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Some physical and biochemical compositions of the sweet cherry (*Prunus avium* L.) fruit

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Abstract. Given the fact, that the sweet cherry is enjoying growing interest from larger growers, the question is how to diversify the production. Besides producing fruits for fresh consumption, it is necessary to establish new ones, targeted to specific directions for industrial processing. Our research in Maros County has the purpose to select the suitable cherry cultivars for industrial use. The selection examined the fruits which are suitable for industrial processing, has high soluble solids content, dark red colour, can be used as natural food colouring matter. Also, the fruits have excellent quality and high nutritional content value.

Keywords: fruit quality, soluble solids, total acidity, colour intensity, elites

1 Introduction

The cherry fruit grows in small quantities worldwide. Even so, in the temperate zone the cherry plays an important role because of the special character of its fruit, ripening period and its wide utilisation in the food industry [7, 10, 11].

According to FAO dates, the world sweet cherry production ranges between 1.3 – 1.5 million tonnes, in abundant years exceeds 1.6 million tonnes (FAO-STAT, 2008). Regarding the growing area, Europe has a leading role, with more than 50% from the world production. Romania's cherry production in 2000 was cultivated on 7150 acres. In the period between 2010 and 2015 the growing area is estimated to be 67000 acres [3]. The sweet cherry cultivation is determined by the climate, the area, the cultivars and the costs of production (labour costs, technology, market structure). While the Western European countries show a descending production because of their higher labour costs, in countries like Turkey, Spain, South-America and USA the production is growing. The former Soviet Union countries have become important cherry suppliers.

The sweet cherry has become a more sought produce on internal and world markets. It would be appropriate to establish new plantations, where beside intensive cultivation the environmentally safe cultivation is also present. Good results can be obtained by introducing cultivars according to market demands. The availability of the cultivars depends on fruits colours, ripening time, physical and biochemical composition. In the present modern nutritional-philosophy, the organic feeding discovers again forgotten or abandoned dishes, nutritional customs [8, 13, 14]. A substantial part of the world's crop is used for fresh consumption, while in the food industry it is one of the main raw materials, mostly preserved, but it is used as frozen fruit and juice as well. The cultivars with black fruit meat and juice are considered the most appreciated material for the industrial processing, because the sweet cherry can also be used as a natural food colorant [15].

2 Materials and Methods

All investigations in this study were realised in Maros County from 2006 to 2009. The sweet cherry population was evaluated with the purpose to select the suitable cherry cultivars for industrial use. The selection examined the fruits which are suitable for industrial processing, has high solids content, dark red colour, can be used as natural food colouring matter. Also, the fruits have excellent quality and high nutritional content value.

During the evaluation 15 valuable selections have been selected: '*M-10*', '*M-11*', '*M-13*', '*M-18*', '*M-21*', '*M-22*', '*M-71*', '*M-104*', '*M-105*', '*M-108*', '*M-114*', '*M-115*', '*M-116*', '*M-117*', '*M-122*'. '*Germesdorf*', '*Boambe de Cotnari*', '*Szomolyai fekete*' and '*Bicskei fekete*' recognised cultivars were used for control.

In the selected elites 5 physical (fruit diameter, fruit meat mass, pit mass, pit mass in percent of fruit mass and fruit meat in percent of fruit mass) and 4 biochemical characteristics (soluble solid content, total acid content, total sugar content and colour intensity) were investigated during full maturity time.

The main physical characteristics of the fruits were observed by collecting 50 fruits from each individual each year, and the following characteristics were measured under laboratory conditions.

The biochemical characteristics were realised in the chemical laboratory of Sapientia University, Faculty of Technical and Human Science. A 50 fruit sample was used to determine soluble solids content, using digital refractometer (ATAGO Palette PR-101). Total acids content was established by titration with 0,1N NaOH, while in order to determine the total sugar content the conversion table edited by International Sugar chemical Corporation (ISC) was used according to the refraction value. The fruit colour intensity was measured with spectrophotometer (JENWAY 6300) at 380 nm wavelength.

Data analysis

For data analysis one-way ANOVA was used for testing differences in the data of fruit diameter, fruit mass, fruit meat, pit mass, pit mass in percent of fruit mass, fruit meat in percent of fruit mass and the soluble solids between elites and cultivars. Analysis of variance was used in the case of normal sample distribution and large sample number. In the case of lower sample numbers Kruskal-Wallis and Mann-Whitney non-parametric probes were used.

Pearson's linear correlation was computed to compare the mean fruit diameter with the fruit mass. The statistical analysis of the results was carried out by using the SPSS 17.0 for WINDOWS and MS Excel software.

3 Results and discussions

Comparative examination of the physical features of fruits

The results of the physical features of fruits (perspective elites and control cultivar) are displayed in Table 1. The most important defining characteristic of sweet cherry is the fruit diameter. The European Union standard regulates the lower size of the class I at 17 mm diameter in case of the sweet cherry, but the market is more demanding. For fresh consumption the 24 mm diameter indicates the lower size of class I [12].

However, at the cultivars for industrial processing the 16-17 mm diameter is appreciated as first class. Similarly to the control cultivar, more than 60% of the perspective elites have a greater diameter than 17 mm. Comparing the fruit diameter of selections with that of the control cultivar did not show any significant differences.

During the harvest period, the fruit mass plays a prominent role as a major influence on the weight of fruit harvested per unit time. It determines the productivity of harvest, and indirectly the production's profitability as well.

For industrial use, the 3-4 gram fruit mass indicates the highest fruit mass category [1]. The average fruit mass of the investigated selections ranged from 3.45 g to 4.63 g. The '*M-18*' selection is the exception, with 2.76 g fruit mass.

Related to the fruit weight, the pit mass varies between 0.21 g and 0.40 g within the selections. This indicator plays an important role mainly in case of cultivars for industrial processing. The lowest pit mass is shown at the '*M-18*' selection, while the highest pit mass is found at '*M-108*', which is nearly twice the weight of the selection mentioned above.

It is worth to express the individual fruit mass as a proportion of pit mass, because it reflects the relation between the two indicators. The lower pit mass has no effect if it's only associated with low fruit mass. Significant difference was observed between the perspective elites of the above mentioned indicators: while '*M-13*' selection shows 10.63% pit mass percent of fruit mass, the '*M-114*' has only 6.62% (Table 1).

Analyzing the fruit indicators, a positive and significant correlation has been found between the mean fruit diameter and the fruit mass of the selections ($R^2 = 0.932$, at $p = 0.01$ level) (Figure 1.). The correlation reveals the fruit meat consistency and succulence, which constitutes an important feature in industrial processing.

The chemical composition of fruits

The suitability of fruits for industrial processing is influenced by some biochemical characteristics, such as soluble solid, the acidity and sugar content degree and concordance, and the colour intensity of the fruit, which is used as natural food colorant. The total soluble solids content significantly influences the fruit flavour, because a significant proportion is created by the different sugars.

Table 1: The physical characteristics of the fruits (2007 and 2008).

Cultivar and Elites	Fruit diameter (mm)	Fruit mass (g)	Fruit meat (g)	Pit mass (g)	Pit mass in percent of fruit mass (%)	Fruit meat in percent of fruit mass (%)
Szomolyai fekete	17.34abc±0.55	4.09a±0.10	3.79a±0.05	0.30bcd±0.05	7.33cd±1.04	92.67cd±1.04
M-10	16.80bc±1.82	3.47ab±0.98	3.21ab±0.88	0.26de±0.10	7.45cd±0.77	92.55cd±0.77
M-11	16.72bc±1.13	3.45ab±0.78	3.21ab±0.63	0.24de0.15	6.85d±2.77	93.15d±2.77
M-13	17.13abc±2.81	3.58ab±0.11	3.20ab±0.16	0.38ab±0.05	10.63a±1.71	89.37a±1.71
M-18	15.79c±0.52	2.76b±0.34	2.55b±1.28	0.21e±0.06	7.59cd±1.29	92.41cd±1.29
M-21	17.03abc±2.39	3.81ab±0.97	3.54ab±0.98	0.27cde±0.01	7.27cd±2.29	92.73cd±2.29
M-22	16.98abc±0.22	3.61ab±0.56	3.29ab±0.52	0.32abcd±0.04	8.79bc±0.22	91.21bc±0.22
M-71	18.19abc±3.99	4.49a±1.93	4.14a±1.80	0.35abc±0.12	7.83cd±0.58	92.17cd±0.58
M-104	18.26abc±2.25	3.86ab±1.34	3.60ab±1.33	0.26cd±0.01	6.95cd±2.20	93.05cd±2.20
M-105	18.84ab±1.81	4.63a±0.51	4.24a±0.48	0.39a±0.02	8.44bcd±0.40	91.56bcd±0.40
M-108	19.40ab±0.65	4.08ab±0.63	3.68ab±0.63	0.40a±0.00	9.85ab±1.54	90.15ab±1.54
M-114	18.04abc±1.12	3.53ab±1.25	3.29ab±1.18	0.23abcde±0.09	6.62abcd±0.01	93.38abcd±0.01
M-115	18.22abc±1.13	4.06ab±0.68	3.78ab±0.63	0.28abcde±0.05	6.90abcd±0.05	93.10abcd±0.05
M-116	18.70ab±3.28	4.39a±1.43	4.09a±1.43	0.3abcde±0.00	6.95abcd±2.25	93.05abcd±2.25
M-117	19.70a±2.23	4.24a±0.73	3.96a±0.91	0.28abcde±0.04	6.75abcd±2.15	93.25abcd±2.15
M-122	18.08abc±1.85	3.88ab±1.45	3.59ab±1.35	0.30abcde±0.09	7.67cd±0.52	92.33cd±0.52

Explanation: *Mean value ± 95% Confidence Interval for Mean; Different letters refer to $p<0.05$ (ANOVA).*

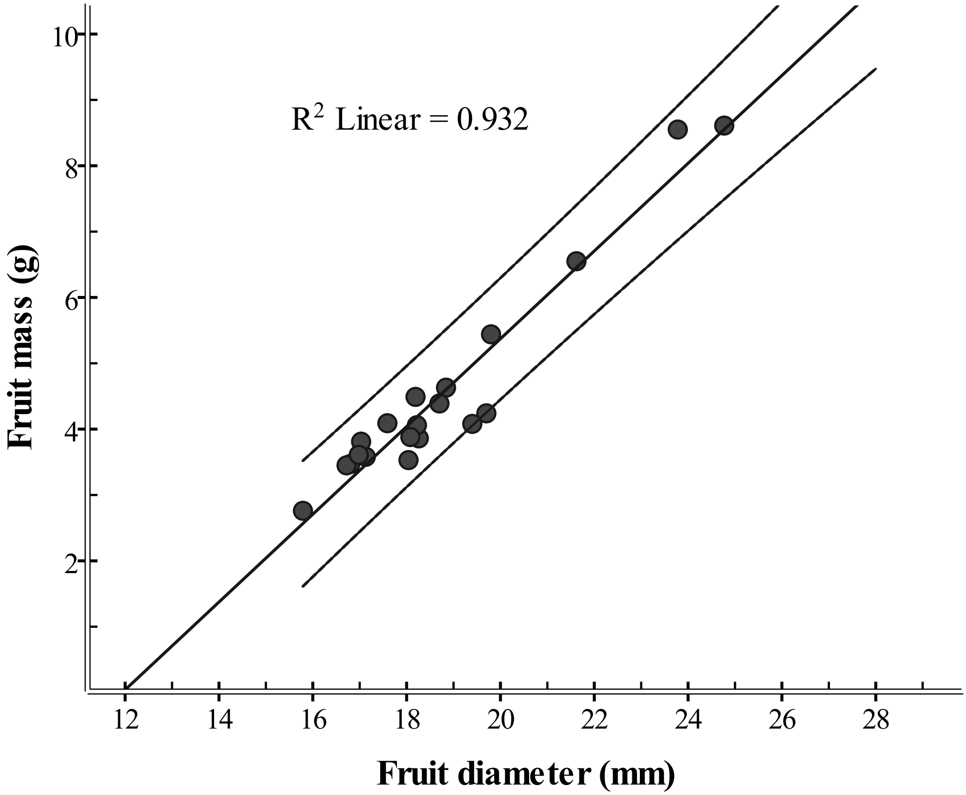

Figure 1: Correlation between the mean fruit diameter and the fruit mass

Total soluble solids

Analyzing the biochemical characteristics of the fruits, the refraction values show the same TSS values at '*M-22*', '*M-18*', '*M-11*' and '*M-13*' selections comparing to nationally recognized cultivars ('*Bicskei fekete*', '*Szomolyai fekete*') exceeding 20 Brix% (Figure 2.). The refraction value of the '*Germersdorf*' cultivars is lower with 7.6-9.1, meanwhile '*Boambe de Cotnari*' shows 11.0-13.0 Brix% differences compared with the TSS values of the above mentioned selections. The difference is statistically significant at $p < 0.001$ level.

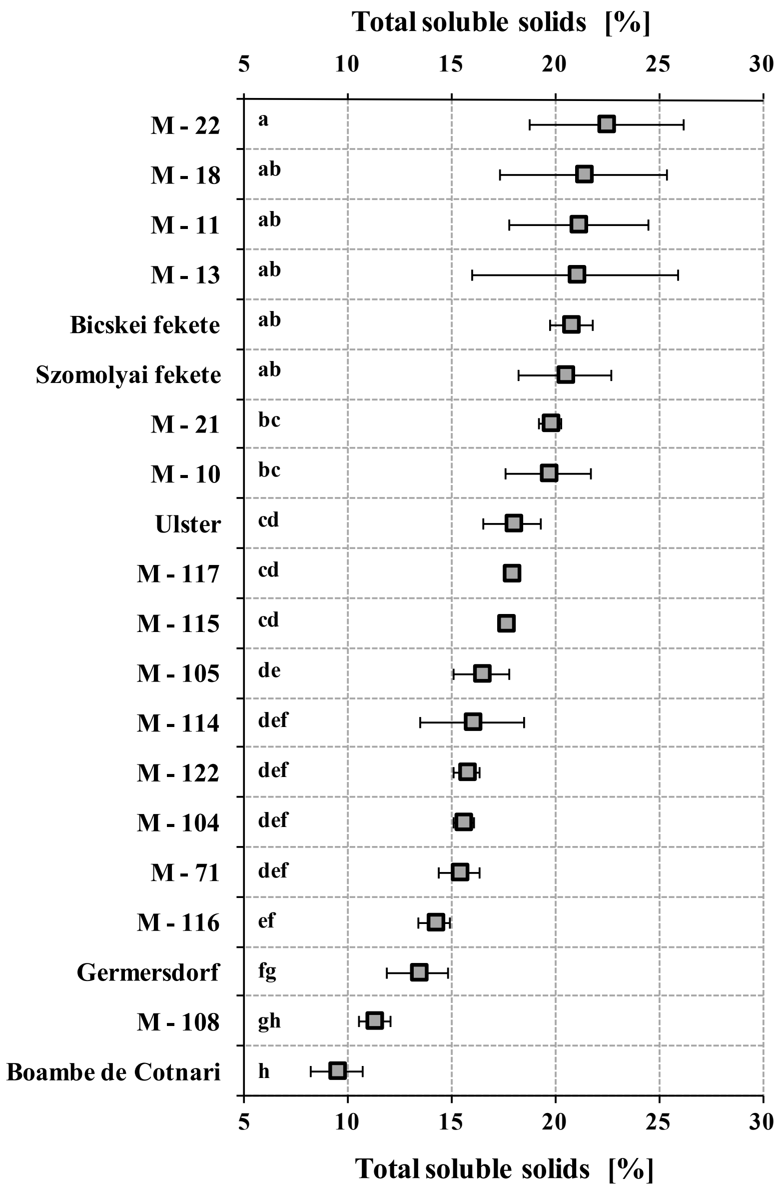

Figure 2: The average TSS concentrations for the period 2007-2009 (Different letters represents significant differences at $p < 0.05$ level (ANOVA)

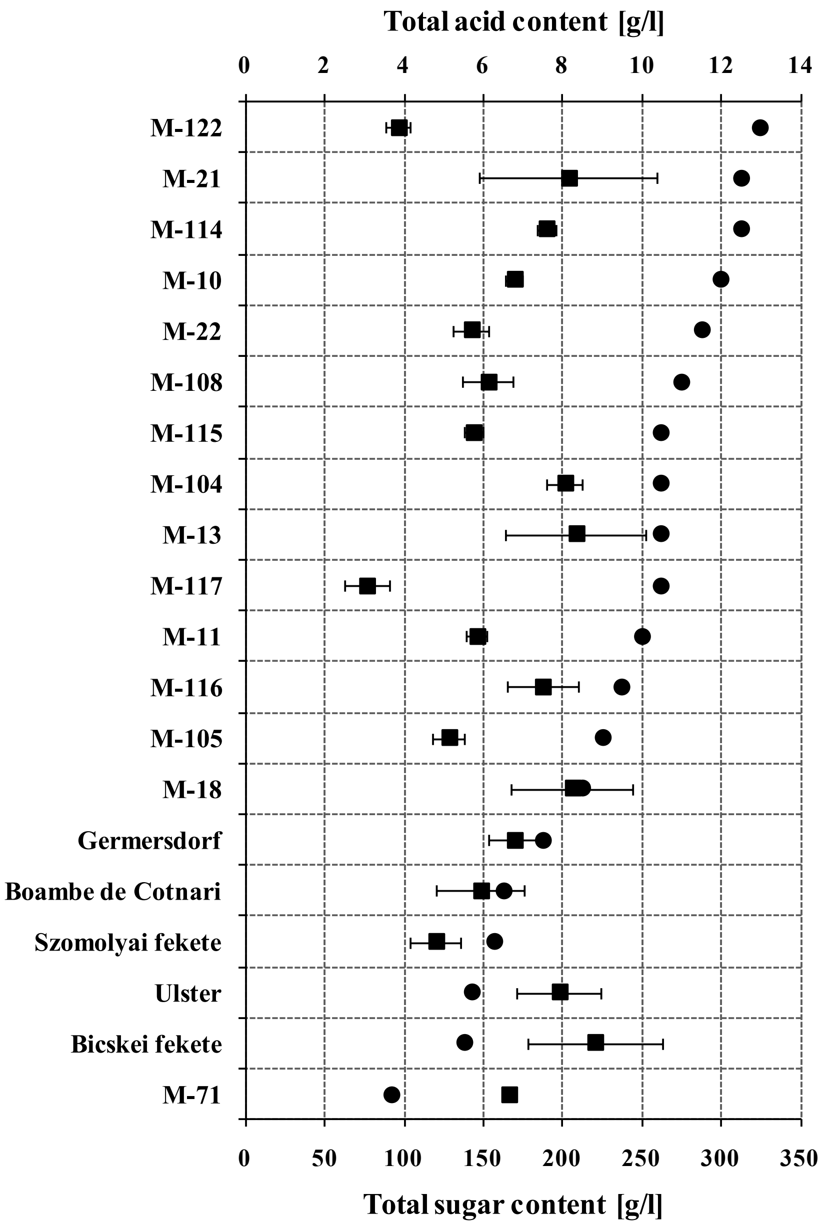

Figure 3: Average total sugar (■) and total acids (•) of fruits (2007 and 2008).

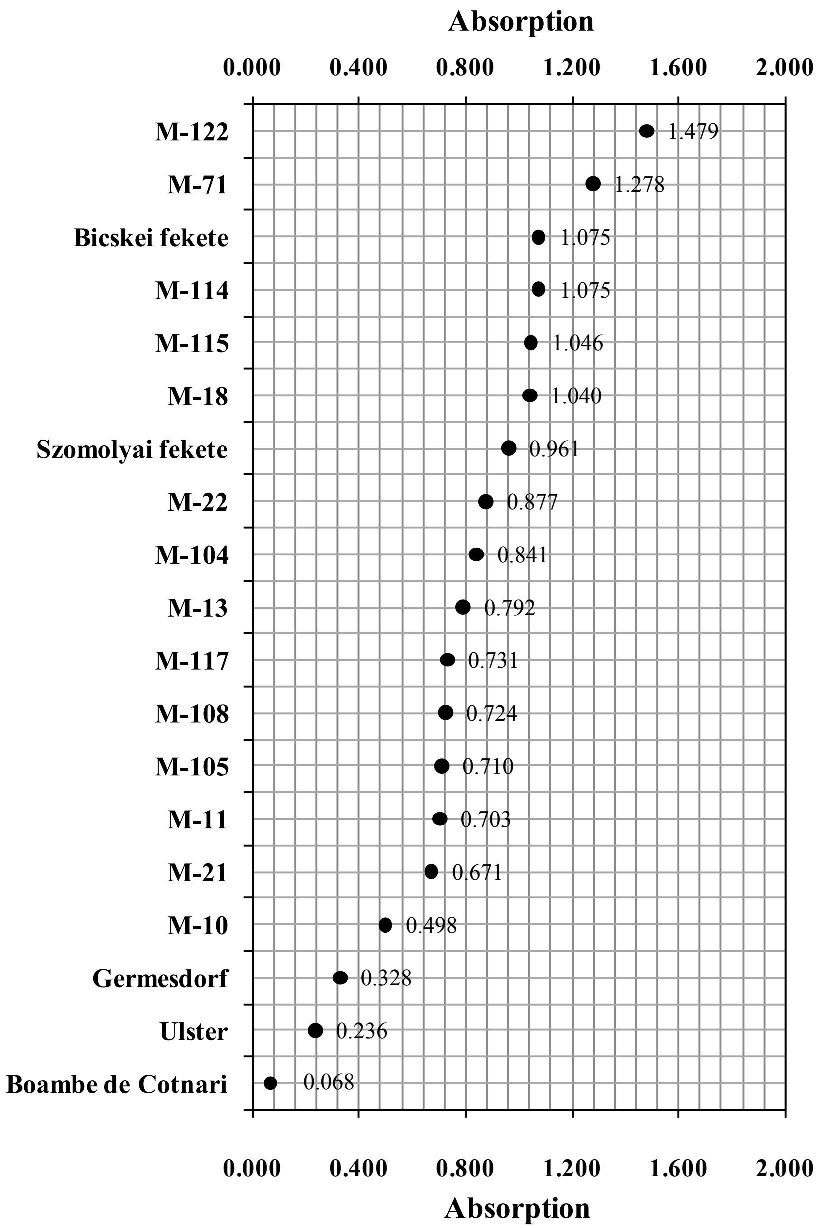

Figure 4: Average absorption spectra of sweet cherry selections and cultivars (2007-2008)

Total acids and sugars content

The investigated prospective elites and control cultivars have very wide total acid content, between 3.7 and 13.0 g/l. Evaluating the values reveals that the control cultivars have low acidity in contrast with the prospective elites (Figure 3.). Referring to sugar content, the '*M-21*', '*M-104*', '*M-13*', '*M-116*' and '*M-18*' selections have higher values compared to the control cultivars.

According to Gyuró and Tóth (1980), Gyuró (1990) and Papp (2003) the flavour of the fruit is greatly influenced by the acid content correlated with the sugar content. Comparing the acid and sugar content concordance of the fruits, the conclusion is that the '*M-104*', '*M-13*', '*M-116*', '*M-18*', '*Germersdorfi*', '*Boambe Cotnari*' and '*Szomolyai fekete*' selections and cultivars shows balanced acid and sugar content. In contrast, the sugar content of the '*M-122*', '*M-21*', '*M-114*', '*M-10*', '*M-22*', '*M-108*', '*M-115*', '*M-117*', '*M-11*' selections is much lower than their values of acidity. At the '*Ulster*', '*Bicskei fekete*' and '*M-71*' selections and cultivars the sugar content is higher than the acidity content.

The results of spectrophotometric evaluation of the fruits

According to literature reports, the '*Bicskei fekete*' and '*Szomolyai fekete*' have intense colorant juice [2, 6, 12]. Their spectrophotometric evaluation of colour intensity at 380 wavelength (nm) ranged from 0.96 to 1.08 absorbance characteristic value. Comparing the absorbance value of the '*M-122*' and '*M-71*' selections with that of the '*Bicskei fekete*', 0.400 and 0.200 difference was observed in favour of the selections (Figure 4.). In case of three selections ('*M-114*', '*M-115*', '*M-18*') higher absorbance values were found than at the '*Szomolyai fekete*' cultivar. Thus, the above selections ('*M-122*', '*M-71*', '*M-114*', '*M-115*', '*M-18*') have more intense pigments than '*Bicskei fekete*' or '*Szomolyai fekete*' nationally recognized cultivars for industrial processing.

4 Conclusion

Based on the results of the experiments, the following conclusion can be made: Between 2006 and 2009, several sweet cherry prospective elites were selected in Mures County with the purpose to determine the suitable ones for industrial processing. The suitable selections are characterized by black shiny fruits, with firm meat, high TSS concentration, intense colorant juice, balanced flavour, sometimes with a slightly sourly taste. The most predominant fruit dimension is the medium one, but the '*M-117*' and '*M-108*' selections have a fruit diameter between 18 and 21 mm. In the case of fruit for industrial processing, the 18-21 mm diameter defines high quality [3].

The '*M-22*', '*M-18*', '*M-11*' and '*M-13*' prospective elites have solid contents that exceed the amount found in the *Bicske Fekete'* and '*Szomolyai Fekete*' cultivars.

The sugar content calculated on basis of soluble solid content, for '*M-21*', '*M-104*', '*M-13*', '*M-116*' and '*M-18*' shows equivalent values to those found in the '*Bicskei fekete*', making it possible to obtain natural preparations without added sugar.

Spectrophotometric analysis shows that most selections have intense colorant juice. The colour intensity of the juice is accentuated especially at the '*M-122*' and '*M-71*' selections.

These selections could play an important role in a possible breeding program of sweet cherry to expand the present assortment. Therefore a long term national breeding program would be necessary for conserving and improving these individuals.

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