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Sensory quality attributes of sweet cherries (*Prunus avium* L.) – potential impact of acetic acid postharvest sanitation treatments

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1. Introduction, Knowledge, Objectives

In Europe, sweet cherries are popular but highly perishable fruit revealing high postharvest quality losses due to biotic impacts and, thus, have a short marketability. Major influencing factors for postharvest decay are inappropriate storage conditions, resulting in water loss and softening, and microbial spoilage. The main postharvest rots of sweet cherries are brown and gray mould caused by *Monilinia* spp. and *Botrytis cinerea*. However also other fungi such as *Alternaria alternata*, *Penicillium expansum*, *Rhizopus stolonifer* and *Cladosporium* spp. are relevant and forced early decay of fruit (Akbudak et al., 2008; Romanazzi et al., 2008).

In the past, synthetic fungicides were used during fruit growth to reduce postharvest losses. The application of some fungicides, however, resulted in the generation of resistant strains and reduced effectiveness (Holmes and Eckert, 1999). In recent years, applications of chemical (e.g. hydrogen peroxide, ethanol) and physical (e.g. heat, irradiation) postharvest treatments that influence ripening or inhibit microorganism decay increased worldwide (Bal, 2012; Karabulut, 2010; Wilkinson and Gould, 1998). On the other hand, growing consumer rejection and regulatory concerns resulted in the need of new, hazard free and inexpensive methods to maintain fruit quality and extend shelf life.

Acetic acid (AA) is a metabolic intermediate that occurs in plants and animals with fungicidal and antimicrobial properties. In Germany, AA is registered as a preservative agent and is commonly used as antimicrobial preservative or acidulant in a variety of food products (Davidson and Juneja, 1990). The successful application of AA for fruit decontamination has been e.g. demonstrated on apples, mandarins and grapes. Fumigation with AA effectively reduced moulds on sweet cherries, however in a cultivar-specific manner (Chu et al., 1999, 2001). This observation is consistent with our findings that 'Merchant' cherries were more sensitive to moulds than 'Oktavia' cherries. Applying AA at 6 mg L^{-1} prevents early decay of cherries of both cultivars without negative impacts on colour attributes and sugar/acid ratio (Hassenberg et al., 2016).

In the present study, the impact of AA on consumer related issues, i.e. sensory quality characteristics was investigated in sweet cherry fruit of the two cultivars ‘Merchant’ and ‘Oktavia’ to evaluate the practical applicability of this treatment.

2. Material and Methods

2.1 Plant material

Cherries in the ready-to eat ripening stage (BBCH 89; Meier et al., 1994) were harvested from a commercial orchard in Werder (Germany).

2.2 Treatment and sensory evaluation

Sweet cherries were randomly sorted into 5 groups with 20 fruit each. Two groups of 20 fruit each were used as controls (group I and II). The other groups were fumigated with AA (3, 6 or 9 mg L^{-1}, group III – V). Following the method of Sholberg and Gaunce (1995), modified by Hassenberg et al. (2010), cherries were fumigated with AA (100 %, Carl Roth GmbH & Co., Karlsruhe, Germany) in a sealed Perspex box (volume = 22.4 L) at 23 °C for 30 min. The box lid was fitted with a gasket and flanged to hermetically seal the chamber. Before fumigation the chamber was humidified for 30 min to water-saturate the atmosphere. Therefore, tissue paper soaked with deionized water was placed in the chamber and an axial blower (XD 8025 HS, Deqing Xinda Electric CO., LTD., Huzhou, China) ensured adequate air movement and a well-mixed atmosphere. After stopping the axial blower and removing the tissue paper, cherries were placed on a grid in the chamber, and AA at concentrations of 3, 6 and 9 mg L^{-1} (related to the chamber volume), was injected with a syringe onto a paper filter through a port in the lid. After the injection, the axial blower, located under the paper filter, was turned on again. During treatments, temperature and relative humidity were kept constant. After AA treatment, fruit were packed in batches and stored at 4 °C or 20 °C in water saturated air for 14 d.

Due to the fact that the sensation of freshness may differ between professionals and consumers (Péneau et al., 2007), the sensory test was performed by an untrained panel of 3 female and 2 male employees of ATB and of Humboldt University. The members of the panel had a mean age of 45 years (youngest member: 21 years, oldest member: 59 years). Sensory attributes were determined by descriptive test procedure according to Busch-Stockfisch (2005; choosen attributes: total impression, smell, flavour and texture) in an intensity scale, ranging from 0 (unincisive) to 100 (incisive). At treatment day, only controls (group I) were analysed; at day 5, fruit of all other groups were tested. Therefore, 30 min before the test, 10 fruit of group II – V were placed on plates at 23 °C and then tested by the panellists in a randomized manner. All data were statistically analyzed (ANOVA) with WinSTAT (R. Fitch Software, Bad Krozingen, Germany). Treatment means were compared using the Duncan’s multiple range test ($p \leq 0.05$). In the figure, data is presented as mean values.

3. Results

Cherries of the two cultivars significantly differed in their responses towards AA treatments. Exemplarily for all results, only results obtained on fruit after 5 d of storage at 20 °C will be presented and discussed in detail.

At first, the panellists evaluated the ‘overall typical impression’. ‘Merchant’ cherries of controls, and those treated with AA of 3 mg L^{-1} did not show significant differences. In contrast, cherries fumigated with 6 or 9 mg L^{-1} AA got significantly lower ratings in ‘overall typical impression’ (Fig. 1, left). ‘Oktavia‘ cherries seem to be more sensitive to AA fumigation (Fig. 1, right). Even AA application of only 3 mg L^{-1} resulted in significantly lower ratings of ‘overall typical impression’, which further declines with increasing AA concentrations.

Also for the criterion “smell” differences in the respective ratings were cultivar-specific. For ‘Merchant’ cherries, panellists found cherry smell typical irrespective of the AA concentration applied. In contrast, AA treatment resulted in a tendentious less typical cherry smell at 3 and 6 mg L^{-1} AA in ‘Oktavia’ cherries. Fumigation with 9 mg L^{-1} AA, on the other hand, caused significantly the impression of an atypical cherry smell. Furthermore, panellists noticed a pronounced AA smell even at 3 mg L^{-1} AA, however, only in ‘Oktavia’ cherries. In ‘Merchant’ cherries, virtually no AA smell was perceived by the panel, even at 9 mg L^{-1} AA.

AA treatment did not significantly affect “sweetness” of ‘Merchant’ cherries, although fruit treated with 6 mg L^{-1} AA were rated as sweeter. In ‘Oktavia’ cherries, the impression of “sweetness” was not significantly influenced by AA application, except for fruit fumigated with 9 mg L^{-1}, which were judged as less ‘sweet’. ‘Sourness’ of fruit was not affected irrespective of the cultivar and of the AA concentrations used.

All ‘Merchant‘ cherries, treated with AA, were rated less “firm” and less “crunchy” than controls, irrespective of the concentrations used. In contrast, only ‘Oktavia‘ cherries treated with AA 9 mg L^{-1} AA were assessed significantly softer and less crunchy than the other fruit.

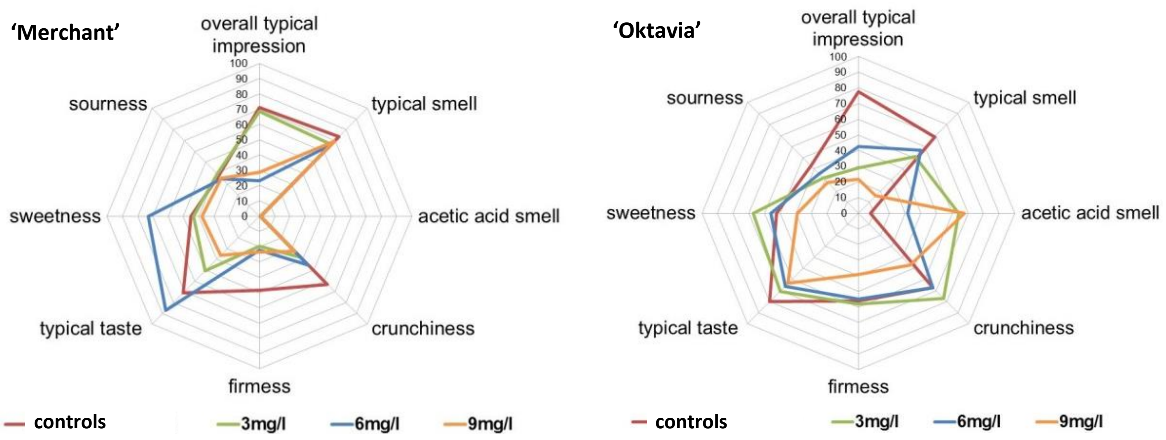

Figure 1: Sensory evaluation (scale: 0 (unincisive) to 100 (incisive) of ‘Merchant’ (left) and ‘Oktavia’ (right) cherry fruit after five days of storage at 20 °C.
Before storage, cherries were fumigated with AA at concentrations of 0, 3, 6 or 9 mg L-1 AA for 30 min.

4. Discussion

Only recently, it was shown that fumigation of strawberries with AA successfully prevented microbial rotting of fruit without negative effects on relevant quality parameters; it let, however, to undesired off-flavour and off-odour in treated fruit (Hassenberg et al., 2010, 2011). Similarly, AA also proved to be effective in reducing microbial loads in cherries (Hassenberg et al., 2016). Results of the sensorial evaluation presented here showed that fumigation with up to 3 mg L-1 AA did not negatively affect the typical overall impression, flavour and smell of 'Merchant' fruit after storage at 20 °C for 5 d to simulate typical conditions at consumer stage. However, this response was largely cultivar-specific because 'Oktavia' cherries were much more sensitive to AA treatment. Even low AA concentration resulted in undesired sensory quality changes, i.e. insufficient total impression, and atypical acetic acid smell and flavour.

Generally, 'Oktavia' is characterised as middle to late-maturing cultivar with a low cracking susceptibility (Bundessortenamt, 1997), in contrast to early-maturing, cracking-susceptible 'Merchant' cherries. Cracking susceptibility, beside other features, includes the facilitated formation of micro-cracks in the fruit cuticle (Børve et al., 2000). These, in turn, might allow easy absorption of AA by diffusion of it into and accumulation of AA in the fruit. However, AA fumigation resulted in a lower acceptance of the fruit by panellists mainly in 'Oktavia' cherries. Thus, the reasons for these diverging responses to AA treatments are not clearly understood and might be attributed to differences in their specific chemical-physical membrane properties, which need further investigation.

5. Conclusions

It has been previously shown that fumigation of sweet cherries with acetic acid vapour (AA) may reduce the risk of microbial rot (Hassenberg et al., submitted). However, evaluation of the AA treatment effects on sensorial quality revealed that in 'Merchant' cherries application of acetic acid at 3 mg L- 1 can be recommended. In contrast, for 'Oktavia' fruit, even these low concentrations resulted in undesired off-flavour and off-odour, thus AA fumigation has to be excluded as postharvest sanitation treatment.

6. Literature

Akbudak, B., Tezcan, H. and Eris, A. (2008). Effect of low-dose gamma irradiation on the quality of sweet cherry during storage. Italian Journal of Food Science, 20: 383-392.

Bal, E. (2012). Effects of essential oil treatments combined with hot water treatment on improving postharvest life of sweet cherry. Fruits, 67: 285-291.

Balbontín, C., Ayala, H., Bastias, R., Tapia, G., Ellena, M., Torres C., et al. (2013). Cracking in sweet cherries: A comprehensive review from a physiological, molecular and genomic perspective. Chilean Journal of Agricultural Research, 73: 66-72.

Børve, J., Sekse, L., Stensvand, A., (2000). Cuticular fractures promote postharvest fruit rot in sweet cherries. Plant Diseases 84: 1180-1184.

Bundessortenamt (1997). Beschreibende Sortenliste Steinobst. Landbuch Verlagsgesellschaft, Hannover.

Busch-Stockfisch, M. (2005). Praxishandbuch Sensorik in der Produktentwicklung und Qualitätssicherung. Behr's Verlag GmbH & Co.KG, Hamburg.

Chu, C.-L., Liu, W.-T., Zhou, T. and Tsao, R. (1999). Control of postharvest gray mold rot of modified atmosphere packaged sweet cherries by fumigation with thymol and acetic acid. Canadian Journal of Plant Science, 79(4): 685-689.

Chu, C.-L., Liu, W.-T. and Zhou, T. (2001). Fumigation of sweet cherries with thymol and acetic acid to reduce postharvest brown rot and blue mold rot. Fruits, 56: 123-130.

Davidson, P.M. and Juneja, V.K. (1990). Antimicrobial agents. In: Branen, A.L., Davidson, P.M., & Salminen, S. (eds.): Food additives. Marcel Dekker, New York, 83-137.

Hassenberg, K., Geyer, M. and Herppich, W.B. (2010). Effect of acetic acid vapour on the natural microflora and *Botrytis cinerea* of strawberries. European Journal of Horticultural Science, 75: 141–146.

Hassenberg, K., Geyer, M., Ammon, C. and Herppich, W.B. (2011). Physico-chemical and sensory evaluation of strawberries after acetic acid vapour treatment. European Journal of Horticultural Science, 76: 125–131.

Hassenberg, K., Schuhmann, F., Förster, N., Herppich, W.B., Geyer, M., Ulrichs, U. and Huyskens-Keil, S. (2016). Acetic acid is a promising postharvest treatment to improve hygienic conditions, retain characteristic quality attributes and prolong marketability of sweet cherries. Book of Abstracts of the III International Symposium on Horticulture in Europe – SHE 2016, Chania, Crete (Greece), 17.-21.10.2016, pp. 114-115.

Hassenberg, K., Schuhmann, F., Förster, N., Herppich, W.B., Geyer, M., Ulrichs, U. and Huyskens-Keil, S. (2018). Effects of acetic acid vapour on the microbial status of 'Merchant' and 'Oktavia' sweet cherries (*Prunus avium* L.). Food Control, submitted.

Holmes, G.J. and Eckert, J.W. (1999). Sensitivity of *Penicillium digitatum* and *P. italicum* to postharvest citrus fungicides in California. Phytopathology, 89: 716.

Karabulut, O.A. (2010). Controlling postharvest diseases of sweet cherry. Stewart Postharvest Review, 6(1): 1-6.

Meier, U., Graf, H., Hack, H., Hess, M., Kennel, W., et al. (1994). Phänologische Entwicklungsstadien des Kernobstes (*Malus domestica* Borkh und *Pyrus communis* L.), des Steinobstes (*Prunus*-Arten), der Johannisbeere (*Ribes*-Arten) und der Erdbeere (*Fragaria* x *ananassa* Duch.). Nachrichtenblatt des Deutschen Pflanzenschutzdienstes 46, 141-153.

Péneau, S., Brockhoff, P.B., Escher, F. and Nuessli, J. (2007). A comprehensive approach to evaluate the freshness of strawberries and carrots. Postharvest Biology and Technology, 45: 20–29.

Romanazzi, G., Nigro, F. and Ippolito, A. (2008). Effectiveness of a short postharvest treatment to control postharvest decay of sweet cherries and table grapes. Postharvest Biology and Technology, 49: 440-442.

Sholberg, P.L. and Gaunce. A.P. (1995). Fumigation of fruit with acetic acid to prevent postharvest decay. HortScience, 30: 1271–1275.

Wilkinson, V.M. and Gould, G.W. (1998). Food irradiation: A reference guide. Cambridge: Woodhead Publishing.