Influence of hot water treatment on different quality parameters of apples during storage

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Summary

Organically farmed apples of the cultivar ‘Topaz’ were hot water treated (55 °C, 2 minutes) immediately after harvest and then placed in cold storage (1 °C, air) for 15 weeks. The influence of hot water treatment on peel firmness, titratable acidity, antioxidant capacity and total phenolic content, as well as some sensory properties during storage was investigated. Heat-treated apples softened less rapidly and had a higher antioxidant activity than untreated apples. The thermal treatment did not influence the antioxidant capacity and its total phenolic content. There was no significant sensory difference between treated and untreated apples prior to the beginning of maturity for consumption.

Introduction

Seeing organically produced apples as a challenge because completing effective synthetic fungicides to delay or prevent fungal infections during storage is not permitted. The most damaging post-harvest disease is the Glomerosporella which can occur in over 50% of the fruit in storage. Our institute The Institute of Chemistry and Biology has been working since 1999 on this topic and has been doing research on the effects of hot water treatment on Glomerosporella on organically produced apples (cultivar ‘Topaz’). Below 5% of the apples were infected after a storage time of 4 months, irrespective of storage conditions (cold storage or controlled atmosphere storage). In contrast, more than 56% of the untreated apples stored at 1 °C in air showed the disease, and even 24% of these stored under controlled atmosphere showed the typical Glomerosporella NR (Trierweiler et al., 2003). The reason for this satisfying reduction is probably the temperature sensitivity of the fungus Glomerosporella.

Post-harvest heat treatment is a known method used for disinfestation and sterilization of a variety of plants, e.g. corn, flowers, and vegetables. Hence, there are studies concerning the influence of thermal treatment on the physiology and the biochemistry of plants. Lewis et al. (1990) reported that heat treated ‘Golden Delicious’ apples (38 °C, 6 days) softened more slowly than untreated fruits. There was also a faster decline in titratable acidity by heat treated apples and an increased respiration. The aim of the present study was to investigate the influence of the thermal treatment on different quality parameters like peel firmness, titratable acidity, antioxidant capacity, total phenolic content, and sensory quality of apples (cultivar ‘Topaz’).

Material and methods

For the investigations apples of the cultivar ‘Topaz’ were received directly from an organic farmer and dipped into hot water (55 °C) 2 minutes) by using equipment which holds 20 kg fruit boxes. After the thermal treatment in October 2004 the fruits were stored at 1 °C in air (relative humidity 95%). The dipped and the control (untreated) apples were examined every three weeks over a period of 15 weeks. For each type of sample and analysis, triplicate analyses were done. Each sample consisted of 3 apples.

Firmness

Fruit and peel firmness were evaluated with a TA.XT2 Texture Analyser (Stable Micro Systems). Apples were penetrated by a 3.14 mm2 diameter-rod, the downward distance was set at 12.5 mm. Firmness was expressed as kg/cm2.

Titratable acidity

The sum of titratable acidity was determined by the use of poten-


tiometric titration to pH 8.1 with 0.1 N NaOH. The concentration of NaOH per 10 g fruit was multiplied with factor 0.67 for molarity.

Antioxidant capacity

The ABTS method described by Mishra et al. (1990) was used for the determination of the antioxidant capacity. 100 g of fruit were mixed with 10 ml bidistilled water and 10 ml hexane in a Waring Blender and afterwards centrifuged at 800 g for 15 minutes. The water and fat soluble supernatant was saved. A solution of 5 mM ABTS (1,2,3-Amino-bis-3-ethylbenzothiazoline-6-sulfonic acid) was diluted for the hydrophilic antioxidant capacity in 5 mM sodium phosphate buffer pH 7.4 until absorbance readings reached a value of 1.5 at 755 nm. For the lipophilic antioxidant capacity 5 mM ABTS solution was diluted in ethanol and adjusted to an absorbance of 0.7 at 755 nm. The system was standardized by means of 100 μl of 0.4 mM Trolox (6- Hydroxy-2,5,7,8-Tetramethylchromane-2-

carbonyl acid). The Trolox Equivalent Antioxidant Capacity was calculated as the concentration of Trolox in phosphate buffer that has an antioxidant potential equivalent to the same volume of sample after a reaction time of 15 minutes in the ABTS solution. The amount of hydrophilic and lipophilic antioxidant capacity was added together for the whole antioxidant capacity.

Total phenolics

Total phenolics were determined using the Folin-Ciocalteu reagent. Complete et al. (1995). 10 g homogenized fruit (Rübe-Mixer 400) were dispersed (Ultra-Turrax) in about 25 ml malt extract and mixed off in a fusing bottle over a Buchner funnel. The filter residue was again dispersed with about 25 ml methanol and sucked off. This procedure was repeated once. The filtrate was collected in 100 ml graduated flask and adjusted with methanol to 100 ml. All chemicals were prepared in 95% ethanol. 125 μl of the extract were mixed with 425 μl of Folin-Ciocalteu reagent (previously diluted 10:63 with
Sensory evaluation

A noticeable sensory difference between the heat-treated and untreated apples was measured with the "mouth-out-of-the-mouth" (MOM) test (Saxton et al., 1991, p. 67) by a trained sensory panel. Each panelist was given 5 coded samples of halved apples. Two of the samples belonged to one type (e.g., heat treated) and three to the other (e.g., untreated). Panelists were asked to taste each product and select the two samples that were different from the other three. Presentation design was randomized. The test form was designed with the sensory program "Flav Acqu 2.0 M". The data interpretation was done with "Proc Calibration 2.10.0 D".

Statistics

For cultivation 60 apples were placed in storage. Measurements were done at 3 weeks after period of 15 weeks. The results reported in this work are the averages of three measurements. For each measurement a randomised sample of three apples was taken. Data are presented as mean and standard deviation, and statistical analysis was carried out using the paired Student t-Test. Differences were considered to be significant if p<0.05.

Sensory differences among treatments were evaluated using the binomial test with the α risk. The probability that S samples are equal or similar was tested by the χ²-test, too.

Results and discussion

The changes of peel firmness of heat treated and untreated apples (cold storage) during 15 weeks of storage are shown in Fig. 1. At the beginning and after 3 weeks of storage there was no difference between the dipped apples and the control samples. After 6 weeks of cold storage, however, the peel of untreated apples softened faster. According to the measurements carried out after 9 (p<0.05), 12 (p<0.001) and 15 weeks, the rate of softening was slower in the water treated apples than in untreated ones. Changes in the exocarp of heat treated apples may be responsible for this observation. Llorca et al. (1996) reported that untreated apples showed in many areas a network of surface cracks in contrast to heat-treated fruits where this structure was much less apparent. Infra-red photographs showed that directly after hot water treatment apples treated themselves to a downward distance of 5 mm to about 30°C (Schmittmeyer et al., 2003). It is conceivable that in small regions the flesh is firmer because of the heat treatment. Indeed, an increase of flesh firmness was not found but possibly the resistance of the peel was higher because of a firmer flesh in the outer layer of the treated apple. This temperature fluctuation, metabolites of the respiratory metabolism, were also investigated in this study (Fig. 2). By the sixth week of storage the decrease in organic acids in both samples was nearly at the same level. From the ninth week on a gradual decline of titratable acidity in the hot water treated apples could be observed. After three months of storage no difference was significant (p<0.05). Our Results agreed with other publications in which heated fruits were lower in titratable acidity (Aiquet et al., 2005; Llorca et al., 1998). A possible reason is the beginning of the decarboxylase which is associated with an increase in respiratory activity, and hence, with a decline in the involved metabolites.

![Graph showing changes in titratable acidity during storage](image)

There is a growing interest in antioxidants because of their radical scavenging activities in the human body. Therefore, the antioxidant capacity and the total phenol content was examined. The results are shown in Fig. 3. Over a period of 15 weeks in cold storage, the antioxidant capacity of hot water treated and untreated apples was found to be nearly constant and at the same level. As a result, it can be said that the thermal treatment of apples did not influence the antioxidant capacity. Similar results were found for total phenolics.

The content did not differ in the two samples. For investigation of a sensory difference between heat water treated and untreated apples the "two-out-of-three" test was selected. After 2 weeks of cold storage the first test was carried out. The panelists could significantly distinguish between the two samples (p<0.05).

The proximate test of similarity shows that 35.6% of a universe of treated and untreated apples. With the following tests the panelists, however, could not distinguish
between the samples after 10 and 15 weeks of storage. This leads to the conclusion that the hot water treated and untreated apples are equal or similar.

The detected differences at the beginning of the cold storage period were not based on a difference in the aromatic ratio, because no differences were observed between the hot water treated and untreated apples. A possible reason for the examined findings may be related to changes in synthetic of aroma compounds which were not determined in this work.

References


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