

CHEMICAL AND MECHANICAL PROPERTIES OF JAPANESE QUINCE (*CHAENOMELES JAPONICA* (THUNB.) LINDL.) EXPOSED TO THE OZONE DURING COLD STORAGE

– Research paper –

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Abstract: This study analysed the effect of applying gaseous ozone for 15 and 30 minutes on mechanical and chemical properties of six Japanese quince variety. Among the tested varieties, Gold Calif demonstrated superior mechanical durability, as it required the highest levels of force and energy to puncture and underwent the most substantial deformation. Extended storage of quince fruits for 60 days resulted in a marked decline in vitamin C levels, with an average reduction of 19.8%. Notably, the Rasa variety retained the greatest concentration of vitamin C, measuring 120.29 mg · 100 g⁻¹. Exposure to gaseous ozone significantly boosted the total phenolic compound content; a 30-minute treatment led to a 6.2% increase when compared to untreated, fresh samples. After two months of storage, phenolic levels dropped by 6.5% relative to the initial fresh fruit values. Additionally, Japanese quince fruits exposed to ozone for 30 minutes exhibited enhanced antioxidant properties, reflected by a 5.8% rise in DPPH activity and a 5.5% increase in FRAP values over non-treated fruits. On the basis of the study, gaseous ozone can significantly influence chemical composition, increasing the mechanical resistance and health-promoting value of fruits.

Keywords: ozone gas, japanese quince, chemical properties, bioactive compounds

INTRODUCTION

The *Chaenomeles* genus, belonging to the Rosaceae family and classified under the Maloideae subfamily, is among the earliest cultivated plants. Belonging to this family, the *Chaenomeles japonica* - Japanese quince, is a shady shrub known for its sour fruits with a rich chemical composition. The species is very similar to quince (*Cydonia oblonga* Mill.). Japanese quince cultivation is especially widespread in Europe countries such as Poland, as well as in Baltic countries such as Estonia, Latvia, Lithuania (Bieniasz et al. 2017, Moneva et al. 2023, Byczkiewicz et al. 2019). *Chaenomeles japonica* shows great diversity in both plant and fruit traits, and seed propagation often results in morphological and biochemical variability. The development of new cultivars alters the genetic background, leading to changes in morphology, physiology, and metabolism (Radziejewska-Kubzdela et al. 2020, Misina et al. 2020).

Chaenomeles japonica is mainly known for its ornamental properties and fruits rich in health-promoting compounds. The fruit of the Japanese quince is a rich source of organic acids, phenolic compounds and vitamin C, making it highly valuable for food industry processing (Bieniasz et al. 2017). The total phenolic content of fruits ranges from 3506 to 4550 mg GAE · 100 g⁻¹, and vitamin C from 114 – 169 mg · 100 g⁻¹ (Urbanavičiūtė et al. 2020). Many phenolic compounds can be identified in the composition of the fruit, but the most noteworthy are chlorogenic acid, catechin, epicatechin procyanidin B1 and B2 (Du 2013). Fruits have antioxidant, antidiabetic, anti-inflammatory and diuretic effect. It is used in the management and cure of skin abrasion, ulcers, urinary problems and sore throat (Rather et al 2020). Long-term storage of fruit may cause a change in their chemical properties, reduce the total content of organic compounds, and thus reduce the value of the raw material (Pott et al. 2020).

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The reason for the decrease in the value of the raw material may be caused by mechanical damages such as crushing, abrasion or bruising. The mechanical resistance of fruit is influenced by various factors, such as morphological characteristics, stage of ripeness and variety (Stropek 2020, Gorzelany et al. 2024).

Ozone is used in a non-thermal preservation method that enhances food safety while maintaining food quality and being environmentally friendly. Ozonation is an effective process of reducing water loss, enhance antioxidant activity and lower ethylene emissions, thus minimizing quality loss in fruits during cold storage. Ozone disinfects raw source, thereby extending its shelf life (Jaramillo-Sanchez et al. 2019, Contigiani et al. 2019). Ozone

disinfectant and biocidal properties have gained the publicity in the fruit and vegetable industry, as the ozone molecule quickly breaks down into oxygen, leaving no residue on the product. However, the use of ozonation requires determining the appropriate dose due to the different species and variety reactions (Zardzewiały et al. 2020). The use of ozonation technology for Japanese Quince fruit can contribute to increasing the value of the raw material, thus contributing to the development of storage technology for this species.

The aim of this experiment was to determine the possibility of using the ozone gas process to improve the morphological, chemical and mechanical properties of Japanese quince fruit at different times of refrigerated storage.

MATERIALS AND METHODS

Plant materials

Japanese quince fruits (*Chaenomeles japonica*), from six varieties 'Darius', 'Gold Calif', 'Maksym', 'North Lemon', 'Rasa' and 'Tamara', were hand-picked in September 2024 on the farm of Mrs. Monika Murawska located in Stoczek Łukowski (51°57'48" N 21°58'06" E, Lublin Voivodeship, Poland). Non-ozonated and ozonated Japanese quince fruits were used for storage tests (water content and mechanical properties) and stored under refrigerated conditions (temperature 4 °C) for 60 days.

Ozonation Process

Japanese quince fruits were randomly divided into three batches of 2000 g each. The first batch was left without of ozonation – control sample. Second and third batch was ozonated in concentration of 10 ppm (flow rate 4 m³·h⁻¹, temperature 20 °C) for 15 min and 30 min; respectively. The ozonation were carried out in a plastic container with dimensions L × W × H - 0.6 × 0.4 × 0.4 m. Ozone gas was produced using KORNOA A40 standard ozone generator (Korona, Piotrków Trybunalski, Poland) and its quantity was measured using an Ozone Solution 106 M UV detector (Hull, MA, USA).

Morphological characteristics of Japanese quince

The sample consisted of 10 fruits from each variant. For each fruit length and diameter was measured with an accuracy of 0.01 mm, and the weight was measured with an accuracy of 0.001 g. For individual fruits, their density (kg·m⁻³) was also calculated as the ratio of their mass and volume determined as the volume of the ellipsoid of length

and diameter (Szpunar-Krok et al. 2021; Shahbazi et al. 2015)

Water content measurement

The water content in Japanese quince fruits were determined by the drying method (105 oC) in accordance with PN-90/A-75101-03:1990 by placing the fruit in a laboratory dryer – SLW 115 SMART (POL-EKO®, A.Polok-Kowalska sp.k., Wodzisław Śląski, Poland). The measurements were performed immediately after the mechanical properties measurements. Measurement results are given in percentages (%). Each series of measurements was performed in triplicate.

Mechanical Properties of Japanese Quince Fruits

The selected mechanical properties were tested using a strength test for puncture resistance with a $\phi = 4$ mm diameter punch using the Brookfield CT3-1000 texture analyzer (AMETEK Brookfield, Middleboro, MA, USA) and TexturePro CT software. Puncture resistance measurements of the skin and flesh of Japanese quince fruits were conducted at two locations in the central part of the fruit perpendicular to its length, with 20 repetitions for each series of measurements. The puncture tests were performed with the following parameters: Fv = 0.1 N (preliminary force); V1 = 0.5 mm·s⁻¹ (rate of movement of the beam load cell during measurement). Each measurement was taken on both fresh raw material and raw material ozonated with specific doses on the 1st, 30th, and 60th days of storage.

Determination of pH and acidity

According to the method given in PN-EN 12147:2000, the pH value and total acidity (as citric acid) of the Japanese quince fruits were analysed using method of the sample potentiometric titration analysis with a standard 0.1 M NaOH solution at pH = 8.1 using TitroLine 5000 (SI Analytics, Weiheim, Germany). The analyses were performed in triplicate. The results are expressed as g of citric acid per 100 g of fruit. Each fruit was analysed 24 h after ozonation.

Determination of bioactive compounds

The determination of vitamin C content was made based on the methodology included in PN-A-04019:1998. The total phenolic content was determined according to the methodology in Gorzelany et al. 2022. The result was expressed in mg GAE · 100 g⁻¹. The antioxidant properties were tested using the DPPH, ABTS and FRAP methods based on the methodology of Gorzelany et al. 2022. The results were expressed in mM TE · 100 g⁻¹, mM TE · 100 g⁻¹ and mM Fe²⁺ · 100 g⁻¹; respectively.

Each measurement was performed three times on the 1st, 30th, and 60th days of storage.

Determination of fruit color

The determination of the colour of quince fruit was carried out using the NR20XE colourimeter (Łódź, Poland) and CQCS3 computer software (Łódź, Poland). The colourimeter used for the measurements was used to read the colour values in the CIE LAB system (CIE 1978) - L* (lightness), a* (redness) and b* (yellowness). The colorimeter was calibrated against a standard (No. 21833042) (Commission International de Eclairage 1971) Each measurement was performed 10 times on the 1st, 30th, and 60th days of storage

Statistical analysis

Statistica 13.3. (TIBCO Software Inc., Tulsa, OK, USA) was used to perform statistical analysis of the obtained results, including three-way analysis of variance (ANOVA) and NIR significance test at the significance level of $\alpha = 0.05$.

RESULTS AND DISCUSSION

Morphological characteristics of Japanese quince

The fruits of the Japanese quince cultivars analysed in the strength tests showed variations in their morphological traits, which were influenced by the

cultivar type, harvest date, storage duration, and length of ozonation (Table 1).

Depending on the Japanese quince variety, the length of the fruit ranged from 52.0 – 62.20 mm, the width from 52.25 – 62.98 mm, and the weight from 84.40 – 125.35 mm.

Table 1. Morphological properties of Japanese quince fruits depending on the cultivar, duration of storage, and time gaseous ozonation

Variables		Length (mm)	Diameter (mm)	Sphericity coefficient (%)	Weight (g)	Density (g·cm ⁻³)
Cultivar	Darius	52.0a±7.0	52.25a±6.8	100.4b±3.1	84.4a±32.0	1,11d±0,14
	Gold Calif	55.2b±4.9	54.01ab±3.9	98.8a±5.7	87.4a±16.6	1,03c±0,12
	Maksym	54.6b±3.7	55.58bc±4.5	101.1b±4.3	87.5a±11.0	1,00c±0,12
	North Lemon	62.2d±9.8	62.98d±8.3	101.9b±9.4	107.2b±22.6	0,84a±0,14
	Rasa	55.2b±4.6	56.673c±5.3	101.8b±5.6	86.8a±16.6	0,93b±0,10
	Tamara	61.9c±7.7	61.61d±6.9	99.8ab±5.6	125.9c±35.8	1,01c±0,10
Time gaseous ozonation (min)	0	58.1b± 9.5	57.9b±8.2	100.3ab±8.2	102.4b±36.9	0.98a±0.14
	15	55.6a±6.7	55.6a±6.4	100.1a±7.4	89.6a±19.9	1.00a±0.15
	30	56.8ab±8.4	58.0b±6.8	101.5b±7.7	97.7b±24.2	0.98a±0.15
Duration of storage (days)	1	61.3b±10.5	57.6b±6.1	96.9a±9.5	104.3b±27.9	0.98ab±0.16
	30	54.6a±6.1	55.6a±6.6	101.1b±4.7	91.4a±24.5	1.03b±0.14
	60	54.7a±5.8	58.4b±8.5	103.9c±6.6	93.9a±30.8	0.95a±0.13
Mean		56.8±8.3	57.2±7.2	100.6±7.8	96.5±28.4	0.99±0.15

Data are expressed as mean values (n = 10) ± SD; SD – standard deviation. Mean values within columns with different letters are significantly different (p < 0.05)

Statistical analysis showed a significant effect of the variety, storage time and ozonation time of quince fruits on the analysed morphological features. The only exception was density, which was independent of ozonation time. The fruits with the greatest length, diameter and sphericity coefficient, and the lowest density were characterized by the North Lemon variety (Table 1). The Tamara variety had the highest mass, and the Darius variety had the highest density, which were the smallest and lightest. The lowest sphericity coefficient was recorded for the Gold Calif variety.

Mechanical characteristics of Japanese quince

Damage during harvest or transport can lower the value of the raw material. The firmness and texture of fruit are important indicator of quality fruits and vegetables (Pereira et al. 2017). These factors have a significant impact on the storage capacity of the raw material, its taste, and the content of health-promoting compounds. Damage and storage can significantly affect the water content of fruits, and therefore their weight and biometric properties (Nunes et al. 2007, Hossain et al. 2020). The water content of fruits varied depending on the variety, ozonation time and storage time (Figure 1).

The water content in Japanese quince fruit varied significantly depending on the variety, the average value being 87.25%. The Maksym variety was characterized by the highest water content – 90.05%. The use of ozonation had no significant effect on water loss in fruit. Fruit storage for 60 days resulted in a decrease in water content in Japanese

quince fruits by 6.1%. Long-term or inappropriate storage of fruit in refrigerated conditions increases fruit transpiration, which may result in a loss of weight and a decrease in water content (Lentzou et al. 2021, Singla et al. 2021). The mechanical properties of Japanese quince fruits varied depending on the variety, ozonation time and storage time (Table 2). Depending on the variety, the force required to puncture the fruit ranged from 30.01–40.89 N. The Gold Calif variety was characterized by the most resistant to mechanical damage, as it required significantly the greatest force and energy to puncture and underwent the greatest deformation. On the other hand, the lowest puncture force and deformation were recorded for the Tamara variety, and energy for the Rasa variety. The Rasa variety was also characterized by the lowest water content, the highest of which was recorded for the Maksym variety. The fruits subjected to ozonation for 15 minutes were characterized by significantly the highest puncture force and energy, i.e. the highest resistance to mechanical damage. During storage, the water content in the fruits and the force required to puncture them decreased significantly, while the deformation increased. Based on the results obtained in the study, it was found that ozonation has a beneficial effect on the mechanical properties of Japanese quince fruit, which may reduce losses of the raw material during storage and improve its quality.

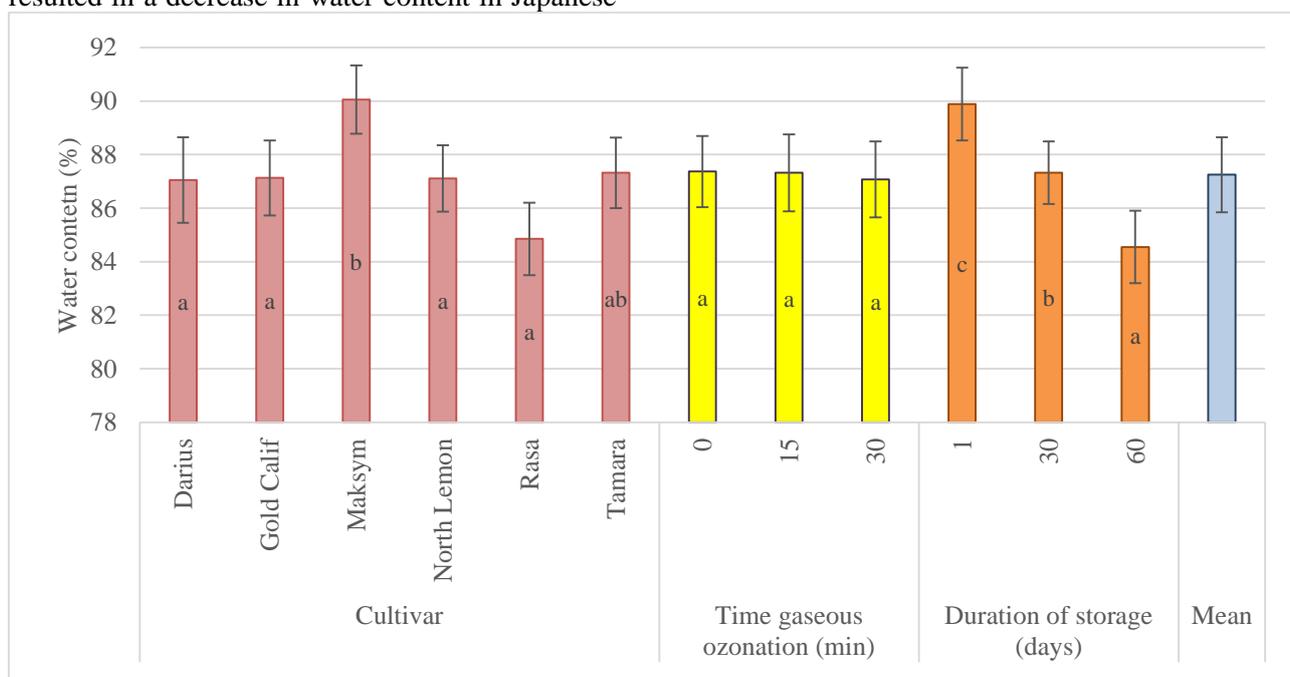


Figure 1. Changes in water contents in Japanese quince of six varieties, relative to the duration of exposition to ozone and duration of storage. Data are expressed as a mean values ($n = 3$) \pm SD; SD – standard deviation, different letters are significantly different ($p < 0.05$)

Table 2. Mechanical properties of Japanese quince fruits depending on the cultivar, duration of storage, and time gaseous ozonation

Variables	Force (N)	Deformation (mm)	Energy (mJ)	
Cultivar	Darius	35.60b±6.38	1.93c±0.74	66.85b±13.9
	Gold Calif	40.89c±11.48	2.88d±0.86	84.02c±22.5
	Maksym	32.15a±4.67	1.88c±0.58	58.07a±12.5
	North Lemon	30.44a±9.21	1.66b±0.38	60.07ab±17.2
	Rasa	34.50b 6.45	1.59ab±0.40	56.35a±11.1
	Tamara	30.01a±4.43	1.42a±0.43	57.18a±10.6
Time gaseous ozonation (min)	0	32.92a±8.87	1.93a±0.69	61.6a±16.9
	15	36.15b±7.81	1.88a±0.80	67.2b±18.7
	30	32.72a±7.97	1.87a±0.77	62.5a±17.8
Duration of storage (days)	1	38.48b±7.46	1.50a±0.6	69.9b±15.7
	30	31.57a±7.91	1.95b±0.7	54.7a±18.2
	60	31.74a±7.81	2.23c±0.8	66.7b±16.3
Mean	33.93±8.36	1.89±0.76	63.8±18.0	

Data are expressed as mean values (n = 10) ± SD; SD – standard deviation. Mean values within columns with different letters are significantly different (p < 0.05)

Chemical composition of fruits

Japanese quince fruits are known for their characteristic tart fruits rich in bioactive compounds (Kazimierczak et al. 2025). The content of health-promoting compounds in fruit such as organic acids and polyphenols may be influenced by a number of factors, such as harvesting, transport and storage. During the storage period, fruits may degrade, which may significantly affect their content of bioactive compounds and antioxidant value (Al-Dairi et al. 2021, Ziv et al 2021, Iturralde-García et al. 2022). As the fruit continues to ripen during storage, its levels of organic acids gradually decline. These acids are susceptible to breakdown and their concentrations can fluctuate depending on conditions like temperature (Yang et al. 2021, Tatari 2024). Ozonation is used as a treatment that can reduce fruit transpiration (Samandeeep et al, 2023, loss of bioactive compounds (Lv et al. 2019) and thus improve the quality of the raw material

(Sachadyn-Król et al. 2020). The pH value varies depending on the variety, ozonation time and storage time (Figure 2).

No significant differences were noted between in the pH value, regardless of the variety. The average pH value of Japanese quince fruit was 2.99. The fruits of the Tamara variety were characterized by the lowest pH value - 2.94, while in the case of the Maksym variety the pH value was the highest - 3.06. Ozonation significantly affected the average pH value in Japanese quince fruit, the use of 15 minutes increased the value by 5.2%, compared to fresh fruit. Fruit storage did not significantly affect the pH values. The results are comparable to those obtained in the experiment where the pH value of Japanese quince fruit ranged from 2.93 to 3.49 (Wojtyś et al. 2024, Gorzelany et al. 2024). The total acidity varies depending on the variety, ozonation time and storage time (Figure 3).

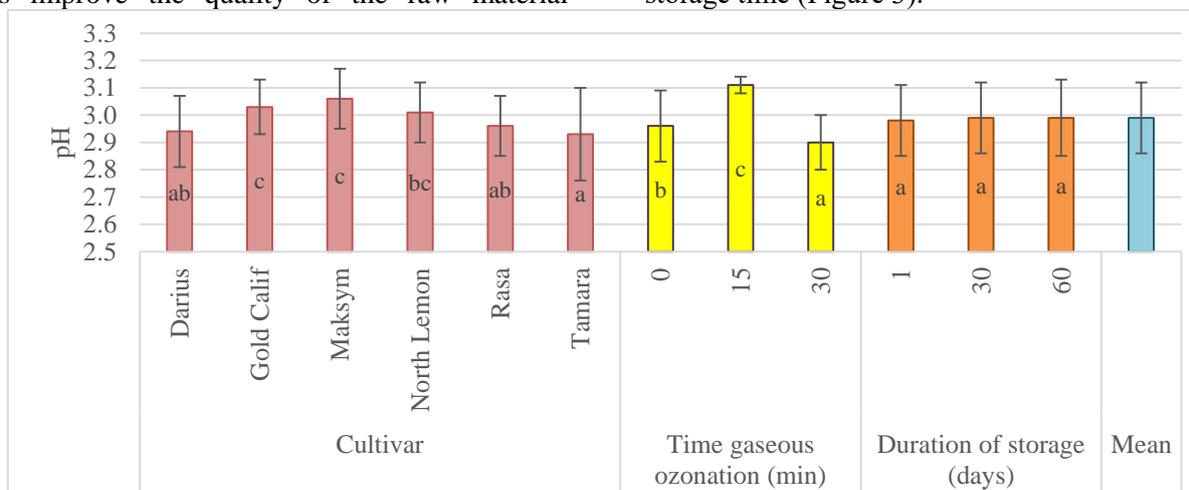


Figure 2. pH value of Japanese quince of six varieties, relative to the duration of exposition to ozone and duration of storage. Data are expressed as a mean values (n = 3) ± SD; SD – standard deviation, different letters are significantly different (p < 0.05)

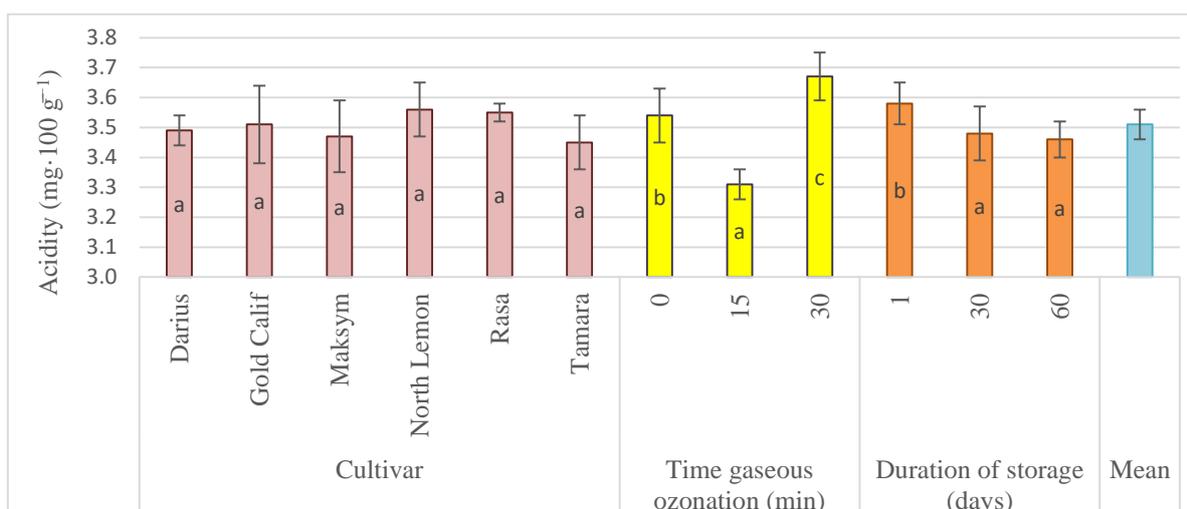


Figure 3. The acidity of Japanese quince of six varieties, relative to the duration of exposition to ozone and duration of storage. Data are expressed as a mean values ($n = 3$) \pm SD; SD – standard deviation, different letters are significantly different ($p < 0.05$)

The acidity value did not differ significantly depending on the variety, the average value in the tested Japanese quince varieties is $3.50 \text{ mg} \cdot 100 \text{ g}^{-1}$. The highest acidity value was recorded in the North Lemon variety - $3.56 \text{ mg} \cdot 100 \text{ g}^{-1}$, and the lowest in the Tamara variety - $3.45 \text{ mg} \cdot 100 \text{ g}^{-1}$. The average acidity value obtained in this experiment is comparable to the results of the study Marat et al 2022, where the mean value is $3.50 \text{ mg} \cdot 100 \text{ g}^{-1}$. Ozonation significantly reduced acidity, the average value decreased by 6.5% for fruits ozonated for 15 minutes. Fresh fruit was characterized by

significantly higher acidity compared to fruit stored for 30 and 60 days.

Japanese quince fruit is known for its content of phenolic compounds, including: quercetin, benzoic acid, epicatechin and procyanidin B2 (Du et al. 2013, Ma et al. 2022). According to scientific reports, Japanese quince fruit has antioxidative properties, hepatoprotective property, antiallergic and antipruritic abilities, and also neuroprotective abilities (Watychowicz et al. 2017). The content of bioactive compounds varies depending on the variety, ozonation time and storage time (Table 3).

Table 3. Chemical properties of Japanese quince fruits depending on the cultivar, duration of storage, and time gaseous ozonation

Variables	Ascorbic Acid Content ($\text{mg} \cdot 100 \text{ g}^{-1}$)	Total Polyphenols Content ($\text{mg GAE} \cdot 100 \text{ g}^{-1}$)	DPPH ($\text{mM TE} \cdot 100 \text{ g}^{-1}$)	ABTS ($\text{mM TE} \cdot 100 \text{ g}^{-1}$)	FRAP ($\text{mM Fe}^{2+} \cdot 100 \text{ g}^{-1}$)	
Cultivar	Darius	109.8 ± 6.0	396.0 ± 28.3	2.49 ± 0.07	1.75 ± 0.04	0.33 ± 0.01
	Gold Calif	111.3 ± 6.3	394.5 ± 14.1	2.54 ± 0.08	1.74 ± 0.04	0.35 ± 0.01
	Maksym	120.2 ± 10.1	382.8 ± 13.1	2.54 ± 0.05	1.74 ± 0.04	0.33 ± 0.01
	North Lemon	96.7 ± 14.0	383.7 ± 14.2	2.50 ± 0.04	1.73 ± 0.04	0.35 ± 0.01
	Rasa	120.3 ± 13.4	392.2 ± 11.6	2.54 ± 0.07	1.74 ± 0.03	0.34 ± 0.02
	Tamara	117.7 ± 12.2	369.1 ± 12.0	2.53 ± 0.05	1.72 ± 0.04	0.35 ± 0.02
Time gaseous ozonation (min)	0	111.4 ± 13.8	373.4 ± 14.9	2.41 ± 0.07	1.73 ± 0.04	0.33 ± 0.02
	15	113.3 ± 13.1	393.6 ± 12.8	2.53 ± 0.06	1.74 ± 0.04	0.35 ± 0.01
	30	113.3 ± 13.7	398.2 ± 20.4	2.56 ± 0.06	1.73 ± 0.04	0.35 ± 0.01
Duration storage (days)	1	124.1 ± 9.1	396.6 ± 21.3	2.55 ± 0.09	1.75 ± 0.04	0.36 ± 0.02
	30	113.0 ± 9.5	391.5 ± 11.6	2.50 ± 0.04	1.73 ± 0.03	0.35 ± 0.01
	60	100.9 ± 9.9	379.2 ± 14.5	2.40 ± 0.04	1.70 ± 0.04	0.32 ± 0.02
Mean	112.7 ± 13.5	385.2 ± 16.5	2.54 ± 0.06	1.74 ± 0.04	0.35 ± 0.01	

Data are expressed as mean values ($n = 10$) \pm SD; SD – standard deviation. Mean values within columns with different letters are significantly different ($p < 0.05$)

The content of ascorbic acid significantly differed depending on the tested variety, the average value of ascorbic acid in the fruit was $112.66 \text{ mg} \cdot 100 \text{ g}^{-1}$, the Rasa variety was characterized by the highest value of vitamin C - $120.29 \text{ mg} \cdot 100 \text{ g}^{-1}$. The results obtained in this experiment are comparable to those obtained in studies of (Rubinskienė et al. 2014, Baranowska-Bosiacka et al. 2017), where the authors determined that the value of vitamin C in Japanese quince fruit ranges from 72.00 to $127.50 \text{ mg} \cdot 100 \text{ g}^{-1}$. The use of ozone gas did not significantly affect the ascorbic acid content. Storage of fruit for 60 days significantly affected the vitamin C content, reducing the average value in quince fruit by 19.8%, compared to fresh fruit. The chemical properties of fruits may change during long-term storage, and inappropriate fruit storage conditions may lead to a decrease in the content of health-promoting compounds, including vitamin C (Giannakourou et al. 2003, Verbeyst et al. 2013). The average content of phenolic compounds in the tested Japanese quince fruits is $385.20 \text{ mg} \cdot 100 \text{ g}^{-1}$. The average content of phenolic compounds obtained in the experiment is comparable to those obtained in the study of (Ros et al. 2004), where the value ranges from 185 to $413 \text{ mg} \cdot 100 \text{ g}^{-1}$. The total content of phenolic compounds in the selected fruit varieties tested did not differ significantly. The use of gaseous ozone significantly increased the total content of phenolic compounds, ozonation of the fruits for 30 minutes increased the value by 6.2% in comparison to fresh fruits. Fruit storage significantly affected the content of phenolic compounds. After 60 days of storage, this value decreased by 6.5%, compared to fresh fruit.

The antioxidant activity of Japanese quince fruit was determined using three methods: the DPPH radical, the ABTS cation radical, and the FRAP method. The average antioxidant value of the fruits is $2.54 \text{ mM TE} \cdot 100 \text{ g}^{-1}$ (DPPH), $1.74 \text{ mM TE} \cdot 100 \text{ g}^{-1}$ (ABTS) and $0.35 \text{ mM Fe}^{2+} \cdot 100 \text{ g}^{-1}$ (FRAP). Significant differences in mean antioxidant values of fruits can only be observed in the FRAP analysis. North Lemon varieties, compared to the rest of the varieties, were characterized by the highest FRAP antioxidant value - $0.36 \text{ mM Fe}^{2+} \cdot 100 \text{ g}^{-1}$. The use of gaseous ozone and fruit storage for 60 days significantly affected the DPPH and FRAP values. Japanese quince fruits ozonated for 30 days had a 5.8% higher DPPH value and a 5.5% higher FRAP value in comparison to non-ozonated fruits. Compared to fresh fruit, fruit storage for 60 days reduced the DPPH value by 5.9% and FRAP by 11.2%. The results of the antioxidant potential of the analyzed fruits are consistent with the results of studies by other authors who analyzed the chemical properties of quince (Cascales, E. and García, J. 2020 & Rubinskiene, M. et al. 2014).

Color properties of Japanese quince

All activities related to fruit processing such as harvesting, transport, storage, and storage procedures can affect the raw material characteristics such as texture, flavor, and color (Wojdyło et al 2014, Sood et al. 2015). The color values measured by the CIELAB $L^*a^*b^*$ method varied depending on the variety, ozonation time and storage.

Table 4. Color values of Japanese quince fruits depending on the cultivar, duration of storage, and time gaseous ozonation

Variables		L^*	a^*	b^*
Cultivar	Darius	$62.97b \pm 5.38$	$16.25c \pm 3.81$	$48.65b \pm 5.94$
	Gold Calif	$61.74b \pm 7.72$	$15.60c \pm 3.43$	$47.76b \pm 9.22$
	Maksym	$59.53a \pm 6.10$	$12.60b \pm 3.60$	$42.45a \pm 5.75$
	North Lemon	$69.38c \pm 2.78$	$9.52a \pm 3.03$	$51.88c \pm 4.78$
	Rasa	$68.08c \pm 2.87$	$11.03b \pm 2.55$	$47.01b \pm 3.47$
	Tamara	$69.59c \pm 3.32$	$12.02b \pm 3.26$	$55.19d \pm 3.27$
Time gaseous ozonation (min)	0	$65.29ab \pm 7.03$	$13.43b \pm 3.82$	$49.43b \pm 7.59$
	15	$66.05b \pm 5.30$	$12.16a \pm 3.76$	$49.53b \pm 5.96$
	30	$64.30a \pm 6.64$	$12.9ab \pm 4.50$	$47.50a \pm 7.13$
Duration of storage (days)	1	$68.22b \pm 4.45$	$11.96a \pm 4.05$	$50.55c \pm 5.82$
	30	$64.28a \pm 6.48$	$12.97b \pm 4.21$	$49.00b \pm 6.67$
	60	$63.15a \pm 6.87$	$13.58b \pm 3.78$	$46.92a \pm 7.85$
Mean		65.22 ± 6.40	12.84 ± 4.07	48.82 ± 6.98

Data are expressed as mean values ($n = 10$) \pm SD; SD – standard deviation. Mean values within columns with different letters are significantly different ($p < 0.05$)

The average color values of fresh Japanese quince fruits obtained in this experiment are: L* - 65.22, a* - 12.84, b* - 48.82. The results obtained in this experiment are comparable to those obtained in the study of (Wojtyś et al. 2024), the average color parameters for fresh Japanese quince fruits are: L* - 82.11, a* - 11.54, b* - 58.76. Statistical analysis showed a significant effect of the variety, storage time and ozonation time of quince fruit on all the

colour space coordinates determined for them. The lowest lightness (L*) and share of yellow colour (b*) were characteristic of the Maksym variety, and the lowest share of red colour (a*) were characteristic of the Norh Lemon variety. The highest lightness and share of yellow colour were noted in the Tamara variety. On the other hand, the highest share of red colour was characteristic of the Dariusz variety.

CONCLUSION

Based on the results obtained in this experiment, it was determined that there were significant differences between the tested Japanese quince varieties. Ozonation, as well as cold storage, had a significant effect on the mechanical and chemical properties. The Gold Calif variety showed the highest resistance to mechanical damage, requiring the most force and energy for puncturing and exhibiting the greatest degree of deformation. Storing the fruit for 60 days had a significant impact on vitamin C content, leading to a 19.8% average decrease in quince. Among the varieties, Rasa had the highest vitamin C level at 120.29 mg·100 g⁻¹. Treatment with gaseous ozone notably enhanced the total phenolic content, with a 30-minute ozonation

increasing the levels by 6.2% compared to fresh fruit. However, after 60 days of storage, the phenolic content declined by 6.5% relative to fresh fruit. Japanese quince fruits subjected to 30 minutes of ozonation exhibited a 5.8% increase in DPPH activity and a 5.5% increase in FRAP values compared to fruits that were not ozonated. The study demonstrated a significant enhancement in the chemical composition of Japanese quince fruits following exposure to gaseous ozone. Ozonation positively influenced the levels of health-promoting compounds and mechanical resistance, which can be used to improve the quality of Japanese quince fruit.

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