Hungarian University of Agriculture and Life Sciences

The effect of grafting and storage on the inner content values of melon (*Cucumis melo* L.)

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1. INTRODUCTION, AIMS

Melon (*Cucumis melo* L.) is an important and valuable fruit-substitute vegetable plant, which in Hungary was grown on approximately 485 ha in 2021 (KSH 2022). It is expected that the proportion of open fields will decrease while the proportion of cultivated areas increases. However, if the proportion of forced growing areas increases, more and more modern facilities and more and more advanced technology will be needed, both in melon and watermelon cultivation.

There are 6 major growing regions of melon cultivation in Hungary: the Heves-Jászság and Békés regions, the South-Baranya region, the Tolna region, the Debrecen-Derecske region, and the Nyírség region. It can be said that 75 % of the melon growing areas in Hungary are located in the Békés and Eastern Hungary regions. The growers of this region quickly realized that the most important thing is not the size of the production area, but the use of intensive technology. It was here that the frameless foil covering was first used, which was replaced by small-tunnel cultivation, as well as foil mulching, modern drip tape irrigation and reasonable fertilization.

However, as a result of monoculture cultivation, the soils became infected, root pests multiplied and nowadays this is an increasing problem in intensive agriculture. Since the banning of methyl bromide-based soil disinfectants and the spread of fusarium wilt (*Fusarium oxysporum* f. sp. *niverum*), the grafting of melons onto pumpkin rootstocks has become essential worldwide.

The use of grafted seedlings has been a common practice among watermelon growers in Hungary for many years and nowadays it has almost taken over compared to seedling production in the traditional way. In the cultivation of melon the importance of grafting increased with the spread of fusarium wilt in Hungary.

Grafted plants are characterized by earliness, cold tolerance, and resistance to soil-borne diseases. Several types of grafting can be used for melons, the semi-cotyledon and its improved version, the rootless semi-cotyledon grafting are the most common in our country.

Grafting however, can change the inner content values, this effect can be both positive and negative, so it is crucial to choose the right rootstock-scion combination.

In the case of melon sensory evaluations play a major role, as there are very contradictory consumer opinions regarding the quality of grafted melons. Many consumers complain that melons “have pumpkin flavor", while others cannot tell the difference between grafted and self-rooted fruits. There are also differences among varieties which are most easily distinguished by their flesh color, sweetness, firmness and juiciness. Melons, when properly ripe, have a sweet, fruity taste and aroma, whereas the unripe fruit is usually characterized by its cucumber like taste and aroma. The aroma and the right texture greatly influence the consumer satisfaction.

In recent years the use of artificial sensory systems have gained more and more popularity, since subjectivity can be completely filtered out, unlike in human sensory evaluations, moreover there are cases where human sensory evaluations can not be performed due to health-damaging effects. By "copying" the human tongue and nose, the electronic tongue and electronic nose can analyze liquids and gases.

Already in present days food science and food industry like to use analytical tools that enable fast and cost-effective tests. NIR (Near Infrared Spectroscopy) is a testing method that enables rapid, quantitative and qualitative testing of the inner content values of foods.

In order to clarify the contradictions related to vaccination, I had the following aims for my doctoral thesis:

- To compare the yield and inner content parameters of self-rooted, self grafted and interspecific rootstock grafted melons in a field experiment.
- Examining the effect of grafting (on self and on interspecific rootstock) and storage (room temperature or refrigerated storage), finding suitable storage parameters.
- Comparison of sensory evaluation, electronic tongue, electronic nose and NIR analyses.
- Improvement and development of non-destructive measurement methods (NIR, electronic tongue, electronic nose) with which varieties, variety types, grafting and storage combinations can be differentiated.

2. MATERIALS AND METHODS

I set up my field experiments in 2018 and 2019 at the Soroksár Experimental and Research Farm of the Hungarian University of Agricultural and Life Sciences.

In 2018 due to plant protection problems occurring in the field experiment I carried out storage and variety comparison tests (refraction and carotene content measurements, sensory evaluations, NIR and electronic tongue measurement) with collected samples.

In 2019 samples of the field experiment, as well as collected samples were used to carry out the grafting and storage examinations (yield amount, average yield per stem, average weight, refraction, carotene and flavonoid content, sensory evaluations, NIR, electronic tongue and electronic nose measurements).

Samples used in the experiment

Rootstocks: The rootstock used for my field experiments was Shintosa Camelforce and the rootstock of the collected Jannet samples was Routpower.

Scions: The sample collected in both experimental years was the Jannet variety (grafted and self-rooted), and in the first experimental year, I used the Centro, Celestial, Donatello, Aikido, and London varieties to perform the comparison tests. For the field experiments from the Cantaloupe type I chose Centro in the first year, and Sveglio in the second year, and from the Galia types I chose London variety.

Place, conditions and methodology of the experiment

In 2018 and 2019, the melon grafting field experiment was set up at the Soroksár Experimental and Research Farm of the Hungarian University of Agricultural and Life Sciences.

Field experiments 2018-2019

I achieved the development suitable for grafting with the different sowing times of the rootstocks and scions, and then I carried out the grafting by choosing the semi-cotyledon grafting method without roots, the dates of which can be seen in **Table 1**.

I used intensive technology, our experiment was characterized by drip irrigation, row covering and intensive fertilization. I did not differentiate between the watering and fertilization of self-rooted and grafted melons.

The experiment was set up in 4 repetitions in random placement with 20 plants per repetition. Both varieties were grafted onto self and interspecific rootstocks, and I considered self-rooted plants as controls. 20 plants per treatment and per repetition were used, so my experiment was made up of about 480 plants in total.

Table 1. Sowing, grafting and planting dates, Soroksár 2018-2019

Treatments	Sowing		Grafting		Planting	
	2018	2019	2018	2019	2018	2019
Self-rooted	April 17.	April 15.	-		May 17.	May 24.
Self-grafted	April 10.	April 08.	April 24.	April 30.	May 17.	May 31.
Rootstock	April 17.	April 15.	April 24.	April 25.	May 17.	May 24.
Scion	April 10.	April 08.				
Row and plant to plant distance			Grafted: 230 x 100 cm (0.43 plant/m^2)			
			Self-rooted: 230 x 50 cm (0.87 plant/m^2)			

In 2018 plants developed properly after planting, however virus testing showed that *Zucchini yellow mosaic virus* (*CYMV*) infected my plants, and other viruses were also detected.

It was clear that the planted plants would not yield the right amount and quality of fruit, so I had to decide in which direction to continue the experiment. I came to the decision that I would try to collect samples from growers and perform the planned measurements on them.

Collected samples

In 2018 due to the failed field experiment I performed the tests with materials collected from producers. There were both self-rooted and grafted fruits from the Jannet variety.

In addition to the grafting and storage experiment, I also performed a variety comparison test with the varieties Aikido, London, Celestial, Donatello, and Centro.

Method of measurements

1st experimental year

In 2018, I stored the Jannet fruits from grafted and self-rooted plants in cold storage at 2 °C (7 days). Some of the self-rooted samples were stored at 17 °C. Fruits originating from grafted plants started to become over-ripe so I couldn’t do the 17 °C storage with them.

I performed the variety comparison tests on fresh samples, without storage experiments.

The laboratory tests performed after the grafting, storage and variety comparison experiments were: refraction and carotene measurement, sensory tests, and NIR and electronic tongue measurement.

2nd experimental year

In 2019, I again carried out the grafting and storage experiment with the Jannet variety, regardless of the success of the field experiment I obtained samples from the same producers as the previous year.

I performed the field experiment and the laboratory tests of the collected sample at the same time, according to the same method. I used 25-25 fruits per treatment, 5 plants fresh processing, 5 plants 3 days room temperature storage, 5 plants 5 days room temperature storage, 5 plants 5 days refrigerated storage and 5 plants 8 days refrigerated storage. Room temperature storage took place at 17 °C, and refrigerated storage at 2 °C.

After the storage experiment, the following measurements were performed: refraction, electronic nose, NIR electronic tongue measurement and sensory evaluation. In orange-fleshed melons, the carotenoid content, while in green-fleshed melons the carotenoid and flavonoid content was also measured.

Determination of yield

In the 2019 field experiment after picking I measured the weight of the harvested fruits per plot in the open field, using a digital scale. I calculated the amount of fruit per plot (kg/plant), the average weight of the fruits (kg/fruit), and according to the picking times, I prepared the picking curve of the different pickings projected on the plants (kg/plant).

Standard analytical measurement methods

Refraction measurement method

I measured the soluble solid content using a digital refractometer (PAL-1, ATAGO).

HPLC measurements

Carotenoids and polyphenols were measured with an HPLC device (HITACHI CHROMASTER, JAPAN) during our tests. The instrument was operated and chromatograms were evaluated with the help of EZChrome Elite Software.

Method for measuring carotenoid composition

Carotenoids were separated on a Purospher® STAR RP C18 end-capped 3 µm, 250 × 4.6 mm column with 50 minute long gradient elution according to the method of Daood et al. (2014) detection was performed at 195-700 nm.

Method for measuring polyphenol composition

The separation was optimized on a Nucleosil Protect-1 (Macherey-Nagel, Germany) C18 column with a length and inner diameter of 3 μm and a particle size of 3 mm.

All polyphenol content was measured spectrophotometrically with Folin-Ciocalteu reagent at λ=760 nm (SINGLETON and ROSSI 1965).

Correlation analytical methods

I thawed and filtered 5x50 ml of each melon sample in the first year, and 3x50 ml in the second year. For the electronic tongue measurements, I made a 10-fold dilution (10 ml, filled to volume in a 100 ml volumetric flask) of each sample in three repetitions, so I got 15 repeated samples per type and per treatment.

NIRS

In 2018 and 2019 for the Near Infrared Spectroscopy (NIRS) measurements, we recorded the spectra with a MetriNIR Analyzer desktop device (MetriNIR Kutató, Fejlsztó és Szolgáltató Rt., Budapest). The instrument operates in the spectrum range of 740-1700 nm, with a step interval of two nm.

Electronic tongue

In both experimental years, the electronic tongue measurements were carried out with an AlphaASTREE (Alpha M.O.S., Toulouse, France) potentiometric device, which consists of seven working electrodes (BB, CA, HA, JB, JE, GA, ZZ) supplied with partially selective organic membranes (CHEMFET) and an Ag/AgCl reference electrode, this enables the examination of liquid food samples.

Electronic nose

Instrumental aroma profile measurements were performed with an Alpha MOS Heracles NEO electronic nose device (Alpha M.O.S., Toulouse, France).

Sensory evaluation

Sensory tests were carried out according to the ISO 6658 standard, performed by at least 10 reviewers, who analyzed the texture the, flesh color, melon sweet and fermented aromatics, the sweet and fermented tastes, juiciness, taste persistence and aftertaste.

Statistical analysis

Analysis of standard analytical measurements

The obtained results were analyzed with the SPSS 23.0 statistical program package. Univariate and multivariate analysis of variance (ANOVA and MANOVA) were used to evaluate the experimental years 2018-2019.

Analysis of sensory evaluation

Attributes were analyzed on unstructured line scales using ProfiSens profile analysis supporting software (KÓKAI et al. 2004). Data was analyzed with one-way ANOVA and Fisher LSD for testing significant differences.

Analysis of correlative methods

NIRS

After the raw spectrum evaluation, the data was analyzed in the spectrum range of 950-1650 nm. In both experimental years, the spectra were first performed with detrend and Savitzky-Golay smoothing filter (2nd order polynomial). The NIR data was analyzed using the R-studio "aquap2" package.

Electronic tongue

Before analyzing the data of the electronic tongue, we applied a pretreatment procedure called drift correction in both experimental years. In the case of the analyzes performed in the first experimental year, the "*Additive correction relative to all samples*" developed by KOVÁCS et al. (2020) was used, while in the second experimental year, the "*Additive correction relative to reference samples*" correction was used.

During the tests, the models were built using LDA (Linear Discrimination Analysis). The models were created as described above for NIR.

Electronic nose

The AlphaSoft control and data analysis software was used for the measurements and evaluation of the recorded chromatograms. The multivariate dataset describing the aroma profile was further evaluated using principal component analysis (PCA) and linear discriminant analysis combined with principal component analysis (PCA-LDA).

3. RESULTS

In the collected Jannet samples from the experimental year 2018, a significant difference was observed in the refraction as a result of both grafting and storage.

When examining the **carotenoid content**, I could separate and identify 8 components (phytoene, phytofloene, cis-β-carotene, β-carotene, ζ-carotene, mutato-xanthin, lutein, viola-xanthin) and also calculated total carotene content. A significant difference was found in the individual carotenoids as well as the total carotene content.

In the case of **sensory evaluations**, the fermented taste and aroma showed no significant difference between the two aforementioned types, in terms of juiciness, texture and sweet aroma, the grafted Jannet was better, however in the other parameters, self-rooted treatments were stronger. Melons stored at 2 °C also showed similar results.

By performing **NIR and electronic tongue** tests, we were able to separate grafted and self-rooted fruits from each other (**Figure 1.**).

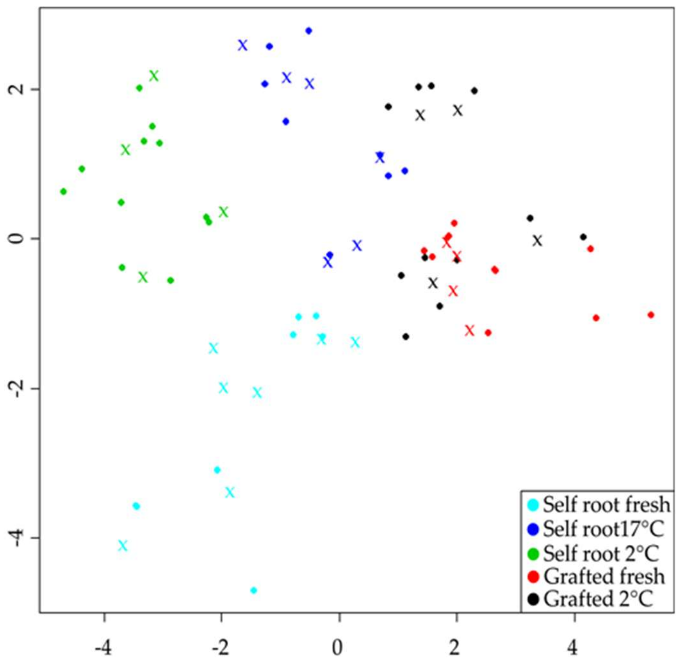

Figure 1. Jannet variety electronic tongue LDA classification model for separating the grafting and storage parameters ($p<0.05$), 2018
(In the figure ● =training, x= validation)

After performing the statistical evaluation during comparison tests between varieties, no significant difference could be detected in the **refraction** of the five melon varieties.

Similar to the previously described Jannet variety, the following 8 **carotenoids** were identified from the fresh melon samples during the comparison tests of the variety: phytoene, phytophloene, cis-β-carotene, β-carotene, ζ-carotene, mutato-xanthin, lutein, viola-xanthin, moreover we measured the chlorophyll-A and chlorophyll B content of two green-fleshed varieties. Total carotene content was significantly lower in the green-fleshed varieties, while among the orange-fleshed varieties Centro had a significantly higher total carotene content.

Regarding the **sensory evaluation** the statistical analyzis showed a significant difference in three parameters for the two green-fleshed varieties: fermented taste, aroma and flesh color (**Figure 2.**). In case of the orange-fleshed varieties fermented smell was the parameter that showed difference (**Figure 3.**).

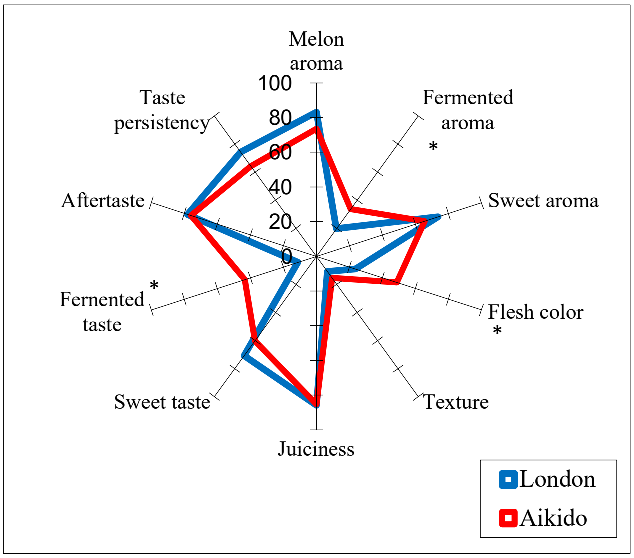

Figure 2. Sensory evaluation of Galia type melon varieties, 2018

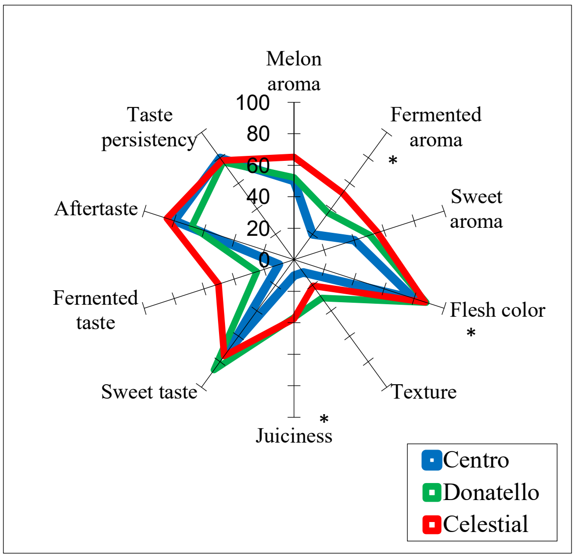

Figure 3. Sensory evaluation of Cantaloupe type melon varieties, 2018

After the evaluation, the results of the PCA model for the **electronic tongue** showed a high separation tendency (**Figure 4.**), mainly between Cantaloupe and Galia type melons. For all varieties, there was a 100% identification with **NIRS**.

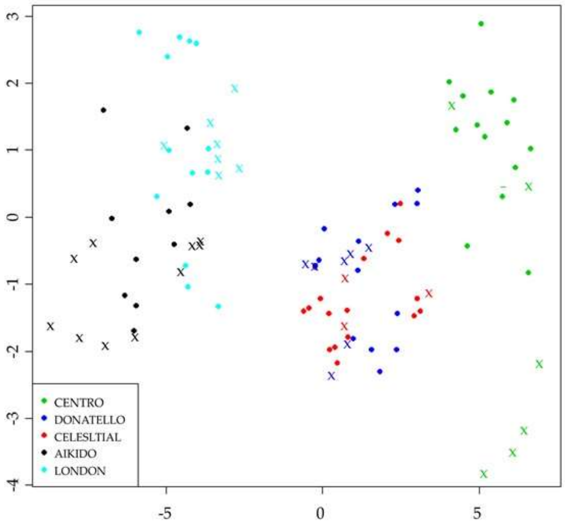

Figure 4. E-tongue LDA model dot diagram for the separation of melon varieties, ($p<0.05$), 2018

(In the figure, ●=training, x=validation)

In the second experimental year, harvesting took place a total of 10 times (July 17, 21, 23, 26, 30, and August 01, 05, 08, 12, 21). In the second experimental year in terms of the picking curve, yield per stem, and fruit quantity, self-grafted plants gave the lowest, and grafting on interspecific pumpkin rootstocks gave the highest results.

Grafting onto an interspecific rootstock slightly increased the **refraction value** of fresh fruits in the Jannet variety. In the case of the London and Sveglio varieties, it can be observed that the refraction was higher after storage than in the fresh samples, both in the self-rooted and in the interspecific combination.

Examining the **carotene content** of the Sveglio variety, out of the 9 identified compounds, lutein, the tetra-dehydro-ϒ-carotene and the β-cryptoxanthin showed differences between the individual storage parameters however, the statistical evaluation did not show a significant difference neither as an effect of grafting nor storage between the individual combinations.

Examining the **polyphenol content** of the London melon variety (**Figure 5.**), 12 flavonoids were identified (flavan-3-ols, protocatechuic acid, 3-hydroxybenzoic acid, hydroxybenzoic acid, cinnamic acid glucoside, d-catechin, naringin diglucoside, naringen, cinnamic acid, procyanidin).

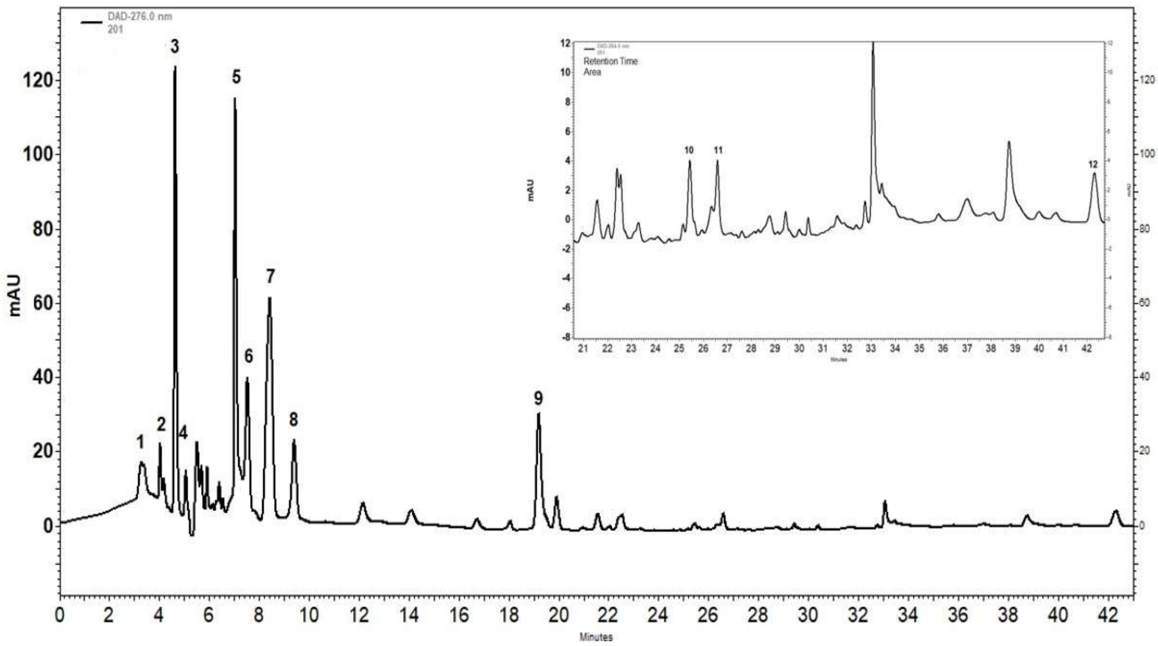

Figure 5. Chromatogram of polyphenol composition of London variety, 2019

1: flavan-3-ols 2: protocatechuic acid 3: 3-hydroxybenzoic acid 4: flavan-3-ols 5: hydroxybenzoic acid 6: cinnamic acid glucoside 7: d-catechin 8: naringin diglucoside 9: naringen 10: cinnamic acid 11: cinnamic acid 12: procyanidin

As well as the total polyphenol contents were determined. Regarding the grafting and storage treatment, the statistical evaluation did not show a significant difference in either case.

Regarding the **sensory evaluation** of Sveglio, it can be said (**Figure 6.**) that there are sensory differences between the three grafting combinations, and it can also be established that the sensory parameters of the self-rooted and self-grafted fruits are closer to each other, compared to those grafted onto the interspecific rootstock. In the sensory parameters of the Sveglio variety, the melon scent, fruit flesh color, and the sweet taste and smell differed among the grafting combinations. The London variety (**Figure 7.**) showed a difference in the flesh color and the sweet taste. For this variety, according to the reviewers, the parameters of the melons grafted onto interspecific rootstock were the highest in terms of flavor retention, sweet aroma, flesh color and sweet taste.

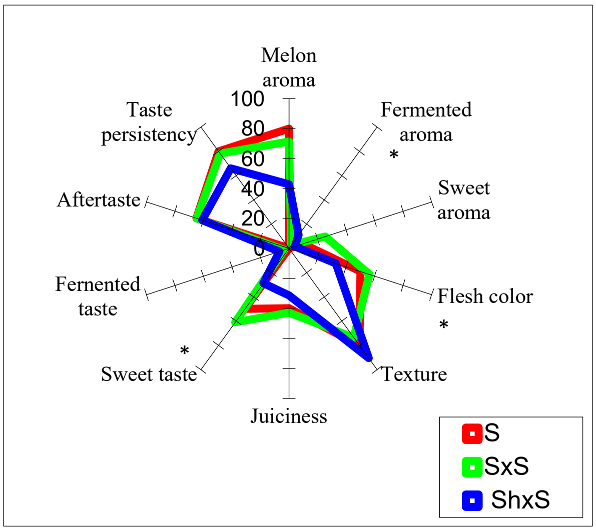

Figure 6. Sensory evaluation of Sveglio's grafting combinations, 2019

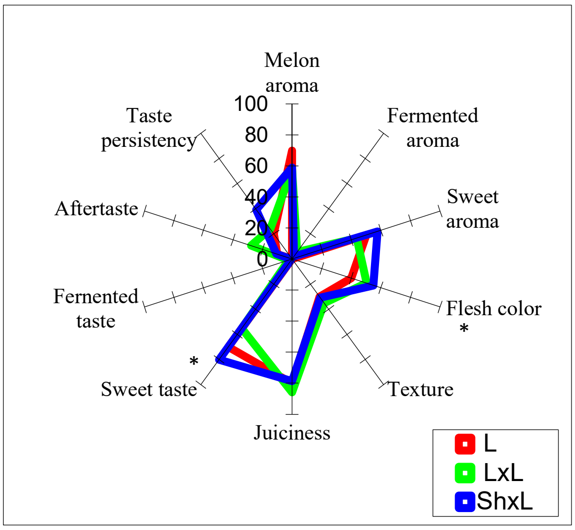

Figure 7. Sensory evaluation of London's grafting combinations, 2019

In the case of self-rooted fruits, the Brix° was between 7.2-8.7 on average, while in the grafted group it was much higher, the lowest value was 10.6 and the highest was 11.7. The refraction of self-rooted fruits showed an increasing tendency as storage progressed, except for fruits stored at room temperature or in cold storage for 5 days, where the values were the same. Regarding the trend in the **refraction** of the Jannet variety, the self-rooted fruits showed an increasing tendency as storage progressed.

Similar to the Sveglio variety, 9 **carotenoids** were identified using HPLC technique in the Jannet variety (violaxanthin, lutein, β-cryptoxanthin, tetra-dehydro-ϒ-carotene, cis-ζ-carotene, ζ-carotene, β-carotene, phytophloene, phytoene), and the total carotene content was calculated. Statistical tests on the effect of grafting showed a significant difference between the carotene content of the grafted and self-rooted fruits in the case of the 3 and 5 day storage treatments.

After completing the statistical analysis in the case of the Jannet variety, a significant difference in the **sensory parameters** was found in six of the 10 examined parameters: in the case of melon aroma and texture, the self-rooted was significantly higher, while in the case of juiciness, sweet taste, aftertaste and flavor retention, the grafted fruit was (**Figure 8.**). In contrast to the 2018 reviews, the respondents did not feel a fermented taste or smell in the case of the grafted and self-rooted fruits either.

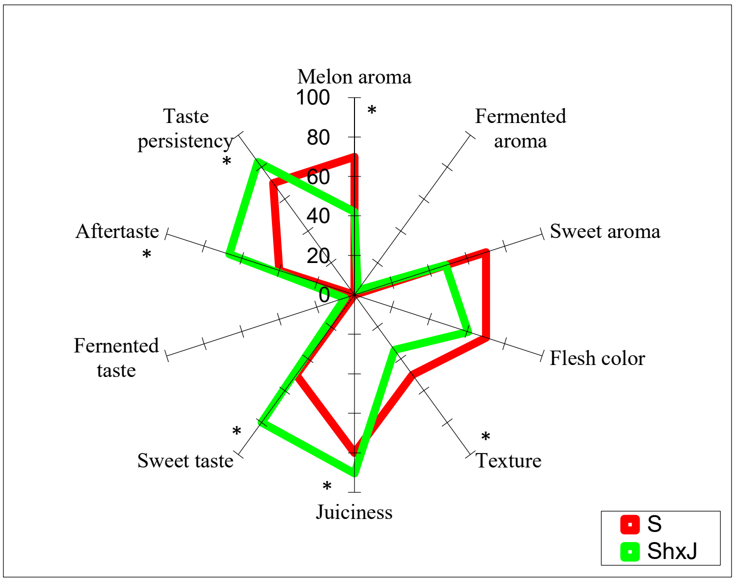

Figure 8. Sensory evaluation of Jannet melon variety, 2019

In general **NIR** was more sensitive to detect the effect of storage conditions (**Figure 9.**), while **e-tongue** was not sensitive to these changes, which suggests that the aroma and flavor changes during storage are not so strong in the case of self-rooted melons.

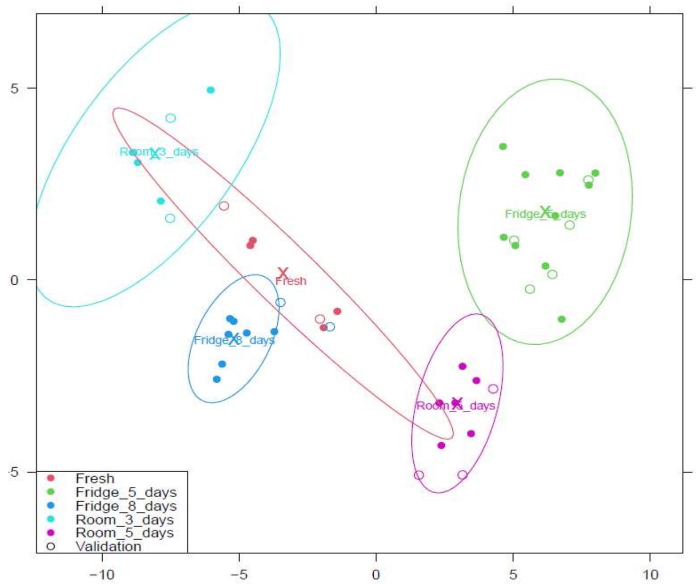

Figure 9. LDA model of London NIR measurement results for storage, 2019

From the field experiment and the grafting and storage experiment of the collected samples, the measurements with the **electronic nose** also took place in the experimental year of 2019. The evaluations were carried out with three-fold cross-validation, the solid dots shown in the figures represent the validation points, and the empty circles the validation itself. The electronic nose successfully separated the London, Sveglio and Jannet varieties (**Figure 10.**).

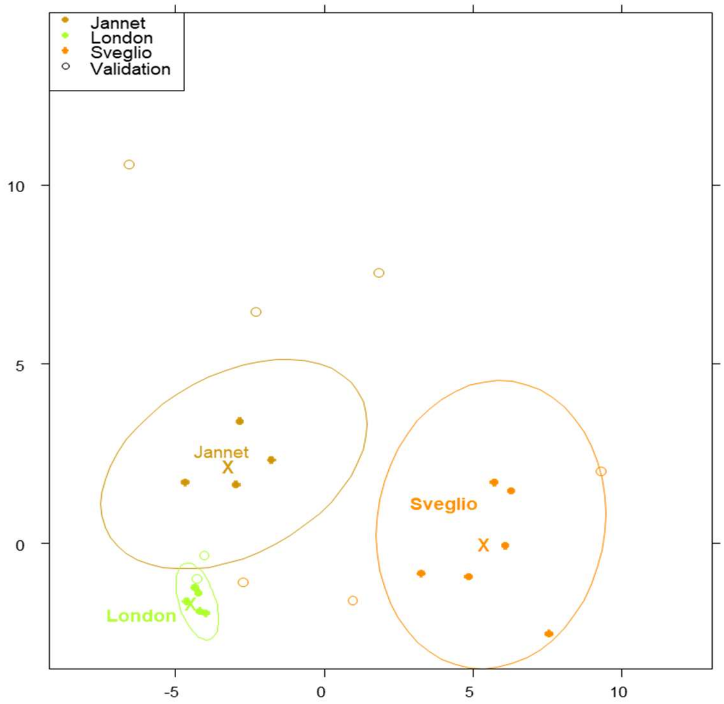

Figure 10. PCA-LDA model e-nose dot plot for variety comparison ($p<0.05$), 2019

The results were not so strong for the storage parameters. In examining the effect of grafting, also looking at all samples, there was no difference between the grafting treatments (self-rooted, self-grafted and grafted onto interspecific rootstock). The models were also built separately for the three varieties (Sveglio, London, Jannet), but in this case too, the results were not sufficiently strong.

Overall, it can be concluded that the varieties were well separated by the electronic nose, but it did not show great efficiency within the varieties. Among the three tested varieties, London showed the best results in the effect of storage, while Jannet and Sveglio showed better results in terms of grafting.

4. CONCLUSIONS, RECOMMENDATIONS

I drew the following conclusions from the melon grafting and storage experiments set up in 2018-2019, during which I measured the inner content values, yield averages and sensory parameters:

The field experiment in **2018** was destroyed due to a virus infection, so it became inconclusive from the point of view of inner content value measurements.

Regarding the **carotenoid** content, in case of lutein CONDURSO et al. (2012) reported a significant increase due to grafting however, I came to the conclusion that the lutein content was not affected by grafting, but it was reduced by storage.

According to SZAMOSI (2009), grafting can change the flavor and aroma composition in the case of melon consumers might even feel a stronger fruity taste and aroma. In my first experimental year, I also came to the same conclusion when judging the Jannet variety by **sensory evaluation**, the grafted plants had a sweeter smell, however the tasters felt the taste of the self-rooted fruits to be sweeter.

Regarding **NIR and electronic tongue** measurements, I came to the conclusion that NIR and electronic tongue are capable of separating grafted and self-rooted fruits, moreover the different storage conditions could be also differentiated by them.

In relation to the **refraction** in variety comparisons, I found that the refraction of the varieties does not show a big difference in the tests.

In terms of **carotenoid** content, it can be established that the lutein content is higher in green-fleshed melons, and β-carotene in orange-fleshed ones, thus confirming the results of ESTERAS et al. (2018) and HENAN et al. (2016).

Regarding the **sensory evaluations**, I concluded that the Celestial variety has the best sensory parameters among the tested varieties.

I came to the conclusion in the case of **NIR and electronic tongue** measurements that these devices are suitable for separating the different variety types (Galia and Cantaloupe). The electronic tongue was able to separate the two Galia type melons from each other well, and from this I conclude that it can distinguish not only the variety types, but also the varieties themselves. This supports the study by SEREGÉLY et al. (2004), according to which different types of melons can be distinguished using the NIR method.

Overall, it can be said about the measurements of the first year that the correlative analytical techniques (electronic tongue and Metri NIR) confirmed the ANOVA results with the complete separation of Cantaloupe and Galia type melons.

The combination of **electronic tongue** and **near-infrared spectroscopy** provides a rapid, non-destructive means of monitoring melon varieties and the effects of storage on melon quality.

I drew the following conclusions from the grafting and storage field experiments of the experimental year **2019**:

In terms of **yield averages per plant**, it can be said that grafting increases the amount of yield per plant in the case of the London and Sveglio varieties, while self-grafting reduces it, which supports the results of TARCHOUN et al. (2005), according to which a higher average yield can be achieved with grafting.

Regarding the **average weights**, I observed that the grafting did not change the average weights of the fruits, thereby refuting the claims of ODA (2002), LEE and ODA (2003) and SZAMOSI (2007a) that the average weight can improve as a result of grafting.

As for the **refraction**, I came to the conclusion that the refraction of the Sveglio variety increased slightly during storage, and the refraction of the fruits grafted onto the interspecific pumpkin rootstock was also higher. In the case of the London variety, the refraction of the three grafting combinations is different, but storage does not affect it to a great extent.

Regarding the **carotene content** of Sveglio, I came to the conclusion that the total carotene content is not significantly affected by grafting and storage, but the proportion of carotenoids present is.

Based on the measurements, I found that the amount of different **flavonoids** is not greatly affected by grafting nor storage.

In terms of the **sensory evaluations** in the case of the Sveglio variety I found that the interspecific pumpkin rootstock grafted combination is characterized by a weaker melon scent, fruit flesh color and a less sweet taste, thus confirming DAVIS et al. (2008) and ROUPHAEL et al. (2010) who claim that the change in different flavor and aroma substances also depends on the grafting and the choice of rootstock.

As a result of the **NIR and electronic tongue** measurements I came to the conclusion NIR was more sensitive to detect the effect of storage conditions, while e-tongue was not sensitive to these changes, which suggests that the aroma and flavor changes during storage are not so strong in the case of melons.

Regarding the **electronic nose** measurements, I found that the device is able to separate melon varieties from each other.

5. NEW SCIENTIFIC RESULTS

Based on the grafting and storage experiments set up in 2018 and 2019 and the performed examinations, I can formulate the following scientific results:

1. In melon I showed that in Cantaloupe type varieties (Sveglio, Jannet) in addition to the common carotenoids violaxanthin is also present.
2. The lutein content in Cantaloupe type melons is not affected by grafting, but storage reduces it.
3. In general NIR was more sensitive to detect the effect of storage conditions, while e-tongue was not sensitive to these changes, which suggests that the aroma and flavor changes during storage are not so strong in the case of melons.
4. NIR and the electronic tongue are suitable devices for detecting different grafting and storage combinations of melon.
5. The electronic nose is able to separate the melon varieties with high efficiency, but it does not work effectively enough to separate the grafting and storage treatments.

6. PUBLICATIONS FROM THE SUBJECT OF THE DISSERTATION

Journal articles with impact factor

Németh Dzs., Balázs G., Daood H., Kovács Z., Bodor Zs., Zaukuu J-L.Z., Szentpéteri V., Kókai Z., Kappel N. (2019): Standard Analytical Methods, Sensory Evaluation, NIRS and Electronic Tongue for Sensing Taste Attributes of Different Melon Varieties. Sensors. 5010.(19):1-19. doi:10.3390/s19225010. (IF 3.03; Q2).

Németh Dzs., Balázs G., Bodor Zs., Zaukuu J-L. Z, Kovacs Z., Kappel N. (2020): Food quality attributes of melon (*Cucumis melo* L.) influenced by grafting. Progress in agricultural engineering sciences. (16): 53-66. (IF 0.43; Q3).

In reviewed article

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