PROFESSIONAL FINAL REPORT

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INTRODUCTION

Sour cherry is a non-climatic, mostly self-propelled and very sensitive fruit. Tart cherries are very juicy and pleasantly acid, making them superior for cooking and baking compared to their sweet cherry relative. It has outstanding importance in the food industry as a natural colorant (Inántsy-Balázs, 2004). This fruit has exceptionally beneficial nutritional content, with higher concentration of vitamins, minerals, antioxidants and bioactive components (melatonine) than the sweet cherry. The melatonine component have antioxidant effect and several beneficial effects. It has a role in preventing changes in the cell and the tissue levels in the body. Besides they are neutralizing the free radicals, slowing down the aging processes, regulating the biorhythm and reducing the day to day stress. Furthermore they are inhibit the cell growth, thereby promoting the preventive defences of the body against the tumors, particularly against the colorectal cancer (Bíró et al., 2015; Homoki et al., 2015).

However the nutritional content considerably decrease during the fruit procession (Homoki et al., 2014). It is especially suitable for fresh consumption due to the harmonic sugar/acid ratio. The high level of the phytonutrients will be very important in the future as a functional food, because healthier eating became one of the top food trends among consumers.

The conquering Hungarian people gathered their wild fruits and subsequently they were grown from the seedlings and the seeds. The first archaeological finds from Hungary come from the time of the Hungarian conquest (Mándy, 1971). Sour cherries are known from the ancient times in Hungary. Tart cherry production of the European Union represents a significant volume within the world market. Hungary is recognized as one of the most important producer of the tart cherry in Europe. The Hungarian varieties are unique in the world. The stone fruit has high importance in Hungary, being the second of the production volume, and high percentage of the export. The Carpathian Basin can be considered as a secondary gene centre of the sour cherry, therefore several cultivar groups can be found in Hungary, which could be regarded as excellent breeding materials.

The development of the sour cherry growing regions began in the surroundings of Debrecen, Újfehértó, Nyíregyháza, Mátészalka and Kisvárda in the 16th and 17th century (Pusztai, 1970).

The Hungarian sour cherry breeding has been going on for 60 years, resulting in 18 state registered cultivars. The most important breeding methods are the landrace selection and cross breeding. The first cultivated landscape variety of tart cherry in Hungary is named ‘Pándy’. This variety laid the foundation of the domestic sour cherry production. As a result of clone selection, useful varieties had been selected during the last quarter of the 20th century as ‘Újfehértói fürtös’, ‘Debreceni bőtermő’ and ‘Kántorjánosi’, which furnish more than a half of the Hungarian sour cherry market. Two further local varieties have been approved and registered by the Hungarian State: ‘Petri’ and ’Éva’ in 2007 (Szabó and Szőke, 2008). The choice of varieties has been increased due to the novelties.

The primary importance goals of the breeding are to find some types of sour cherry trees, which are self-fertile, have rich and high quality yield, excellent nutritional values, the suitability for fresh consumption, the high degree of disease tolerance and the harvest time is different from that of the oldest varieties.

The Hungarian tart cherry production has a remarkable economic potential (Takács et al., 2016). The market and selling prices of interior tart cherry have fluctuated hectically in recent years, often in a given year. The reason for this is partially resulted from the short tart cherry production season which is accompanied by the restricted storage period, as harvested fruit can be stored longer than a few days without remarkable decline. In addition to the prices determined by traders, the prices of the industrial processing tart cherry also have a negative impact on the price of fresh consumption tart cherry (Apáti-Gonda, 2009).

Tart cherry is widely used in the food industry, and some are excellent for fresh consumption. The beneficial effects of fresh tart cherry consumption on health has also been proven. To increase the fresh consumption of tart cherry we need to provide longer availability of fresh fruit.

The Hungarian export is reported to be between 10 to 20 thousand tons of fresh tart cherries per year, largely to German canning industry (Kurmai, 2015). The average consumption of sour cherry is between 0.9 and 1.3 kilograms in Hungary.

As regards the industrial processing of fruits suitable for making different kinds of food. Tart cherry is used by food industry, producing canned fruit and juice products in Hungary, but it is also an important raw material for the alcoholic beverage and confectionary and freezing industry. It can be said, the compote is one of the most important processing form of sour cherries in Hungary.

During the application period (01.09.2018. – 31.08.2020.) we performed the planned monitoring and observation of vegetative growth and yield of different rootstock-scion combinations in field studies, measuring the inner nutritional parameters of different sour cherry varieties which have high antioxidant content and examining the effect of different storage methods for the self-life and the fungal populations of the Hungarian sour cherry varieties (‘Érdi bőtermő’, ‘Petri’, ‘Újfehértói fürtös’). The selection work of accessions was also moved on in our variety collections and gene banks. The achieved results of the different research areas were presented constantly.

There were 5 research areas mentioned in the call for proposals:

I.1. Observation of the gene bank items
- I.1.1. Breeding and testing of *Monilinia laxa* resistant sour cherries with examinations of the endogenous compounds
- I.1.2.Phenotypic characterisation of sweet cherry accessions

I.2. SSR analysis of sweet cherry accessions

I.3. Studying of the sour cherry storage and developing new storage processes to increase the fresh consumption

I.4. Examination of the nutritional value for the different sour cherry varieties

I.5. Developing new sour cherry orchard type

I.1. OBSERVATION OF THE GENE BANK ITEMS

I.1.1 BREEDING AND TESTING OF *MONILINIA LAXA* RESISTANT SOUR CHERRIES WITH EXAMINATIONS OF THE ENDOGENOUS COMPOUNDS

In the past our breeding work focused on the self-fertility, and resulted in the most important Hungarian sour cherry cultivars. Using the well productive cultivars the Hungarian sour cherry growing could develop in the last decades. The most important Hungarian cultivars are highly susceptible to *Monilinia laxa*, and epidemic periods has therefore been created several times in the infection-critical years. For this reason a resistance breeding programme has been started since 1990. Aim of the breeding program is to produce genotypes having high tolerance against the most important diseases of sour cherry, but their fruit characteristics and productivity are similar to ’Érdi bőtermő’. The ‘Csengődi’ cultivar is used as resistance donor in the past decades

and nowadays as well. The research work can be divided into two parts, each building on each other. In the first part the *M. laxa* resistance of the selected genotypes was examined with spontaneous *in vivo*, artificial *in vivo*, and artificial *in vitro* infections. The order of disease resistance of spontaneous and artificial *in vivo* infections showed the same results. On this basis it can be considered that all but one of the eight hybrids (9/79-80) were significantly resistant than the cultivar 'Érdi bőtermő', however between the resistance levels are well distinguished differences. On the basis of the comparison of different inoculation methods the artificial *in vivo* inoculation was the most suitable method for the examination of *M. laxa* resistance. The artificial *in vitro* infection is very provocative, the circumstances of isolation are too favourable to the pathogen thus, and objective ranking is made more difficult despite of the detectable differences in resistance.

In the further examinations we asked whether the behaviour of different genotypes to *M. laxa* could be characterised with the determination of carbohydrates, methyl donor compounds and endogenous formaldehyde originated from leaf and phloem tissues. Among the carbohydrates in leaves and in phloem tissues mainly the glucose quantity could be associated with the disease resistance of sour cherry cultivars and hybrids. In the susceptible group higher, while in the resistant group significantly lower glucose contents were measured, in more examination times which were independent of each other.

In order to study the inoculation induced defence reactions the time dependent changing of glucose, fructose and sucrose were examined. On this basis the defence reactions could be followed up well with the examination of concentration changing of glucose thus the differences between the most resistant and the most susceptible genotypes are well detectable.

In homeostasis, after different inoculation methods, the methyl donor compounds and the endogenous formaldehyde were measured in the phloem tissues of the genotypes. Among methyl donor (choline, betain, carnitine, trigonelline, trimethyl lysin) compounds the choline was well detectable. The quantity of choline could be associated with the resistance; its quantity is higher in the resistant and lower in the susceptible genotypes. On the basis of the quantity of endogenous formaldehyde the resistant and susceptible groups are also separable from each other in stress-free status. Compared to choline, the time dependent changing of formaldehyde shows reverse tendency, which is also suitable for making differences between defence responses. On the basis of the quantitative changing of the examined endogenous compounds well detectable differences could be measured between the susceptible and resistant genotypes even in the first hour after the inoculation. This finding is confirmed by the fact that the fast

disease response of the plants, the fast recognition of the pathogen determines basically the further disease process.

Basic criterion of the successful breeding is application of such breeding methods which can speed up the time-consuming selection work. Our results could be encouraging prognostications if we improve our current work with the examinations of endogenous compounds, it can be possible to separate the susceptible and resistant genotypes at an early juvenile age (before blooming), and this will make the time-consuming selection work easier.

In 2019, we continued the data acquisition and selection work of accessions in our local variety collections and gene banks. All genotypes was observed and measured in different phenological stages. We are starting to prepare exchanging germplasm materials and expanding our cherry disease resistance breeding programs by introducing North-Eastern Hungarian and Iranian genotypes. The major selection objectives are to broaden the range of ripening times, develop self-fertile varieties with high yields of good fruit quality, and to increase disease resistance/tolerance.

In this year one candidate variety (VN7) from our landrace selection have been added to the National Variety List Registry with a new name ’Márta’.

I.1.2.PHENOTYPIC CHARACTERISATION OF SWEET CHERRY ACCESSIONS

Detailed morphological characterisation and phenological description of twenty Hungarian sweet cherry landraces have been performed according to UPOV descriptors. These data are included in our local database and will be shared among stakeholders in request.

As a result of the landscape selection in northern Hungary, a new variety was reported in National Agricultural Research and Innovation Centre (NARIC) in 19.08.2020. ‘Clone D’ *Prunus cerasus* L. is protected by an EU patent under the name ‘Olibell’ (patent protection number: 20201762, protection period: 2020-2050) candidate variety. Currently, the Hungarian variety test is underway, the DUS test carried out. The published date was 15.10.2020. **NARIC was concluded a license agreement with the said ’Olibell’ sour cherry variety with ARTEVOS GmbH in Germany in 2019. The license has the rights or duties of maintaining patenting and selling planting material of the D-clone variety in different countries, which is fixed by contract.**

I.2. SSR ANALYSIS OF SWEET CHERRY ACCESSIONS

S-allele analysis of sour cherry accessions

At NARIC Fruitresearch Institute identification of S-alleles responsible for self-fertility of sour cherry has been initiated in autumn, 2017. Self-fertility of sour cherry has been determined by mutant – thus non-functional – *S*-allele combinations. In our first experiment 17 seedling originating from 'Érdi bőtermő' x 'Csengődi' cross have been analysed.

DNA analysis have been performed followed by allele-specific *S*-allele investigation. The cultivar 'Csengődi' holds S_1, S_{6m2}, S_{36b2} alleles, whereas 'Érdi bőtermő' has S_4, S_{6m}, S_{35}, S_{36b} alleles, their offsprings can have these alleles in different combination.

For self-fertility two from the mutant alleles - S_{6m}, S_{6m2} ; S_{36b} *and* S_{36b2} - must be presented together.

According to our results in our sour cherry population five accessions showed self-fertility, while the latter 12 are self-sterile.

Testing sweet cherry fruit size markers

According to several authors (e.g. Zhang et al. 2009), the major fruit size QTL of sweet cherry is linked to BPPCT038 and CPSCT034 markers.

In our work we applied these markers on 19 sweet cherry cultivars important in Hungarian fruit growing, additionally, five control cultivars were used. In our work we found two accessions that proved to be homozygous for large fruit size, therefore can inherit this trait with high effect.

Phenotype data from previous years and molecular results were compared by statistical method and showed correlation. Preparation of scientific paper is in progress.

Fruit morphological characterisation and phonological description of twenty Hungarian sweet cherry landraces have been performed.

Detailed characterisation of sweet cherry accessions by SSR markers is in progress.

Phenotypic characterisation of sweet cherry accessions

Detailed morphological characterisation and phenological description of twenty Hungarian sweet cherry landraces have been performed according to UPOV descriptors. These data are included in our local database and will be shared among stakeholders in request.

SSR analysis of sweet cherry accessions

In order to discriminate among accessions an SSR based identification method is under development. SSR markers were selected according to their polymorphism.

Markers presumably associated with flowering time:

Twenty-nine sweet cherry accessions, mostly Hungarian landraces having diverse flowering time were selected for the analysis. Hungarian commercial cultivars ‘Rita’ and ‘Katalin’, and an international cultivar ‘Regina’ were used as reference.
AglA1-5 forward and AglA1-CT reverse primers were used according to the protocol described by Trainin et al. (2013). Among sweet cherry accessions and reference cultivars analysed nine different PaSOC1 alleles were found (between 200 bp and 248 bp) in 14 different combinations.

Markers reported to have high polymorphism among *Prunus* accessions:

According to the literature the markers RPPG2-022, RPPG1-037, RPPG1-041, BPPCT 040, PceGA34, UDP96-003 and UDP98-412 were selected in order to test them in our cherry collection. The conditions of PCR reactions were optimised for each marker and then multiplex PCR method of primer combinations were developed. We have the first promising results with different primer combinations on either accessions having presumably different / similar genetic background.

26 sweet cherry accessions and eight sour cherry accessions were analysed by this marker set. PCR reactions followed by fragment analysis of the PCR products were performed according to the different protocols recommended to each primers.
This set of primers was eligible in distinguishing all accessions from each other as all items had unique pattern. The results are presented in **Table 1**.

Table 1: Genotypes of the cherry accessions analysed by seven SSR markers indicated by fragment sizes (bp.)

Accession	Cultivar	Allele 1	Allele 2	Allele 3	Allele 4	Allele 1	Allele 2	Allele 1	Allele 2	Allele 1	Allele 2	Allele 1	Allele 2	Allele 1	Allele 2	Allele 1	Allele 2
Pándy 141	Sour Cherry	92	96	119	119			135	135	236	239	133	133	200	204	117	117
D-41-47 (UK 98-2-9/d)	Sour Cherry	96	96	117	122			134	134	221	239	141	141	200	215		
Szamosi meggy	Sour Cherry	92	96	117	119	140	152	131	135	236	239	123	133	200	204	119	119
Rékasi	Sour Cherry	92	96	119	119	121	121	135	135	236	239	123	133	213		119	119
Újfehértói fürtös	Sour Cherry	92	96	119	119	153	160	135	135	236	239	123	133	200	204		
Bosnyák	Sour Cherry	92	111	117	129	143	153	135	135	236	239	123	139	242		117	117
Késői cigány A	Sour Cherry	96	117	119	122	139	153	131	131	236	251	123	123	200	202	119	119
Érdi bőtermő	Sour Cherry	96	117	122	122	141	153	135	135	236	251	123	123	200	202		
Early Rivers	Sweet Cherry	121	125			133	141	146	146	242	256	121	121	200	200	121	125
Ulster	Sweet Cherry	119	125			135	154	129	137	242	242	121	125			119	125
Tavricsanka	Sweet Cherry	117	117					138	138							117	119
Chilei 1 Bing BFO-B14-T20 A	Sweet Cherry	117	119					122	132	242	256	125	125			117	119
UK-98-1-26 (Rukszandra)	Sweet Cherry	117	119					146	146								
UK-98-1-33 (Krasznaja plotnaja)	Sweet Cherry	120	120					139	139	236	242	121	121			117	119
UK-98-1-28 (Donyeckij ugoljok)	Sweet Cherry	100	117			141	141	122	137	242	242	121	121			117	117
UK-98-1-38 (Plakucsnaja)	Sweet Cherry	100	117			154	154	122	146	242	242	121	125				
UK-98-1-40 (Aelita)	Sweet Cherry	100	118			141	141	139	146	242	256	121	121			119	119
UK-98-1-24 (Szesztrjonka)	Sweet Cherry	100	119			141	153	122	137	242	242	121	121			119	119
President Rivers	Sweet Cherry	115	117			132	140	135	135	242	251	121	121			115	117
UK-98-1-13 (Vaszilisza)	Sweet Cherry	117	117			141	141	144	146	236	242	121	125			117	119
Priusordebnaja	Sweet Cherry	117	117			141	141	146	146	242	256	125	125			117	119
Merton Bigarreau	Sweet Cherry	117	119			133	133	121	137	236	242	121	121			117	119
Merton Heart	Sweet Cherry	117	119			140	153	131	146	242	256	129	129			117	119
UK-98-1-17 (Proscsalnaja)	Sweet Cherry	117	119			141	141	144	146	242	256	121	133			117	119
UK-98-1-31 (Szkromnyica N1)	Sweet Cherry	117	119			141	141	146	146	236	256	125	125			117	119
Priusordebnaja	Sweet Cherry	117	119			141	141	146	146	242	256	125	125			117	119
Móri K1	Sweet Cherry	117	119			141	153	129	146	242	242	125	139			119	125
Bigarreau Moreau Sel Pale	Sweet Cherry	117	119			141	166	122	131	242	242	121	121	200	200	117	119
Melitopolszkaja A	Sweet Cherry	117	119			154	154	122	122	236	242	121	133	200	200		
Tarka Százhalombatta	Sweet Cherry	117	119			154	166	122	131	242	242	121	121			117	119
Chilei 4 Bing	Sweet Cherry	117	119			159	159	131	137	236	256	125	125	200	200		
Merton Bigarreau	Sweet Cherry	118	120			141	159	123	138	242	242			200	200	117	119
Bing	Sweet Cherry	118	120			159	159	133	139	236	256	125	125	200	200	117	119
Early Rivers	Sweet Cherry	119	122			133	141	146	146	242	256	121	125	200	200		

The most polymorphic marker was PceGA-34 as it had 7 alleles in sweet cherry and 6 among sour cherry accessions.

Most of the SSR markers showed only two alleles instead of four among sour cherries (blank cells in **Table 1**.), this indicates their homozygosity.

On the basis of our results these primers and protocols were successful and are suitable to distinguish more individuals/accessions.

I/3. EFFECT OF DIFFERENT STORAGE METHODS FOR THE SELF LIFE AND THE FUNGAL POPULATIONS OF THE HUNGARIAN SOUR CHERRY VARIETIES

Sour cherry is one of the most important and traditional fruits in Hungary.

It is necessary, the development and the optimization of the pre- and postharvest treatments/technology, because currently, we have limited knowledge about the storage of the fresh tart cherry (*Prunus cerasus* L.), however related studies on sweet cherry (*Prunus avium* L.) may be adopted.

Modified atmosphere is widely used for long-term storage of different fruits. Breathable bags providing Modified Atmosphere Packaging (MAP) have been successfully used for *Prunus avium* (cherry, or sweet cherry), but we have limited knowledge about it's usage for *Prunus cerasus* (sour cherry or tart cherry).

Our aims were to study the effect of Modified Atmosphere Packaging (MAP) on the quality parameters and self-life of different sour cherry varieties.

Different fungicides, biofungicides or biostimulants can be used as pre-and postharvest treatments against the fruit pathogen fungi in 2018 and 2019. The effect of this different pre- and postharvest treatments were tested in 2018 and 2019 on three Hungarian sour cherry varieties: 'Érdi bőtermő', 'Újfehértói fürtös' and 'Petri', while the tested varieties were two in 2020. Sour cherry fruits packaged under modified atmosphere conditions could be stored for 2- 4- and 6 weeks at 0°C with a higher quality and minimal risk of disorder development. As expected, weight loss and the percentage of decay was significantly reduced under MAP and cool storage (0°C).

Luna Privilege (contain fluopiram), Serenade ASO, and Chitoplant were tested as the preharvest treatment for selected varieties in 2018. The Concervol Natural-2 (sugar ester) was the postharvest treatment. In the following years, was not used because it was not sufficiently efficient during storage.

In 2019 year were tested the Chitosan 1% and the Serenade ASO two weeks before harvest. Serenade ASO containing *Bacillus subtilis*. We used this plant protection products for pre-and postharvest treatments.

In 2020 there was only the control setting for two sour cherry varieties. In 2020, due to the weather conditions (freezing, hail), we could not study 'Érdi bőtermő' variety.

The shelf life of the fruits, the colony forming unit (CFU) of moulds isolated from the sour cherry, and the rottening mould populations were analysed in the recent period.

The results were greatly influenced by the varieties.

In 2018, Serenade ASO preharvest treatment reduced most effectively the decay of 'Érdi bőtermő' fruits, while Luna Privilege resulted the best shelf life of 'Újfehértói fürtös' fruits with more than 60% of healthy fruits after two weeks storage. For the 'Petri variety', Boni Protect was the most effective treatment, but after two weeks, only 50% of the fruits remained intact.

The colony forming unit of the fungi isolated from the surface of the fruits has changed comparing the fruits before and following the storage in 2018. Storage increased the CFU of

the fungi, although the average value was lower in case of MAP storage. The average CFU of *Penicillium* sp. doubled, while *Alternaria* sp., *Aspergillus* sp., *Fusarium* sp. increased, or increased more. Only the CFU of the *Rhizopus* sp. decreased.

In 2019, 'Érdi bőtermő' was the most infected after the harvest in case of Serenade ASO treatment, but the pre-Chitosan solution was effective after the 6 weeks. 'Újfehértói fürtös' showed the best results in the shelf life and the determination of colony forming unit experiments as in previous years. *Colletotrichum* sp. was isolated from rottening 'Újfehértói fürtös' and 'Petri' fruits during the shelf life test like in previous year. Biofungicide treatments were less effective against of pathogenic fungi. Mostly, *Penicillium* and *Phoma* sp. were identified in the highest number from the different tart cherries. The ratio of the infected fruits was the lowest in case of the stored 'Újfehértói fürtös' fruits, and the number of isolated moulds was also the lowest.

Concluding of this year, the results of all the tested varieties, the pre-and postharvest treatments were the most effective to prevent the decay of sour cherry and to suppress *Alternaria* sp., *Penicillium* sp., *Phoma* sp., *Leucostoma* sp. and *Rhizopus* sp./*Mucor* species during storage.

After 2020 harvest, the total number of fungi of 'Petri' variety was significantly lower compared to the 'Újfehértói fürtös'. Under 2 weeks storage, 'Petri' showed lower infestation compared to the other studied variety in different storage modes. However, the rate of the deterioration was higher respectively in Normal storage at 4 and 6 weeks. The highest degree of rot was observed in 'Petri' variety during the 4 weeks MAP storage, while in the case of 'Újfehértói fürtös' was measured it after 6 weeks of storage in Normal airspace.

The modified storage operated in the two studied sour cherries for up to 2 weeks, after which there was significant increase in the total germ count.

In 2020, after harvesting, it can be observed in the fungal population of the two varieties examined this year that the presence of anthracnose was prominent in the case of 'Újfehértói fürtös'. The number of *Colletotrichum* species was very high some in recent years. In addition, the incidence of yeasts was also significant in this variety. The presence of the other pathogens tested was low. The presence of all fungi in the Petri variety was low. A *Phoma* sp. its presence after harvest was higher than that of the 'Petri' variety. The Petri variety had a high presence of yeasts.

The presence of *Alternaria* sp. in both varieties was extremely low even before and after the harvest. *Fusarium* species was observed after the harvest and it was no longer present during the storage.

After 2 weeks storage, it can be observed for 'Újfehértó fürtös' variety that the number of intact fruits was higher during normal storage compared to MAP storage. It can be said that during MAP storage, the deterioration was more significant in the variety study.

In the case of 'Újfehértói fürtös', we found that MAP storage can be effective for fresh consumption, the degree of deterioration was lower compared to the other studied variety.

However, for the two storage methods, there was no significant difference within the variety. After 4 weeks of harvesting, it can be said that the proportion of intact fruits was higher compared to the modified air storage even on the 8th day. After days, the number of deteriorated fruits increased continuously, more significant deterioration was observed in the case of MAP. Similar to 'Petri' variety, the rate of deterioration at 2 weeks storage was similar at 4 weeks in the two storage modes. However, compared to 'Újfehértói fürtös', the proportion of intact fruits was much higher in the study period, while the rate of deterioration was lower.

During the 6 weeks storage, the two storage methods of 'Újfehértói fürtös' variety showed similar deterioration trend. The number of intact fruits developed similarly. The study was performed for 6 days because there were no more healthy fruits on 6$^{th.}$ day.

During the 6 weeks experiment, the two storage methods showed a similar deterioration trend for 'Petri' variety. The number of intact fruits developed similarly to the other studied variety. The study was performed for 6 days because there were no more healthy fruits on 6$^{th.}$ day.

In terms of population studies of fungal species, *Colletotrichum* sp. was isolated from rottening 'Újfehértói fürtös' and 'Petri' fruits during the shelf life test like in previous year. Biofungicide treatments were less effective against of pathogenic fungi. Mostly, *Penicillium* and *Phoma* sp. were identified in the highest number from the different tart cherries. The ratio of the infected fruits was the lowest in case of the stored 'Újfehértói fürtös' fruits, and the number of isolated moulds was also the lowest.

Concluding the results of all the tested varieties, the pre-and postharvest treatments were the most effective to prevent the decay of sour cherry and to suppress *Alternaria* sp., *Penicillium* sp., *Phoma* sp., *Leucostoma* sp. and *Rhizopus*/*Mucor* sp. species during storage.

Overall, the rate of deterioration also increase with the increase of the storage period. It can be observed that in 2019, far more fungal species were present on the surface of the sour cherries than in 2020.

It can be said, no correlation was found between the surface CFU and the shelf-life tests, as higher surface contamination did not resulted higher decay rate during storage. There were significant differences between the ratios of different fungal genera on the examined tart cherry varieties.

Due to the significant varietal effect, the efficacy of the treatments was evaluated separately for each, examined variety. In the case of 'Újfehértói fürtös', the proportion of intact fruits was higher (74%) than for 'Érdi bőtermő' (36%) after 6 weeks of storage

In both varieties, it can be said that the pre-harvest chitosan treatment increased, while the pre-storage dipping treatment decreased the proportion of intact fruits. Pre-harvest treatment also had positive effect on the decline, as it reduced its extent. In the case 'Érdi bőtermő', the treatment significantly reduced the number of surface moulds after the harvest. After storage, both treatment methods were effective for both varieties, with minimal contamination on the surface of the dipped samples. In the shelf-resistance test after removal, there was no significant difference between the varieties on 2ndday, the loss was less than 10%, and after 4th day the quality of both varieties decreased.

It was concluded, that MAP storage decreased the decay percentage. In the shelf-life test, the incidence of decay was significantly higher after storage than after harvesting. Fruit surface mould number changed after storage: storage increased the CFU number of sour-cherry, but in the case of MAP storage, this value was lower. The effect of chitosan (pre and post) is positive and marginally (at 10%) significant for 'Újfehértói fürtös' compared to the control samples.

The effect of the treatments is negative for 'Érdi bőtermő' variety. The treatment reduced anthracnose in 'Újfehértói fürtös'.

I.4. EXAMINATION OF THE NUTRITIONAL VALUE FOR THE DIFFERENT SOUR CHERRY VARIETIES

We are measuring the nutritional parameters of fruits of promising selections during and after ripening with standardised methods in 2018, and in the following years, the mentioned parameters were refined as a function of the results.

Standardised methods are using to measure the inner content values:

- Measuring of sugar composition by HPLC and enzymatic method
- Measuring of organic acid composition by HPLC and enzymatic method
- Measuring of total acid content by potentiometric titration
- Determination of element content by AAS
- Determination of ash content by calcination
- Determination of total phenolic (TP), total flavonoid (TF), total antioxidant capacity and total anthocyanin content (TA) by spectrophotometric method.
- Determination of vitamin C content by enzymatic method
- Determination of carothin content by HPLC

The data from the last two years have shown that the sugar content were the same before and after storage, but organic acid composition was significantly decrease during six weeks storage. That means that the examined variety lost their sour characteristic and become a bit sweeter in 2019.

In the course of our studies, we measured the following content parameters of the three examined cherries between 2016 and 2019.

- Total anthocyanin content (mg cyanidin-3-glucoside / kg)
- Total phenol content (mg gallic acid / kg)
- Total flavanoid (mg catechin / kg)
- Total sugar, reducing sugar (% m / m)
- Total antioxidant capacity (mmol trolox / kg)
- Titratable acidity (mmol / kg)
- pH
- Specific electrical conductivity (mS / cm)
- Ash content (% m / m)
- Moisture content (% m / m)

During the application period, the measurement of content parameters was studied in the case of different storage methods (MAP, Normal) in the case of ‘Érdő bőtermő’, ‘Újfehértói fürtös’ and ‘Petri’ varieties.

The anthocyanin content was similar between 2016 and 2019 for all tested varieties. ‘Petri’ variety showed the highest values for all phenol contents in 2016, 2017 and 2019. In 2018, we also measured lower values than the other studied sour cherry varieties. Measurements of total flavonoid content were similar in the study periods. In 2016, we experienced the lowest values for ‘Petri MAP’ (318 mg katechin/ kg)., we obtained values around ~10 % m/m For total and reducing sugars, except for ‘Petri MAP’ and ‘Petri Normal’ (2016 and 2018: ~8 % m/m)). The lowest values were measured in 2018 for the studied sour cherries in the case of titratable acidity. The value of pH ranged on average from ~3 to 4. The storage methods did not significantly affect its value. The specific electrical conductivity was around ~3 mS/cm. ‘Érdi MAP’ and ‘Érdi Normal' showed around ~2 mS/cm values. Almost identical results were measured in case of ash content (0.4 and 0.5 % m/m). During the determination of the moisture content, the values of around ~80% were obtained for the studied varieties. The storage modes did not affect the moisture content.

I.5. DEVELOPING NEW SOUR CHERRY ORCHARD TYPE

In 2018 we prepared the new trial orchard with some promising new scion/rootstock combinations and started to develop a new canopy form in order to determine these orchard type which will be the basic for the new plantation in the future for intensive sour cherry production. We evaluated the combination of 2 scion cultivars (‘Petri’ and ‘Érdi bőtermő’) and 2 rootstocks (GiselA5 and GiselA6), at two spacing combinations (4.5×1.5 m; 4.5×1.0 m) in 2018. In 2019 were started the examination of the scion/rootstock combinations and develop a new orchard type which will be able to become the basis for providing of fresh fruit with high nutritional value.

SUMMARY

Sour cherry (*Prunus cerasus* L.) is cultivated in the second largest fruit in Hungary. The fruits are widely used as they sport some excellent nutritional features. However fairly few postharvest studies are available for this fruit. The postharvest techniques of the sour cherry can be developed with the adaptation of the methods used for other stone fruits. The development of the appropriate storage technology may enable to elongate the self-life, which can positively affect the economy and the processing of sour cherry, with increasing its consumption and trading period.

The unique Hungarian sour cherry variety selection is in the world, so should be enhance the intensification of sour cherry production, improving the quality, thereby the increasing fresh consumption is national economic interest.

At NARIC Fruitresearch Institute identification of S-alleles responsible for self-fertility of sour cherry has been initiated in autumn, 2017. Self-fertility of sour cherry has been determined by mutant – thus non-functional – *S*-allele combinations. In our first experiment 17 seedling originating from ‘Érdi bőtermő’ x ‘Csengődi’ cross have been analysed.

In 2019, one candidate variety (VN7) from our landrace selection have been added to the National Variety List Registry with a new name ’Márta’.

As a result of the landscape selection in northern Hungary, a new variety was reported in National Agricultural Research and Innovation Centre (NARIC) in 2020, called ‘Olibell’.

It can be said, no correlation was found between the surface CFU and the shelf-life tests, as higher surface contamination did not resulted higher decay rate during storage. There were significant differences between the ratios of different fungal genera on the examined tart cherry varieties.

It can be stated that in the case of the examined sour cherry varieties there was no significant difference between the examined nutritional parameters and the different storage methods.

The Genebank items are being exchanged with Iranian partners. The scientific publication of our results is being prepared. The evaluation of the 2020 content parameters is ongoing.

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