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# INFLUENCE OF CONTROLLED ATMOSPHERE STORAGE ON QUINCE (*CYDONIA OBLONGA*) CULTIVARS QUALITY

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***Abstract***

*The aim of this study is to determine the C.A. storage conditions that can preserve better the organoleptic attributes of quince (Cydonia oblonga Miller, Rosaceae family), depending on the level of $CO_2$. The three quince cultivars studied were 'Ekmek', 'Bereczki' and 'Tinella', monitored for 350 days. The samples were stored in C.A. conditions with: T: 1°C, RH: 95%, O2-3% and different levels of $CO_2$, in the Research Center for Studies of Food Quality and Agricultural Products, of the UASMV Bucharest. The following physiological and biochemical measurements: respiration and transpiration rate, maturity index, ascorbic acid content, were compared with organoleptic attributes. After 350 days of storage, from obtained results it was observed a decrease of the ascorbic acid content between 51,4% (for 'Tinella' cv. in 5% $CO_2$) and 70% (for 'Ekmek' cv. in 5% $CO_2$). For respiration rate were observed increases between 85% (for 'Ekmek' cv.in 2% $CO_2$) up to almost 3 times (for 'Tinella' cv. in 0% $CO_2$), between the initial and final moments. As expected, the $CO_2$ content preserved better the quality of quinces compared with control (0% $CO_2$), based on the results obtained from the sensory analysis.*

***Key words****: ascorbic acid, C.A., mass loss, quince, respiration rate.*

## INTRODUCTION

Quince (*Cydonia oblonga* Mill.), is among the oldest cultivated plants, native to Central Asia (Rop et al., 2011), the crop being found mainly in the Mediterranean countries, Germany, Great Britain, Russia, Eastern European countries and South America (Kuden et al., 2009).

Like apple and pear, quince belongs to the subfamily Pomoideae, family Rosaceae, being known for its distinct, sour and astringent fruit taste (Dehghannya, 2018; Karar, 2014; Szychowski, 2014), rich in sclereids (Bădulescu, 2016). It is one of the least cultivated climacteric fruit species in the temperate zone (Rop et al., 2011).

Quince are known as important sources of polyphenols, vitamins and minerals and with high antioxidant capacity (Karar, 2014; Legua, 2013), their consumption having a positive impact on health (Stojanović, 2017). Consumed less fresh (Rop et al., 2011), quinces are of great interest for processing in the form of jams, juices and are used in pastries. Dried quinces are also used as an ingredient in traditional Iraqi (Wojdylo et al., 2014) and iranian food in the form of stew or quince soup (Dehghannya et al., 2018).

The new post-harvest technologies main objective is to find the optimal storage method with maintaining the fruits organoleptic qualities (Oltenacu et al., 2015).

The attributes with the greatest importance in sensory analysis are fruit firmness, perceived by consumers as an indicator off freshness (Cortellino et al., 2017) and taste that is correlated with maturity index (Yoon et al., 2005). One of the most common methods for the preservation of fruit and vegetables is the controlled atmosphere (C.A.). C.A. helps to maintain the organoleptic characteristics during storage (Oltenacu et al., 2013) and prevent loss of fruit quality (Bessemans et al., 2016).

Changes in fruit quality indicators were observed during storage: increased values for dry matter content and maturity index (TSS/TA) and decresed values for firmness (Jan et al., 2012) and ascorbic acid, the final value for each quality indicator depending on the cultivar (Lemmens et al., 2020).

The aim of this study is to determine the C.A. storage conditions that can preserve better the organoleptic attributes of quince (*Cydonia oblonga* Miller, Rosaceae family), depending on the level of $CO_2$.

## MATERIALS AND METHODS

The three quince cultivars studied were 'Ekmek', 'Bereczki' and 'Tinella', monitored for 350 days. The samples were stored in C.A. conditions with: T: 1°C, RH: 95%, $O_2$:3% and different levels of $CO_2$, in the Research Center for Studies of Food Quality and Agricultural Products, of the UASMV Bucharest. The physiological and biochemical measurements like respiration and transpiration rate, maturity index, ascorbic acid content, were compared with organoleptic attributes.

Before sensory analysis sessions the evaluators were trained to recognize the basic characteristics of each variety. The sensory analysis questionnaire contain questions in order to evaluate organoleptic attributes like: exterior appearance, color, smell, taste, and texture (crunchiness).

Respiration rate was determined with a static, closed system, in containers with hermetic closure with a volume of 1180 ml with Lambda T NDIR Monitor, ADC BioScientific LTd.. The respiration rate was measured and the results were expressed in mg $CO_2$/kg/hour (Enciu, 2020; Stan, 2020).

The transpiration rate was determined using a gravimetric measurements (Fante, 2014; Bezdadea-Cătuneanu, 2019) and the results were expressed in g water/100 g f.w./hour.

The quinces total titratable acidity was determined by titration with NaOH 0.1N to 8.2 pH, using the automatic titrator TitroLine. The firmness of the quinces was determined using a piston of 11 mm diameter (Bessemans, 2016; Rizzolo, 2010) of an electronic penetrometer Turoni TR and the results were expressed in kg/cm$^2$. The total soluble solids content of the quinces juice was obtained with refractive device Kruss DR301-95 (%Brix).

The maturity index was calculated using the formula: TSS/TA, and it was correlated with the values of the taste. The firmness of the samples was correlated with the values of the texture. In this study, one of the main purpose was to compare the organoleptic attributes, provided through trained evaluators, for the three quinces cultivars stored for 350 days in C.A.

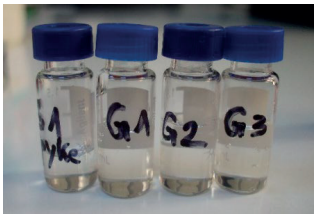


Figure 1. Samples for ascorbic acid evaluation from quince fruits

Ascorbic acid content was determined using the same method described by Bezdadea-Cătuneanu et al. (2017) and Popa et al. (2019). Statistical analyses were performed using Excel, like: mean, standard deviation, ANOVA single factor, T Test and correlations (Pomohaci, 2017; Bezdadea-Cătuneanu, 2019).

## RESULTS AND DISCUSSIONS

Ekmek cv. registered a total score of 4.44 points (Figure 2, Table 1) out of maximum 5 points, for the initial moment, for all five organoleptic attributes. After 350 days of storage in C.A. without $CO_2$, the scores drop at: 2.9 points. Quinces stored in 2% $CO_2$, could no longer be analyzed. The quinces behavior stored in 5% $CO_2$ was different, the score drop at: 4.03 points out of maximum 5 points, after 350 days, for all five organoleptic attributes.

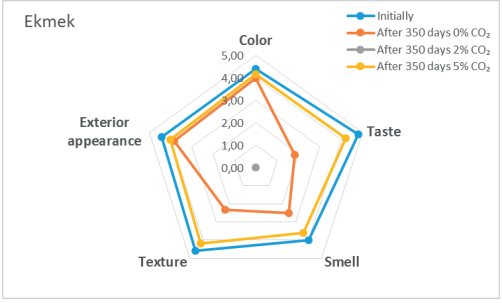


Figure 2. Variation of organoleptic attributes during storage in C.A. conditions for 'Ekmek' cultivar

'Bereczki' cv. registered a total score of 3.84 points (Figure 3, Table 1) out of maximum 5 points, for the initial moment, for all five organoleptic attributes. After 350 days of

storage in C.A. without $CO_2$, the scores drop at: 2.83 points. Quinces stored in 2% $CO_2$, recorded a decrease to 3.03 points. The quinces score, stored in 5% $CO_2$, drop at: 3.38 points out of maximum 5 points, after 350 days, for all five organoleptic attributes.


Figure 3. Variation of organoleptic attributes during storage in C.A. conditions for 'Bereczki' cultivar

'Tinella' cv. registered a total score of 4.56 points (Figure 4, Table 1) out of maximum 5 points, for the initial moment, for all five organoleptic attributes.

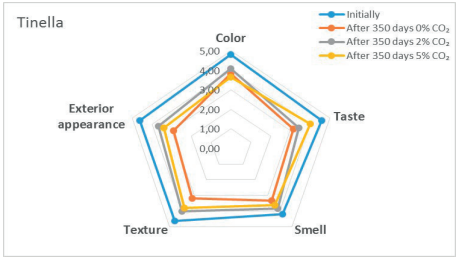


Figure 4. Variation of organoleptic attributes during storage in C.A. conditions for 'Tinella' cultivar

After 350 days of storage in C.A. without $CO_2$, the scores drop at: 3.28 points. Quinces stored in 2% $CO_2$, recorded a decrease to 3.80 points. The quinces score, stored in 5% $CO_2$, drop at: 3.69 points out of maximum 5 points, after 350 days, for all five organoleptic attributes.

All three quince cultivars storage in C.A. without $CO_2$, presented dehydrated peel after storage.

For 'Ekmek' cultivar, the taste and maturity index (TSS/TA) (Table 5) are negatively correlated. But no correlation was observed between firmness and texture.

Slightly negative correlations were reported for 'Bereczki' cultivar between taste of quinces and maturity index (TSS/TA).

For 'Tinella' cultivar, the taste of the fruit is weakly correlated negatively with maturity index. For 'Tinella', the firmness of the quinces was not correlated with texture.

**Respiration rate** (Table 2) showed significant differences ($P<0.05$) for samples stored in 0% $CO_2$, after 210 days, for 'Ekmek' and 'Tinella' cultivars. The tendency to grow maintained up to 350 days. The quince cultivars behaved differently, registering some significant increases compared to the initial moment, thus for 'Ekmek' and 'Tinella', maximum value of respiration rate being registered at 210 days, compared to the initial moment.

**Transpiration rate** (Table 2) of the samples stored in 0% and 5% $CO_2$, showed increases after 210 days, followed by a decrease in values after 350 days of storage.

In 2% $CO_2$, the behaviour of transpiration rate was similar, decreasing at 350 days compared to 210 days, for the 'Ekmek' cultivar and an increase for 'Bereczki' and 'Tinella' cultivars. The values had a decreasing trend at 350 days compared to 210 days.

For 5% $CO_2$, the transpiration rate increased at 210 days followed by a decrease at 350 days.

Table 1. Variation of organoleptic attributes during storage in C.A. conditions for quince cultivars

| | | | Color | Taste | Smell | Texture | Exterior appearance | Total |
|---|---|---|---|---|---|---|---|---|
| **Ekmek** | Initially | | 4,40 | 4,80 | 4,00 | 4,60 | 4,40 | 4,44 |
| | After 350 days | 0% $CO_2$ | 4,00 | 1,83 | 2,50 | 2,33 | 3,83 | 2,90 |
| | | 2% $CO_2$ | | | | - | | |
| | | 5% $CO_2$ | 4,17 | 4,20 | 3,60 | 4,20 | 4,00 | 4,03 |
| **Bereczki** | Initially | | 4,00 | 3,60 | 4,20 | 4,00 | 3,40 | 3,84 |
| | After 350 days | 0% $CO_2$ | 3,83 | 2,00 | 2,83 | 2,33 | 3,17 | 2,83 |
| | | 2% $CO_2$ | 4,00 | 2,17 | 3,00 | 2,50 | 3,50 | 3,03 |
| | | 5% $CO_2$ | 3,92 | 3,00 | 3,60 | 3,00 | 3,40 | 3,38 |
| **Tinella** | Initially | | 4,80 | 4,60 | 4,20 | 4,60 | 4,60 | 4,56 |
| | After 350 days | 0% $CO_2$ | 3,83 | 3,17 | 3,33 | 3,17 | 2,92 | 3,28 |
| | | 2% $CO_2$ | 4,08 | 3,42 | 3,83 | 4,00 | 3,67 | 3,80 |
| | | 5% $CO_2$ | 3,67 | 4,00 | 3,60 | 3,80 | 3,40 | 3,69 |

Table 2. Variation of respiration and transpiration rates during storage in C.A. conditions for 'Ekmek' cultivar

| Ekmek | | Respiration rate | | Transpiration rate | |
|---|---|---|---|---|---|
| | | Average | Std. Dev. | Average | Std. Dev. |
| **Initially** | | 27,3303 | 1,7753 | 0,1153 | 0,0176 |
| **0% $CO_2$** | 210 days | 33,1916 | 7,2097 | 0,0206 | 0,0097 |
| | 350 days | 43,0413 | 12,3647 | 0,0041 | 0,0006 |
| **2% $CO_2$** | 210 days | 45,1075 | 6,7359 | 0,0248 | 0,0014 |
| | 350 days | 23,1412 | 2,5880 | 0,0139 | 0,0014 |
| **5% $CO_2$** | 210 days | 50,4807 | 2,6739 | 0,0368 | 0,0096 |
| | 350 days | 23,7853 | 0,9661 | 0,0289 | 0,0204 |

Table 3. Variation of respiration and transpiration rates during storage in C.A. conditions for 'Bereczki' cultivar

| Bereczki | | Respiration rate | | Transpiration rate | |
|---|---|---|---|---|---|
| | | Average | Std. Dev. | Average | Std. Dev. |
| **Initially** | | 24,4890 | 8,9511 | 0,1132 | 0,0093 |
| **0% $CO_2$** | 210 days | 49,7721 | 12,7657 | 0,0131 | 0,0017 |
| | 350 days | 49,2052 | 1,1895 | 0,0091 | 0,0022 |
| **2% $CO_2$** | 210 days | 43,7863 | 6,1143 | 0,0156 | 0,0103 |
| | 350 days | 63,0061 | 1,4962 | 0,0214 | 0,0000 |
| **5% $CO_2$** | 210 days | 54,3866 | 15,7530 | 0,0479 | 0,0064 |
| | 350 days | 40,8656 | 11,7781 | 0,0096 | 0,0089 |

Table 4. Variation of respiration and transpiration rates during storage in C.A. conditions for 'Tinella' cultivar

| Tinella | | Respiration rate | | Transpiration rate | |
|---|---|---|---|---|---|
| | | Average | Std. Dev. | Average | Std. Dev. |
| **Initially** | | 27,3582 | 1,9520 | 0,0505 | 0,0318 |
| **0% $CO_2$** | 210 days | 20,8385 | 3,0589 | 0,0205 | 0,0062 |
| | 350 days | 78,9048 | 12,5439 | 0,0302 | 0,0087 |
| **2% $CO_2$** | 210 days | 36,5109 | 3,6134 | 0,0263 | 0,0041 |
| | 350 days | 36,0108 | 3,8295 | 0,0318 | 0,0010 |
| **5% $CO_2$** | 210 days | 60,2983 | 32,7145 | 0,0304 | 0,0011 |
| | 350 days | 37,6364 | 3,8392 | 0,0230 | 0,0001 |

Table 5. Variation of maturity index during storage in C.A. conditions for quince cultivars

| Cultivars | | TSS/TA | |
|---|---|---|---|
| | | Average | Std. Dev. |
| **Ekmek** | Initially | 24,58 | 3,74 |
| | 0% $CO_2$ | 50,55 | 1,72 |
| | 2% $CO_2$ | 45,88 | 2,84 |
| | 5% $CO_2$ | 47,90 | 0,84 |
| **Bereczki** | Initially | 23,38 | 0,66 |
| | 0% $CO_2$ | 36,53 | 3,52 |
| | 2% $CO_2$ | 38,16 | 4,26 |
| | 5% $CO_2$ | 41,09 | 1,34 |
| **Tinella** | Initially | 22,23 | 2,51 |
| | 0% $CO_2$ | 33,11 | 0,48 |
| | 2% $CO_2$ | 49,09 | 5,64 |
| | 5% $CO_2$ | 40,59 | 1,50 |

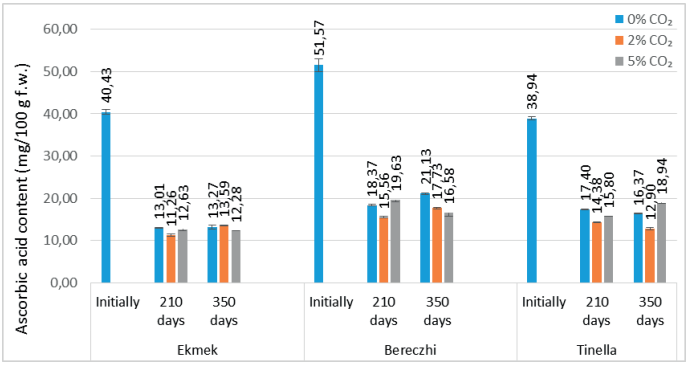


Figure 5. Variation of ascorbic acid content during storage in C.A. conditions for quince cultivars

After 350 days of storage, from obtained results it was observed a decrease of the **ascorbic acid content** between 51.4% (for 'Tinella' cv. in 5% $CO_2$) and 70% (for 'Ekmek' cv. in 5% $CO_2$). For respiration rate were observed increases between 85% (for 'Ekmek' cv. in 2% $CO_2$) up to almost 3 times (for 'Tinella' cv. in 0% $CO_2$), between the initial and final moments. The total ascorbic acid content of 'Ekmek' quince cultivar (Figure 5), recorded 40.43 mg/100 g f.w., similar value of ascorbic acid content with values registered for blueberries, at the initial moment (Shi et al., 2017). The total ascorbic acid content of 'Ekmek' stored in 0% $CO_2$ recorded significant differences during storage, decreasing after 210 days (13.01 mg/100 g f.w.), followed by an insignificant increase 13,27 mg / 100 g f.w. after 350 days. In 2% $CO_2$, 'Ekmek' quinces registered a significant decrease in the total ascorbic acid content, the value being 11.26 mg / 100 g f.w. at 210 days. For 'Ekmek' cultivar stored in 5% $CO_2$, the maximum value was recorded at 210 days (12.63 mg/100 g f.w.), and the minimum value at 350 days (2.777 mg/100 g f.w.).

For 'Tinella' cultivar (Figure 5), the total ascorbic acid content recorde 38.94 mg/100 g f.w. for the initial moment, progressive decrease at 210 days (17.40 mg/100 g mv) and 350 days (16.37 mg/100 g f.w.). In 2% $CO_2$, quinces had a significant progressive decrease for total ascorbic acid content, the value being 14.38 mg/ 100 g f.w. at 210 days, decreasing to 12.90 mg/ 100 g f.w. at 350 days. For quinces stored in 5% $CO_2$, the maximum value was recorded at 350 days of storage (18.94 mg / 100 g f.w.), and the minimum value at 210 days (15.80 mg/100 g f.w.). Rop et al. (2011) recorded values between 41.12 mg / 100 g f.w. and 78.90 mg/100 g f.w. similar values with the initial moment, for all three quince cultivars studied.

## CONCLUSIONS

The $CO_2$ content preserved better the quality of quinces compared with control (0% $CO_2$), based on the results obtained from the sensory analysis.

The total ascorbic acid content decreased sharply during storage for all cultivars, under all conditions.

Respiration rate increased for 'Ekmek' cultivar in 0% $CO_2$ and decreased in the 'Ekmek' cultivar in 2% and 5% $CO_2$. For 'Bereczki' and 'Tinella' cultivars, respiration rate increased in all storage conditions. The transpiration rate decreased for all cultivars, under all conditions.

However, further research it requires for the changes appeared between physiological and biochemical, to highlight the influence of temperature on quinces.

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