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The effect of storage and processing on vitamin C content in Japanese quince fruit

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ABSTRACT

Stability of vitamin C in stored fruit and sugar syrup of Japanese quince was tested. Vitamin C was measured in the fruit at harvest and after a few weeks of storage under normal atmospheric conditions. Sugar syrup obtained from the fruit was subjected to analysis before and after pasteurisation, and after several weeks of storage. The *Chaenomeles* genotypes tested were valuable in terms of vitamin C content. Storage significantly reduced the vitamin C content in the fruit, by 20% on average after 2 weeks of storage. The mechanical treatment and preparation of sugar syrup decreased the vitamin content by nearly two-thirds when compared with the fruit at harvest. Pasteurisation and storage of the sugar syrup contributed to further losses of vitamin C, reducing it to a very low level.

Key words: ascorbic acid, *Chaenomeles japonica*, cold storage, pasteurisation, sugar syrup

INTRODUCTION

The Japanese quince (*Chaenomeles japonica* (Thunb.) Lindl. ex Spach; Rosaceae) is one of the oldest cultivated plants and was used in Chinese medicine 3000 years ago. This dwarf shrub originated from East Asia and was gradually cultivated in other parts of the world. Nowadays, there is a renewed interest in this minor fruit crop, although the fruit is sometimes misidentified as quince (*Cydonia oblonga* Mill.) (Rop et al. 2011). Cultivation of Japanese quince is popular mainly in the Baltic countries: Latvia, Lithuania, Estonia, Finland, Sweden and Poland (Rumpunen 2002, Kviklys et al. 2004, Ruisa and Rubauskis 2004). Breeding programmes of *Chaenomeles* are carried out in many countries of Eastern and Northern Europe (Mezhenskij 1996a). The crop is propagated by seeds, which are extremely heterogeneous, by softwood cuttings or by budding on stocks of other plants of the subfamily Maloideae (Mezhenskij 1996b). Japanese quince, as a pome-type fruit, has many seeds in the core.

There is no specific maturity index of the fruit and it is harvested when it is yellow and has developed a pleasant aroma. It is considered a climacteric fruit although the very high firmness of the fruit at harvest is prolonged during storage and no softening of the fruit is observed. For modern organic horticulture, *Chaenomeles* is a valuable crop with resistance to pests, annual fruit set, high yield and suitability for machine cultivation. Japanese quince is also valuable in terms of high levels of beneficial health nutrients and minerals (Tarko et al. 2010). Owing to the high amounts of pectin compounds (1.3%) (80% protopectin), organic acids, mainly malic and

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citric acids (7.2%), at levels 10 times that of apples, a small amount of soluble solids (3.1%) and specific fruit firmness readings (> 15 kG 1 cm^{-2} at a tip of 8 mm in diameter), bitterness and astringency, the fruit is not suitable for fresh consumption (Skrzyński and Bieniasz 2009, Tarko et al. 2010). It is considered that fruit for direct consumption should contain at least 10 times more sugars than organic acids, whereas for *Chaenomeles* this ratio is about 2-3 (Lesińska 1986, Skrzyński and Bieniasz 2009, Tarko et al. 2010). The high levels of many organic acids, pectin substances, aromatic compounds, vitamin C and phosphorus (P) make the Japanese quince fruit a valuable raw material for processing by the food industry (Lesińska and Kraus 1996, Rumpunen and Kviklys 2003, Seglina et al. 2009). This fruit is often used as an additive to preserves of other fruit, thus improving their processing, taste and health properties (Wojdyło et al. 2008, Nawirska-Olszańska et al. 2010, 2011). The latest studies have shown that Japanese quince juice can inhibit the browning of freshly cut pear slices during nine storage days (Krasnova et al. 2013).

The Japanese quince fruit could be a very important component of functional foods. Total phenolics content and high antioxidant activity suggest that this fruit is a valuable source of bioactive substances (Rubinskienė et al. 2014), similar to quince (*Cydonia oblonga*) (Karadeniz et al. 2005), cornelian cherry (*Cornus mas* L.) (Güleryüz et al. 1998) or sea buckthorn (*Hippophaë rhamnoides* L.) (Heinäaho et al. 2008, Piłat et al. 2012, Rop et al. 2014). However, the processing technology reduces the levels of certain compounds, especially vitamin C (Lee and Kader 2000, Nawirska-Olszańska et al. 2011). Vitamin C has limited stability; in a water solution it is sensitive to heating, especially in the presence of oxygen and copper, iron and silver ions. Breakdown of this vitamin is observed in alkaline and neutral environments (Lee and Kader 2000). The breakdown of L-ascorbic acid is a result of processes such as heating, ultraviolet radiation or the use of preservatives (Santos and Silva 2008). Compared with the fruit of *Cydonia oblonga* syn. *Cydonia vulgaris* L. (Gunes 2003) or cornelian cherry, little is known about *Chaenomeles* fruit physiology, chemical content or the required storage conditions, and the effect of fruit processing on the retention of compounds that are important for human health, including antioxidants such as vitamin C. The aim of the current study was to assess the retention of vitamin C in the fruit and syrup of Japanese quince after storage and processing.

MATERIAL AND METHODS

Plant material

Chaenomeles japonica shrubs were grown at the Experimental Station of the Agricultural University, near Kraków, Poland, 270 m above sea level, 50°09'N and 19°56'E. Mean total precipitation was 663.3 mm, average annual temperature was 8°C. The shrubs had been organically grown from seedlings since 2004 at a spacing of 2.0 × 1.2 m. The plants were grown on a brown soil originated from loess, pH 6.3. The plants were mulched with black woven agrotextile (weight: 90 g m^{-2}) for weed

Figure 1. Morphology of the chaenomeles fruit

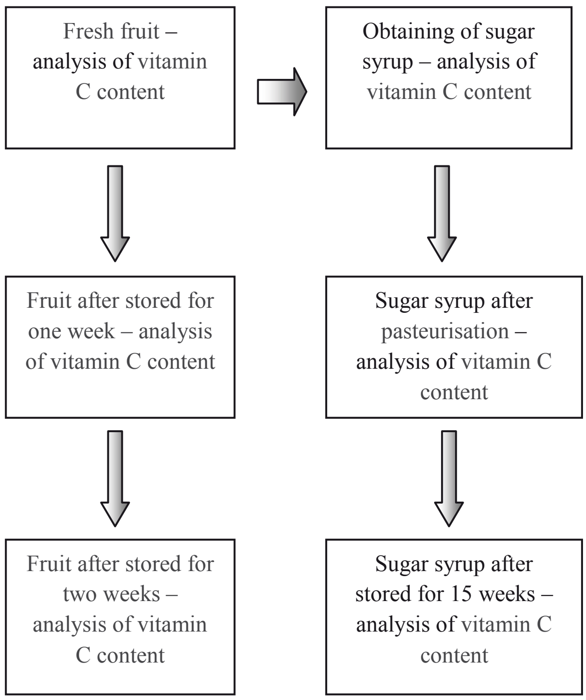

Figure 2. Schematic diagram of the experiment

control. Fruit of nine genotypes was picked in 2009 -2010. According to Skrzyński and Bieniasz (2009), the weight of the fruit ranged from 36.1 g to 70.5 g. The majority of the fruit was of a round shape (Fig. 1), only some genotypes had oblong or ribbed fruit. It has been found that the total soluble solids content ranged from 7.5 to 8.4 Brix%, titratable acidity ranged from 1.96 to 2.07 mg 100 g^{-1} fresh mass, while the ratio of soluble solids and titratable acidity was very low and ranged from 3.1 to 5.5, indicating the usefulness of Japanese quince fruit for processing (Skrzyński and Bieniasz 2009).

The fruit was harvested when the fruit skin had turned from green to yellow. Samples of the fruit (3 kg) were stored in plastic containers, four containers as four replicates for each treatment, for 1 and 2 weeks at 7ºC and 70% relative humidity (RH). Some of the fruit (800 g) was chopped with a ceramic knife and mixed with sucrose at a ratio of 1:0.5 and left for 24 h in darkness at 22-23ºC to produce syrup by the osmotic method. The syrup obtained was pasteurised in glass jars (250 ml) in a water bath at 90ºC for 20 minutes. Afterwards, the syrup in the glass jars was stored at a room temperature of 18ºC for 15 weeks in darkness (Fig. 2).

Analysis of vitamin C content in fruit and sugar syrup

Vitamin C (ascorbic acid) content in fruit was analysed immediately after the fruit harvest, and after 1 and 2 two weeks of fruit storage. Fruit samples of 800 g were chopped and the seeds

Table 1. Effect of storage period on vitamin C content (mg 100 g^{-1}) in Japanese quince fruit in the year 2009

Genotype	Time of analysis	Vitamin C content	Mean for genotype
A2	At harvest	243.0 j*	206.8 d
	After one week of storage	196.4 i	
	After two weeks of storage	180.0 h	
A3	At harvest	136.0 fg	118.2 b
	After one week of storage	131.5 e-g	
	After two weeks of storage	87.0 a-c	
A4	At harvest	96.5 a-c	88.1 a
	After one week of storage	87.2 a-c	
	After two weeks of storage	80.5 a-c	
A9	At harvest	157.5 gh	146.7 c
	After one week of storage	145.3 fg	
	After two weeks of storage	137.3 fg	
A10	At harvest	130.0 d-f	107.6 b
	After one week of storage	103.9 b-d	
	After two weeks of storage	88.8 a-c	
B2	At harvest	90.5 a-c	76.9 a
	After one week of storage	71.1 a	
	After two weeks of storage	69.3 a	
B3	At harvest	102.0 bc	87.6 a
	After one week of storage	86.3 a-c	
	After two weeks of storage	74.4 a	
B6	At harvest	90.0 a-c	77.0 a
	After one week of storage	71.0 a	
	After two weeks of storage	70.1 a	
B11	At harvest	107.0 c-e	89.1 a
	After one week of storage	82.1 a-c	
	After two weeks of storage	78.3 ab	
Mean for time of analysis	At harvest	128.1 c	
	After one week of storage	108.3 b	
	After two weeks of storage	96.3 a	

*Mean values followed by the same letter are not significantly ($p < 0.05$) different according to Tukey's multiple range test were removed. The juice was extracted using a commercial juice extractor. Similarly, the analysis of vitamin C content in sugar syrup was performed three times: before pasteurisation, 1 day after pasteurisation and after 15 weeks of storage. Vitamin C was analysed according to the method based on the oxidation of L-ascorbic acid to dehydroascorbic acid in an acid medium with a blue dye of 2.6-dichloroindophenol, followed by the reduction of the dye to the colourless form, which turns red at pH 4.2 (PN-A-04019 1998).

Statistical analysis

The analysis was performed in four replicates (n = 4). Data was subjected to a two-way (genotype and storage) analysis of variance (ANOVA) using Statistica version 10.0. Post-hoc multiple comparisons were determined by Tukey's Honestly Significantly Different (HSD) test with the level of significance at $p < 0.05$.

RESULTS

In Garlica Murowana, where the Japanese quince bushes were cultivated, the weather conditions varied in both years. The annual sum of precipitation in 2009 (1000 mm) was lower than that in 2010 (1146 mm), while the average annual temperature in 2009 (8.6°C) was higher than the value in 2010 (8.1°C) (data from Garlica Murowana meteorological station).

Table 2. Effect of storage period on vitamin C content (mg 100 g^{-1}) in Japanese quince fruit in the year 2010

Genotype	Time of analysis	Vitamin C content	Mean for genotype
A2	At harvest	172.6 t*	164.1 h
	After one week of storage	163.9 s	
	After two weeks of storage	155.8 r	
A3	At harvest	148.9 p	134.7 g
	After one week of storage	142.5 o	
	After two weeks of storage	112.7 n	
A4	At harvest	82.1 hi	73.0 c
	After one week of storage	76.0 ef	
	After two weeks of storage	60.8 a	
A9	At harvest	110.9 n	99.5 f
	After one week of storage	99.4 m	
	After two weeks of storage	88.1 jk	
A10	At harvest	73.1 de	70.8 b
	After one week of storage	71.2 c	
	After two weeks of storage	68.0 b	
B2	At harvest	86.0 ij	80.4 d
	After one week of storage	81.6 gh	
	After two weeks of storage	73.6 de	
B3	At harvest	92.1 l	90.1 e
	After one week of storage	90.5 kl	
	After two weeks of storage	87.6 jk	
B6	At harvest	74.7 d-f	67.8 a
	After one week of storage	66.4 b	
	After two weeks of storage	62.4 a	
B11	At harvest	88.1 jk	79.5 d
	After one week of storage	78.3 ab	
	After two weeks of storage	72.7 de	
Mean for time of analysis	At harvest	103.1 c	
	After one week of storage	96.6 b	
	After two weeks of storage	86.8 a	

*Explanations: see Table 1

Vitamin C content in fresh and stored Japanese quince fruit

The vitamin C content in Japanese quince fruit at harvest varied among the genotypes (Tabs 1 and 2). High amounts of vitamin C were found for six genotypes (A2, A3, A9, A10, B3, B11) in the first year (Tab. 1) and only for three genotypes (A2, A3, A9) in the second year of the study (Tab. 2). In both years, the most valuable genotype was A2, in which the vitamin C content was detected at a level of 243.0 mg 100 g^{-1} in the first, and 172.6 mg 100 g^{-1} in the second year. After fruit storage, no symptoms of browning or decay were observed. The length of the storage period significantly affected the vitamin C content in the fruit. One and two weeks' fruit storage resulted in a decrease in the vitamin C content in all the genotypes, compared with the levels at harvest time. However, for a few genotypes some regularity was observed: the higher the vitamin content at harvest time, the higher the content after storage. This applied to the following genotypes: A2, A3 and A9. In both years, the significantly lowest level of vitamin C was found after two weeks of storage.

During the storage of Japanese quince fruit, losses of the original vitamin C were observed. The loss level depended both on the genotype and the length of storage period. After one week of storage, the losses ranged from 3.5% (genotype A3) to 23.3% (genotype B11) in 2009 (Fig. 3) and from 1.7% (genotype B3) to 11.1% (genotypes B6 and B11) in 2010 (Fig. 4). The longer storage period (two weeks) of fresh fruit contributed to greater losses of the vitamin. The losses ranged from 12.8% (genotype A9) to 36.0% (genotype A3) in 2009 and from 4.9% (genotype B3) to 25.9% (genotype A4) in 2010. The mean value of vitamin C losses was 15.5% after one week and 24.3% after two weeks in the first year, while the corresponding values in the second year were 6.3% and 15.8%.

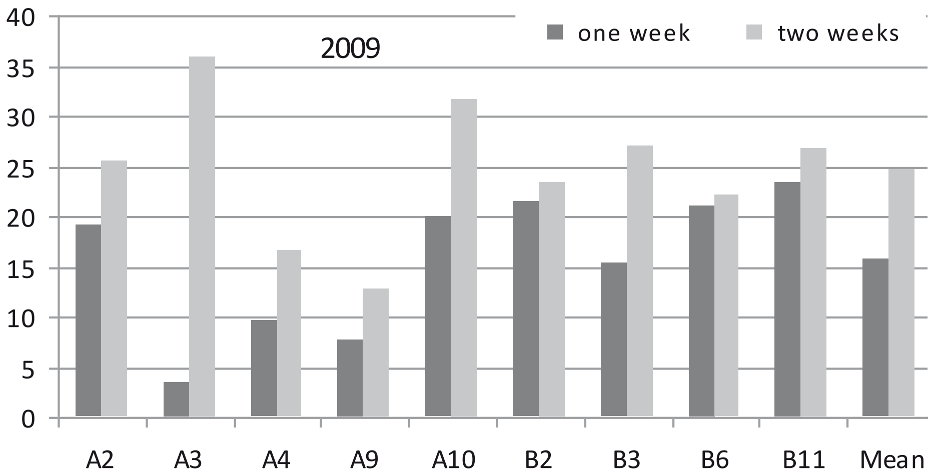

Figure 3. Losses (%) of vitamin C in *Chaenomeles* fruit after storage in the year 2009

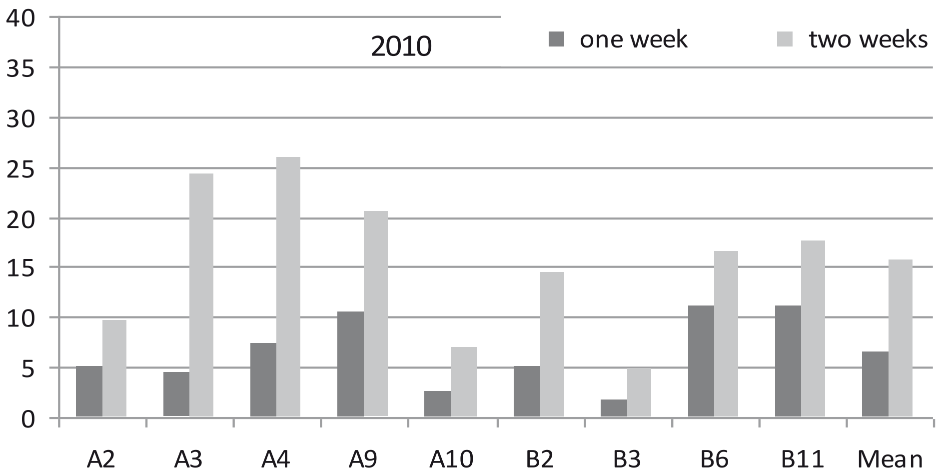

Figure 4. Losses (%) of vitamin C in *Chaenomeles* fruit after storage in the year 2010

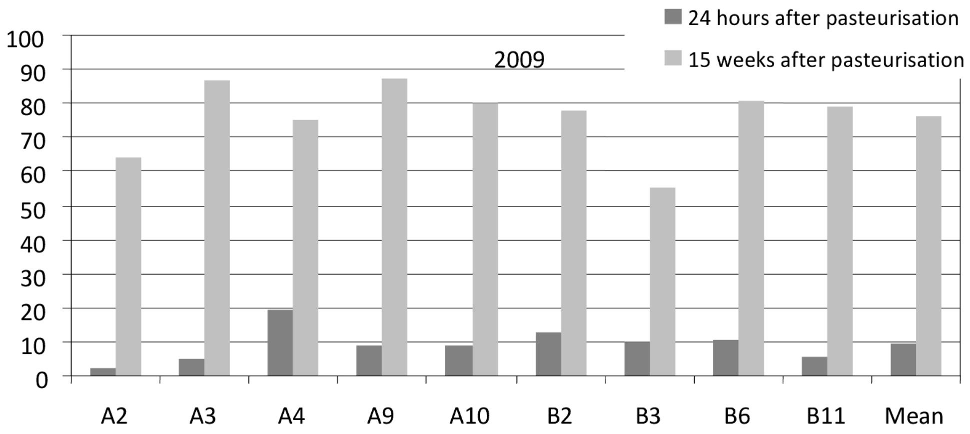

Figure 5. Losses (%) of vitamin C in chaenomeles sugar syrup in the year 2009

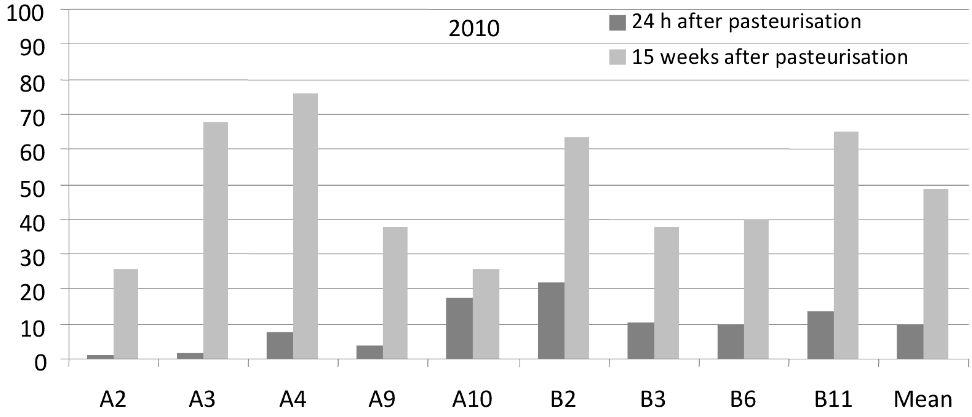

Figure 6. Losses (%) of vitamin C in chaenomeles sugar syrup in the year 2010

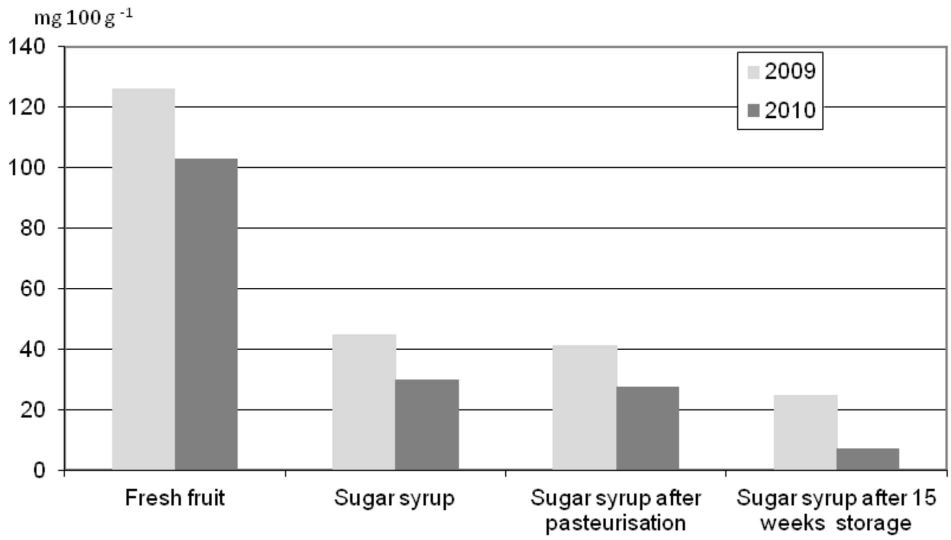

Figure 7. Comparison of vitamin C content (mg 100 g^{-1}) in Japanese quince fresh fruit and after processing in the years 2009 and 2010

Vitamin C content in sugar syrup

The mechanical treatment (chopping) and the process of obtaining syrup from sugar caused the vitamin C content to decrease to nearly a third (depending on the year of the study) compared with the content after fruit harvest (Tabs 1-4). After pasteurisation, the vitamin content was significantly lower than that of the obtained syrup. Furthermore, the long-term storage of pasteurised sugar syrup affected the vitamin content very strongly.

Table 3. Effect of storage period on vitamin C content (mg 100 g^{-1}) in Japanese quince sugar syrup in the year 2009

Genotype	Time of analysis	Vitamin C content	Mean for genotype
A2	Fresh syrup	92.5 o*	84.2 h
	Syrup after pasteurisation	91.4 o	
	After 15 weeks of storage	68.7 n	
A3	Fresh syrup	54.1 l	41.5 f
	Syrup after pasteurisation	53.1 l	
	After 15 weeks of storage	17.4 cd	
A4	Fresh syrup	28.1 fg	20.3 b
	Syrup after pasteurisation	25.9 ef	
	After 15 weeks of storage	6.8 a	
A9	Fresh syrup	66.9 n	57.5 g
	Syrup after pasteurisation	64.4 m	
	After 15 weeks of storage	41.6 j	
A10	Fresh syrup	35.9 i	30.7 d
	Syrup after pasteurisation	29.7 gh	
	After 15 weeks of storage	26.7 e-g	
B2	Fresh syrup	25.6 ef	18.3 a
	Syrup after pasteurisation	20.0 d	
	After 15 weeks of storage	9.4 ab	
B3	Fresh syrup	45.6 k	38.3 e
	Syrup after pasteurisation	40.9 j	
	After 15 weeks of storage	28.4 fg	
B6	Fresh syrup	25.9 ef	21.7 b
	Syrup after pasteurisation	23.4 e	
	After 15 weeks of storage	15.6 c	
B11	Fresh syrup	32.8 hi	24.2 c
	Syrup after pasteurisation	28.4 fg	
	After 15 weeks of storage	11.5 b	
Mean for time of analysis	Fresh syrup	45.2 c	
	Syrup after pasteurisation	41.9 b	
	After 15 weeks of storage	25.1 a	

*Explanations: see Table 1

In each year of the study, the extent of the losses as compared to the initial values (i.e. content before pasteurisation) depended on the genotype and time of analysis.

Pasteurisation caused a small loss of vitamin C, from 1.2% to 17.3% in 2009 (Fig. 5) and from 2.2% to 19.1% in 2010 (Fig. 6), depending on the genotype. Mean values of the losses were 7.3% and 7.6% for the first and second year, respectively. Storage of the pasteurised sugar syrup for 15 weeks resulted in much greater losses of vitamin C ranged from 25.6% to 75.8% (2009) and from 55.0% to 87.3% (2010). Mean values of the losses in each year were 44.5% and 74.6%, respectively.

Figure 7 presents the changes in vitamin C content in chaenomeles fruit and shows the progressive loss of vitamin C after fruit processing and storage of sugar syrup. Regardless of the year, the course of the vitamin C changes was very similar. The greatest decrease in vitamin C content was observed between fresh fruit and sugar syrup; the differences were as follows: 81.46 mg 100 g^{-1} (67.1%) and 73.31 mg 100 g^{-1} (73.3%) in the first and second year of the experiment, respectively. The pasteurisation process decreased the vitamin C level to a much smaller extent, followed by a higher decrease during the period of storage. In general, the final vitamin C content in the sugar syrup after 15 weeks of storage amounted to 24.7 mg 100 g^{-1} and 7.3 mg 100 g^{-1} in the first and second year of the study, respectively. Hence, the corresponding vitamin C losses constituted 80.4% and 92.9%

Table 4. Effect of storage period on vitamin C content (mg 100 g^{-1}) in Japanese quince sugar syrup in the year 2010

Genotype	Time of analysis	Vitamin C content	Mean for genotype
A2	Fresh syrup	59.7 o*	46.5 h
	Syrup after pasteurisation	58.4 o	
	After 15 weeks of storage	21.3 hi	
A3	Fresh syrup	48.3 n	33.5 g
	Syrup after pasteurisation	46.0 m	
	After 15 weeks of storage	6.3 c	
A4	Fresh syrup	16.2 e	11.2 a
	Syrup after pasteurisation	13.1 d	
	After 15 weeks of storage	4.3 ab	
A9	Fresh syrup	24.5 j	16.6 d
	Syrup after pasteurisation	22.3 i	
	After 15 weeks of storage	3.1 a	
A10	Fresh syrup	18.7 f	13.1 b
	Syrup after pasteurisation	17.0 e	
	After 15 weeks of storage	3.7 ab	
B2	Fresh syrup	22.0 i	15.4 c
	Syrup after pasteurisation	19.2 fg	
	After 15 weeks of storage	4.9 bc	
B3	Fresh syrup	37.1 l	29.1 f
	Syrup after pasteurisation	33.5 k	
	After 15 weeks of storage	16.7 e	
B6	Fresh syrup	25.6 j	17.8 e
	Syrup after pasteurisation	22.9 i	
	After 15 weeks of storage	4.9 bc	
B11	Fresh syrup	20.4 gh	14.7 c
	Syrup after pasteurisation	19.3 fg	
	After 15 weeks of storage	4.3 ab	
Mean for time of analysis	Fresh syrup	30.3 c	
	Syrup after pasteurisation	28.0 b	
	After 15 weeks of storage	7.7 a	

*Explanations: see Table 1

when compared with the amounts in the fruit at harvest.

DISCUSSION

The Japanese quince fruit is aromatic, has a defined taste, and contains a large quantity of active ingredients and organic acids, but it cannot be consumed as fresh fruit. The Japanese quince fruit needs processing, and due to its specific character it is widely used as an additive to purées of other fruits, enriching them with healthy compounds (Nawirska-Olszańska et al. 2010, 2011). Therefore, the quality of the raw material is very important, especially the levels of labile compounds, such as vitamin C. Japanese quince is known to have a high vitamin C content. Fruits of *Cydonia oblonga* Mill., which in respect of fruit usability for processing are similar to those of chaenomeles, exhibit much lower levels of ascorbic acid – on average 79 mg 100 g^{-1} (Rop et al. 2011).

In the presented study, the vitamin C content in fresh fruit was high, but varied depending on the year of research and the genotype. Air temperature and precipitation varied considerably in both years of the study, with a lower annual temperature and higher precipitation noted in the second year. The fact is that vitamin C content may vary under the conditions of high humidity and low temperature. At harvest, the mean vitamin C content ranged from 103.1 to 128.1 mg 100 g^{-1} depending on the year, and from 73.1 to 243.0 mg 100 g^{-1} depending on the genotype. It was found that at fruit harvest in the wet and cold year of 2010 the vitamin C content in all the genotypes, except one (A3), was lower than in the drier and warmer year of 2009.

The values of vitamin C content found in the presented study are comparable with (Rubinskiené et al. 2014) or higher than (Hellín et al. 2003b) the results of other studies. Similarly, Ros et al. (2004) reported varied vitamin C content (20-112 mg 100 ml^{-1}, with a mean value of 59 mg 100 ml^{-1}) in the fruit of 24 genotypes originated in Lithuania. Mezhenskij (1996b) reported the ascorbic acid content in the fruit of *Chaenomeles* × *superba* at a level of 60-150 mg 100 g^{-1}. According to Vila et al. (2003), the vitamin C content in the Japanese quince fruit depends on the physiological stage of the fruit, and strongly increases in the fruit during later stages of development. Also, the geographical site has an effect on vitamin C content; the fruit picked at a southerly site had higher vitamin C content than the fruit picked at a northerly site (Vila et al. 2003). The authors state that a milder climate promotes the production and accumulation of vitamin C in chaenomeles fruit. Generally, fruit maturity at harvest and the harvesting method, as well as postharvest handling conditions, affect the vitamin C content in the fruit (Kader 1988).

The Japanese quince fruit shows a gradual decrease in quality after a storage period, although the extent of the changes depends on storage conditions. Vila et al. (2003) report that the chaenomeles fruit kept at 1ºC and 85% RH for nine weeks and at 5ºC and 80% RH for four weeks did not exhibit a severe loss of internal quality. However, the biggest losses are recorded for vitamin C content after storage. In the presented experiment, the mean loss of vitamin C after storage ranged from 15.5% to 6.3% (one week) and from 24.8% to 15.8% (two weeks). As for genotypes, the following regularity was recorded: the higher the content, the lower the losses after the storage period. The most promising genotype proved to be genotype A2, which contained the most vitamins, both in the fruit at harvest and after storage. In the presented study, the Japanese quince fruits, with a strong and nice aroma, were stored under normal atmospheric conditions and the flavours of the fruits were well preserved after the storage period. Some studies indicate that in strawberry, blackcurrant and possibly other berry fruits storage at excessively high CO_2 concentrations reduces the vitamin C content and also causes off-flavours (Agar et al. 1997).

Due to the high usefulness of Japanese quince fruit for processing, the fruit is subjected to various technological processes, which affect the amounts of compounds in the obtained products, such as juice, syrup, candied slices and others. Since vitamin C is one of the most unstable vitamins, and is readily oxidized by many nonenzymatic processes, the amount of this vitamin in fruit products is often tested. Mechanical extraction of the juice from the Japanese quince fruit is rather difficult due to the extremely high fruit firmness. Once the fruit flesh is crushed, the juice is extracted by pressing and the juice yield is 40-60% (Hellín et al. 2003a).

In the presented study, in order to obtain the syrup, the chopped fruit was mixed with sugar and left for several hours. This process already affected the degradation of vitamin C; its amount averaged around 30% of the initial level, measured immediately after the fruit harvest. The level of the vitamin in the sugar syrup is in line with the results of other studies, in which authors reported a content of 35.6 mg 100 g^{-1} and 56.4 mg 100 g^{-1} depending on the genotype (Rubinskiené et al. 2014). To eliminate micro-organisms and to inactivate endogenous enzymes, the obtained syrup was subjected to pasteurisation. The thermal treatment lowered the vitamin level very slightly, and the vitamin content was on average about 92% of the value measured before pasteurisation. Many authors report that storage of *Chaenomeles* fruit and products (juice, syrup, sweet candies, and products with the addition of quince purée) influence the vitamin C content to a great extent. The degradation depends on many factors, e.g. type of product, method of obtaining the product, duration of storage, the initial vitamin content (Hellín et al. 2003a, Vila et al. 2003, Artés-Hernández et al. 2007, Nawirska-Olszańska et al. 2010, 2011). According to Nawirska-Olszańska et al. (2011), the Japanese quince-enriched pumpkin purée was found to be the most attractive. Adding Japanese quince to the pumpkin purée significantly increased the vitamin C content in the final product while contributing to the improvement of its organoleptic and antioxidant properties. Despite the high temperature (90ºC) applied to the purée, the losses of vitamin C were not large. In the discussed study, we observed that vitamin C losses continued during the storage of sugar syrup. The degradation of the vitamin was 44.5% and 62.1%, depending on the year of the study. A probable reason for such high losses of vitamin content was prolonged exposure of the syrup to a temperature of 18ºC, at which the sugar syrup was kept for 15 weeks. Comparing the initial value of vitamin C content recorded in the fruit at harvest with the values measured in the sugar syrup after 15 weeks of storage, it is obvious that only the genotypes with an extremely high level of vitamin C should be selected and used for processing.

CONCLUSIONS

In fresh Japanese quince fruit, the vitamin C content depends on the genotype and the season, and it changes during the storage period. Processing of the fruit affects the vitamin C content to a far greater degree than fruit storage does. The losses of the vitamin observed during processing and heat treatment are sometimes very considerable. Due to the specific character of the Japanese quince fruit and the necessity of processing it, it is important to carry out selection in order to obtain genotypes with high vitamin C content in the fruit.

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AUTHOR CONTRIBUTIONS

M.B. and E.D. – developed the concept and designed the experiment; E.D., M.B. and E.K. – collected data and performed analysis; E.D. and M.B. – analyzed the data and wrote the paper.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

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