' and 'Tontu' (Estonian Variety Register, 2010). Besides

midseason cultivars that predominated in sweet cherry production, the assortment should expand with early–ripening and late–ripening cultivars. By Sansavini & Lugli (2008) the extending the end of season with late ripening genotypes is especially important to northernmost European areas with cool summers since late ripening genotypes usually contain better fruit traits such as size, firmness, colour and taste.

The aim of this study was to evaluate new sweet cherry cultivars and promising selections for ripening time, tree productivity, fruit weight, attractiveness, and biochemical content.

MATERIALS AND METHODS

Twelve Estonian cultivars: 'Anu', 'Arthur' (the control cultivar), 'Elle', 'Elo' 'Ene', 'Irma', 'Jaago', Kaspar', 'Mupi', 'Tontu', 'Taki' 'Tiki' and two selections from the Estonian sweet cherry breeding program, Polli 2–1 and Polli 4–13 as well as two introduced cultivars 'Iputj' (from Russia) and 'Jurgita' (Lithuania) were evaluated in this study in 2007–2009. All cultivars were grown on *P. mahaleb* seedlings rootstock and planted in collection at the Polli Horticultural Research Centre in 2002 except 'Jaago', 'Elo' and 'Tiki' (in 2000). Trees were planted at spacing of 4 x 5 m. Three trees presented each cultivar. The orchard was located on a medium sandy clay loam with low (1.5%) humus content. Herbicide strips were maintained along tree rows and grass sward was mown several times during summer in alleyways. Drip irrigation was not provided.

The fruit yield was recorded annually (kg per tree). Fruits for planned research were harvested at full maturity. Fruits were evaluated for fruit quality characteristics, including average fruit weight (calculated from weight of 100 fruits); soluble solid content (by ABBE Type WYA-IS digital refractometer and expressed as degree Brix (°Brix); titratable acidity (titrating by 0.1 NaOH solution and referring to malic acid); total sugars content (inverted sugar and sucrose) by titration with 0.1% Potassium Hexacyanoferrate (III) solution; and ascorbic acid (determined by using the modified Tillman's method, where ascorbic acid was titrated with 2.6 dichloroindophenol in acid environment). Biochemical content of fruits was estimated using the data of the Laboratory of Biochemistry of the Polli Horticultural Research Centre. Attractiveness of fruits was visually rated on a scale of 1 to 5 with the rating of 5 being the best.

The data were elaborated statistically by analysis of variance and differences were compared using LSD-test at $P = 0.05$.

RESULTS AND DISCUSSION

The winter preceding the 2007 season included two cold periods in February with the minimum temperatures ranging from –22.2°C to –27.7°C which caused different level damages to flowers buds (Kask et al., 2009) however, production in 2007 did not decrease substantially. Weather conditions in 2008 were quite favourable for sweet cherries. But summer of 2009 was extremely rainy: the sum of precipitation in June was 148.8 mm, which was three times more than the long period average.

The period of fruit ripening of the studied sweet cherry cultivars was six weeks long, starting in the third week of June and ending in the last week of July (Table 1).

The earliest sweet cherry to ripen was 'Elo', being 21 days earlier in relation to the cultivar 'Arthur', followed by 'Elle' and Polli 4–13 by 12 and 'Iputj' by 13 days. The latest sweet cherry was Polli 2–1, being 22 days later in relation to 'Arthur'. The fruit ripening time of the cultivar 'Irma' was 14, and 'Anu' 16 days later in relation to the control cultivar. Most of cultivars were of medium ripening time. Thus, all these above–mentioned cultivars and selections ('Elo', Polli 4–13, 'Irma', 'Anu' and Polli 2–1) could contribute to extend the duration of the sweet cherry ripening season.

Table 1. Average ripening time, fruit appearance and biochemical content of sweet cherry cultivars and selections in 2007–2009.

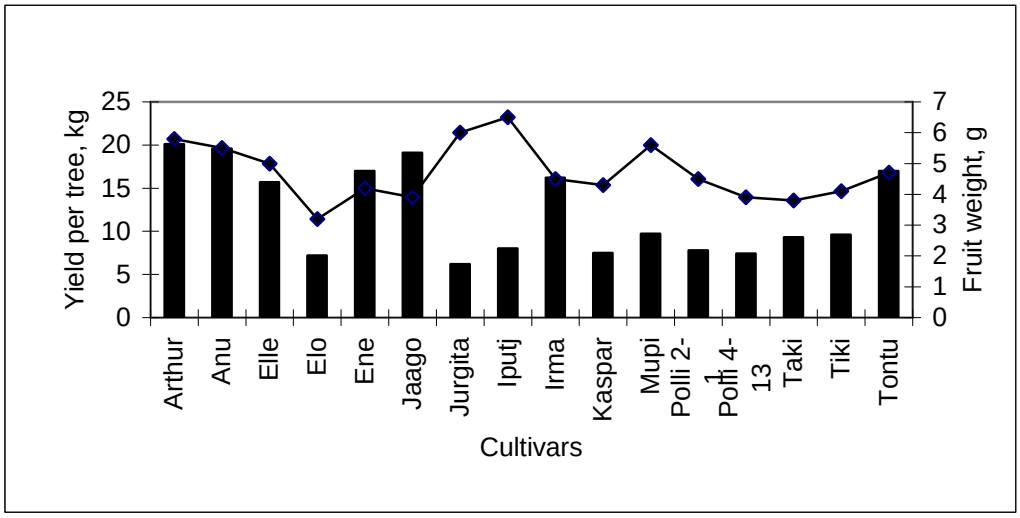
Cultivar	Ripening time	°Brix	Total acids, %	Total sugars, %	Sugar: acid ratio	Ascorbic acid, mg 100 g^{-1}	Fruit attractive ness 1–5 points
Arthur	07.07	17.3bcd	0.60ab	11.2c	18.8b	21.6ab	4.7 ± 0.2
Anu	22.07	19.6d	0.72b	11.1c	19.3b	24.8b	4.6 ± 0.2
Elle	27.06	15.9ab	0.60ab	9.4abc	15.7ab	21.6ab	4.5 ± 0.2
Elo	16.06	14.9a	0.58ab	9.0ab	16.1ab	21.0ab	4.0 ± 0.2
Ene	12.07	17.2bcd	0.75b	11.1c	16.6ab	18.8ab	4.1 ± 0.4
Jaago	01.07	17.0bc	0.65ab	10.4bc	16.5ab	13.8a	4.1 ± 0.3
Jurgita	12.07	17.7bcd	0.67ab	7.7a	11.5a	20.6ab	4.7 ± 0.1
Iputj	28.06	16.3abc	0.50a	10.0bc	20.3b	19.6ab	4.8 ± 0.1
Irma	23.07	17.8cd	0.60ab	10.3bc	17.2ab	19.9ab	4.6 ± 0.1
Kaspar	07.07	17.3bcd	0.54ab	10.8bc	20.0b	21.4ab	4.4 ± 0.1
Mupi	14.07	17.3bcd	0.63ab	11.0bc	17.9b	16.7ab	4.7 ± 0.1
Polli 2–1	29.07	17.8cd	0.61ab	10,1bc	17.2ab	15.5a	4.5 ± 0.1
Polli 4–13	27.06	17.7bcd	0.67ab	10.5bc	16.1ab	21.6ab	4.3 ± 0.1
Taki	05.07	17.0bc	0.70b	10.7bc	15.3ab	16.5ab	4.2 ± 0.1
Tiki	07.07	14.6a	0.60ab	9.8bc	16.6ab	21.4ab	4.2 ± 0.1
Tontu	09.07	18.9d	0.73b	11.1c	15.3ab	21.1ab	4.6 ± 0.1
Average	08.07	17.2	0.64	10.3	16.9	19.2	4.4 ± 0.2
$LSD_{0.5}$		1.8	0.17	2.0	6.3	8.7	

Means followed by the different letter in the same column are significantly different ($P < 0.05$)

Yields in kg per tree as an average of 2007–2009 is presented in Fig. 1. The highest average yields had 'Arthur' (20.1 kg per tree), followed by 'Anu' and 'Jaago' (19.6 and 19.1 kg per tree, respectively). The lowest average yield produced 'Jurgita' (6.0 kg per tree). The differences in yield between different genotypes were statistically significant. Concerning tree size, it should be noted that 'Kaspar', 'Iputj', Polli 2–1 and 'Taki' were small in size, while all the others were medium or relatively large. Though the Russian cultivar 'Iputj' is usually good cropper, but in 2009 its commercial yield was very low due to fruit cracking caused by rainfall before harvest. Rain induced fruit cracking is a great problem in sweet cherry cultivation in many regions of the world (Demirsoy & Demirsoy, 2008). It has usually not been a big problem in our country except in very rainy summers.

Among cultivars, an average fruit weight varied from 6.5 g ('Iputj') to 3.2 g ('Elo') (Fig. 1). Cultivar 'Jurgita' showed the next best fruit weight (6.0 g) followed by

'Arthur' (5.8 g), 'Mupi' (5.6 g) and 'Anu' (5.5 g). Compared with the control cultivar, fruits of 'Iputj' and 'Jurgita' were significantly larger. Among the selections, higher fruit weight had Polli 2–1 (4.5 g) and lower Polli 4–13 (3,9 g). To a great extent, fruit quality (especially fruit weight) determines market value (Crisosto, et al., 2002; Ruisa, 2008). For this reason, 'Iputj', 'Jurgita', 'Arthur', 'Anu' and 'Mupi' may be cultivars of great interest for our fresh fruit market. By Kappel et al. (1996) ideal weight of sweet cherry should be about 11 to 12 g in most European countries. However, majority of local cultivars and selections showed only medium or small fruit weight. It is most likely due to our climatic features: short frost-free period and cool summers.



Average yield: $LSD_{0.5}$ for cultivars = 0.77; $LSD_{0.5}$ for years = 1.31; $LSD_{0.5}$ for cultivars x years = 3.08
Average fruit weight: $LSD_{0.5}$ for cultivars = 0.11; $LSD_{0.5}$ for years = 1.31; $LSD_{0.5}$ for cultivars x years = 0.43

Figure 1. Yield and fruit weight of the sixteen sweet cherry cultivars and selections in 2007–2009.

The soluble solids are one of the best indications of fruit quality (Kappel et al., 1996). By our results the average °Brix value in fruit juice varied among the cultivars from 14.9 to 19.6 (average 17.1) (Table 1). This is a good °Brix value and is well above an acceptable quality threshold value of 14.2 as defined for sweet cherries by E. Vangdal (1980). The cultivar 'Anu' exhibited the highest average °Brix value (19.6) followed by 18.9 in 'Tontu'. The lowest °Brix value showed 'Tiki' and 'Elo', 14.6 and 14.9, respectively, which were significantly lower in relation to the control cultivar.

The average total acids content ranged from 0.50% in 'Iputj' to 0.75% in 'Ene', being average of all studied genotypes by 0.64 (Table 1). No significant differences were found between genotypes in total acids content. The acid content in sweet cherries is low and has no dominating influence on the taste quality (Vangdal, 1985). The total sugar content ranged from 7.7% in 'Jurgita' to 11.2% in 'Arthur', average of all the studied genotypes was 10.3%. The average ascorbic acid content was the highest in 'Anu' (24.8 mg 100 g^{-1}) and the lowest in 'Jaago' (13.8 mg 100 g^{-1}) (Table 1). No significant differences between genotypes in ascorbic acid content were noted.

Attractiveness and size of the fruits are of primary importance. The consumers of many countries prefer a cherry that is large in size, sweet tasting and dark in colour (Turner, et al., 2008). The same traits are also important for Estonian consumers. The fruits of studied genotypes had dark red or dark red to blackish colour except 'Jaago' (its fruits are pinkish yellow). Sweetness is an important trait of fruit that makes them attractive to the consumer. The average sugar:acid ratio was considerably high in 'Iputj', 'Kaspar', 'Arthur', 'Anu' and 'Mupi' (from 17.9 to 20.3). This means that these cultivars are sweet tasting. The most attractive were fruits of cultivars 'Iputj', 'Jurgita', 'Mupi' and 'Arthur' (from 4.7 to 4.8 points) (Table 1). Among the selections Polli 2–1 got the highest scores for attractiveness.

CONCLUSION

Among 16 investigated cultivars and selections the following ones provide a wide range of valuable characteristics: 'Elo', 'Elle', Polli 4–13 and 'Iputj' for very early and early ripening time; Polli 2–1, 'Anu' and 'Irma' for late ripening time; 'Arthur', 'Anu', and 'Jaago' for very good productivity; 'Jurgita', 'Iputj', 'Arthur', 'Mupi' and 'Anu' for fruit size and attractiveness; 'Anu' and 'Tontu' for high °Brix value; 'Anu' for considerably high ascorbic acid content; 'Iputj', 'Kaspar', 'Anu', 'Arthur' and 'Mupi' for remarkably high sugar:acid ratio.

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