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Potravinarstvo® Scientific Journal for Food Industry
Crossref Similarity Check Powered by iThenticate

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Potravinarstvo, vol. 10, 2016, no. 1, p. 598-604
doi:10.5219/672
Received: 17 October 2016. Accepted: 29 November 2016.
Available online: 19 December 2016 at www.potravinarstvo.com

ISSN 1337-0960 (online)

COMPARISON OF THE INFLUENCE OF DEFINED STORING CONDITIONS ON ASIAN AND EUROPEAN PEAR CULTIVARS

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ABSTRACT

The study observed changes in the material composition of European (Conference) and Asian (Yali) pears during the storage period at different temperatures. Three different temperatures were selected for storing, i.e. 1 °C, 5 °C and 20 °C. Assessed for each of the pieces of fruit were flesh firmness, titratable acidity, soluble solids content, content of organic acids, and production of ethylene and carbon dioxide. Fruit stored at 1 °C and 5 °C was analysed before the moment of putting to the store and then after 25, 55 and 70 days of storing. Fruit stored at 20 °C was analysed before the moment of putting to the store and then after 14, 22 and 30 days of storing. The respiration intensity observed through carbon dioxide production at refrigeration conditions was approximately of the same progress for both of the varieties. For the Yali variety, the intensity of respiration of the fruit at the start of the storing period strongly decreased.The same progress was recorded for the Conference variety. Storing at 20 °C increased the respiration intensity. The varieties Yali and Conference which were stored under the temperature of 5 °C had the highest CO_2 production after 70 days of storage. For both varieties the lowest ethylene production during storage was observed at 1 °C. Ethylene production was higher in Yali pear fruits. The Yali variety stored at 20 °C from the beginning produced up to 10 times higher concentration of ethylene than the fruit of the Conference variety. The highest amount of ethylen by the Conference variety was produced by the fruits which were stored under the temperature of 5 °C. At the beginning of the storage period the Conference pears had two-fold higher flesh firmness than the Yali fruit. Fruits of the varieties Yali and Conference which were stored 70 days under the temperature of 1 °C had the highest flesh firmness. For soluble solids and titratable acidity no clear progress was recorded. Malic acid was predominant in both varieties. The Yali fruit contained more citric acid than the Conference fruit. In both varieties soluble solids gradually increased in the early days of storage at all of the monitored temperatures.

Keywords: pear fruit; storage; ethylene; carbon dioxide; acid

INTRODUCTION

The pear tree is included in the Rosaceae family and is an economically important tree species grown in temperate zones **(Bao et al., 2008)**. Consumers evaluate it very positively, mainly because of its distinctive taste properties. Pears fruit are the major source of simple sugars – glucose and fructose etc., organic acids (malic acid and citric acid), minerals, and, last but not least, it also contains a significant amount of ascorbic acid. Sugar and organic acid content have a significant effect on the sensory quality of the fruit, which is also assessed through the physical properties, particularly the size, colour, texture and aromatic properties **(Arzani et al., 2008)**. While stored, the fruit reduces its metabolic activity due to the changes in the concentration of oxygen and carbon dioxide as well as a result of temperature. In addition to keeping good storage conditions, it is necessary to eliminate all the adverse conditions during the growth and ripening of the fruit. **(Chen et al., 2006)**. In recent years, the fruit of Asian pears has been receiving increasing awareness of consumers in Europe. Linked to this is a growing range of cultivars in retail chains, but also in the production practice. To achieve the least possible qualitative and quantitative losses during storage, it is necessary to set optimum storing conditions for individual species or cultivars. Compared to Europe's pears Asian pears are more juicy, and are therefore more susceptible to damaging caused by bruising during handling, which can lead to excessive softening of the flesh and rotting during storage **(Mahajan and Dhatt, 2004)**. To initiate ripening, European pears fruit require the action of rather low storage temperatures, or treatment with exogenous ethylene **(Elgar et al., 1997)**. During storage, climacteric fruits exhibit an increased intensity of respiration and the fruit produces ethylene. Non-climacteric species do not show increased respiration when ripening and the fruit produces ethylene. Cultivars of European pears of *Pyrus comunnis* L. rank among climacteric fruits and feature the formation of butyrous consistency. Cultivars of *Pyrus pyrifolia* Nakai pears are among both climacteric and non-climacteric species; they remain firm and juicy when stored for a long time, but lack the butyrous consistency. **(Jackson, 2003; Itai et al., 2003; Itai and Fujita, 2008)**.

MATERIAL AND METHODOLOGY

Fruit material

The experiment studied the cultivars of European Conference (Figure 2) pears and Asian Yali (Figure 1) pears. The fruit came from orchards of the Horticultural

Figure 1 *Pyrus* x *bretschneideri* variety Yali.

Figure 2 *Pyrus communis* variety Conference.

Faculty, Mendel University Brno, Czech Republic. Once harvested, the fruit of the Yali and Conference varieties were immediately stored under three different storage conditions, at the temperature of 1 °C, 5 °C and 20 °C, normal atmosphere. During storage, the fruit was sampled to determine the physico-chemical parameters, i.e. production of ethylene, production of carbon dioxide, flesh firmness, titratable acidity, soluble solids, and organic acids. For both varieties and for storage temperatures of 1 °C and 5 °C, taking samples from the refrigeration room occurred after specified days of storage: the beginning, i.e. day 0, then day 25, day 55 and day 70. For the storage temperature of 20 °C sampling took place on day 0, day 14, day 22 and day 30. Analysis was carried out each time for three samples per variety to calculate the mean and standard deviation of the parameter observed.

Parameters

Flesh firmness was determined by a manual penetrometer with the punch diameter of 11 mm and expressed in MPa. Total acids were assessed by a pH meter with a combined electrode by alcalimetric titration using the 0.1 $mol.l^{-1}$ NaOH (up to pH 8.1). Contents of acids were expressed as content of malic acid (%). Soluble solids content (SSC) was expressed by the index of refraction (°Bx) measured by Abbe refractometer. Contents of CO_2 and ethylene were determined using the GC Agilent 4890C apparatus. Ethylene was estimated by capillary gas chromatography (CGC) using a flame ionisation detector FID. The content of CO_2 was estimated concurrently using a thermal conducting detector TCD. Organic acids (malic and citric) were assessed by HPLC. Assessment conditions: Column: Prevail 5µm Organic Acid 110A HPLC Column 250×4.6 mm, flow rate of mobile phase 25 mM KH_2PO_4 $1mL.min^{-1}$, wavelength 210 nm, temperature +30 °C. Contents of organic acids were expressed in $mg.kg^{-1}$.

RESULTS AND DISCUSSION

For the Yali variety, the intensity of respiration of the fruit at the start of the storing period strongly decreased as measured by the production of carbon dioxide (Figure 3). The same progress was recorded for the Conference variety, which was associated with a decrease in metabolic processes due to cooling the fruit to 5 °C or as low as 1 °C. Conversely, storing at 20 °C increased the respiration intensity which was particularly true for the Conference variety (Figure 4), where the course was typical of the climacteric fruit type (carbon dioxide production over 40 $mg.kg^{-1}.h^{-1}$ on day 14 of storage).

Under refrigerated conditions (1 °C and 5 °C) the respiration intensity did not change significantly and production of carbon dioxide reached a maximum of 10 $mg.kg^{-1}.h^{-1}$ within the initial 55 days of storage. At the end of storage (day 70) both varieties responded to the temperature of 5 °C by similarly high increase in carbon dioxide production (more than 30 $mg.kg^{-1}.h^{-1}$).

For both varieties, the lowest ethylene production during storage was observed at 1 °C (Figures 5 and 6). The ethylene production slightly grew during storage at both

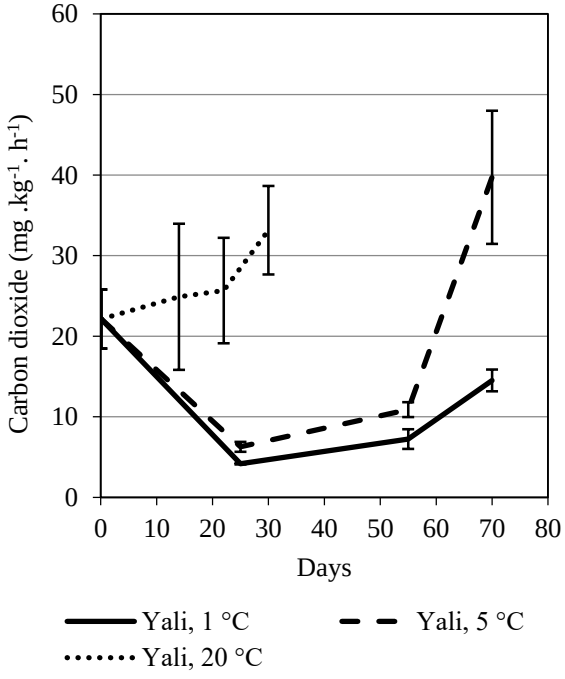

Figure 3 Carbon dioxide generated during the period of storing pears of the Yali variety at different teperatures.

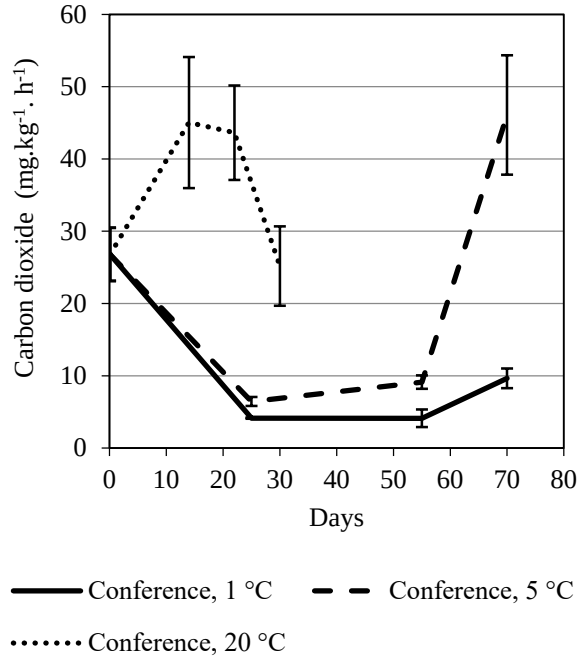

Figure 4 Carbon dioxide generated during the period of storing pears of the Conference variety at different teperature.

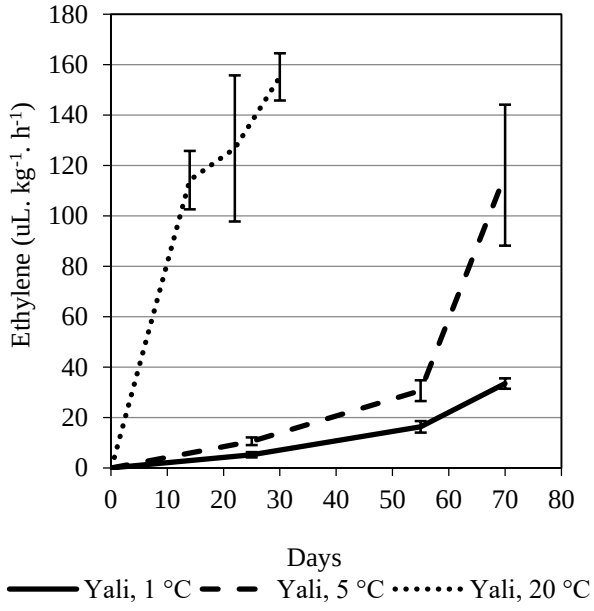

Figure 5 Ethylene generated during the period of storing pears of the Yali variety at different temperatures.

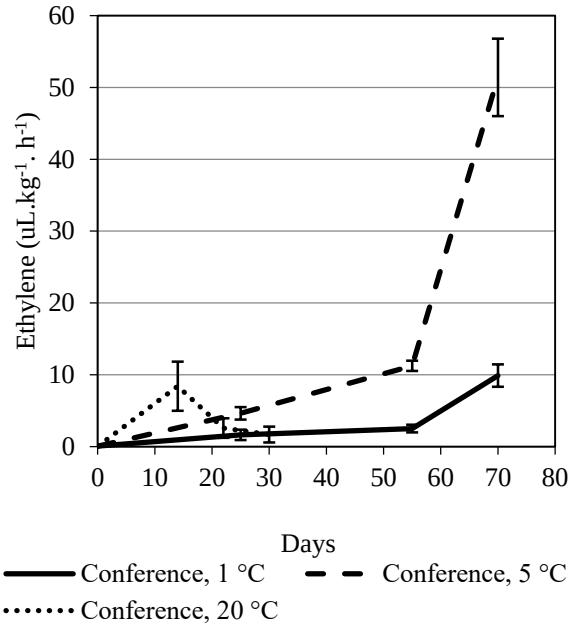

Figure 6 Ethylene generated during the period of storing pears of the Conference variety at different temperatures.

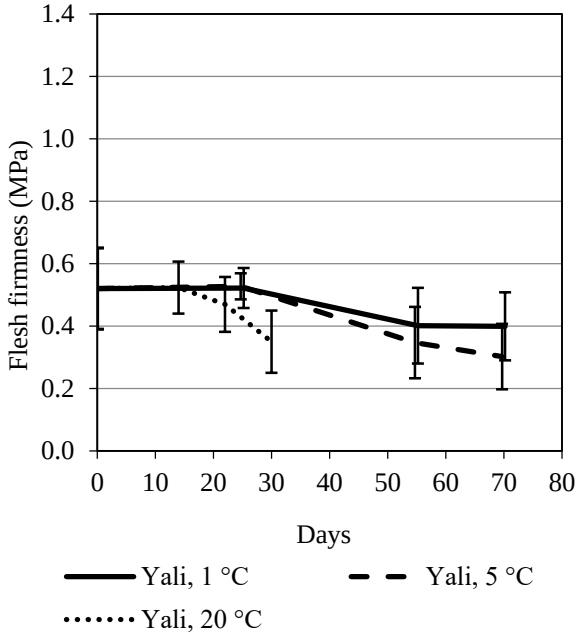

Figure 7 Changed flesh firmness during the period of storing pears of the Yali variety at different temperatures.

refrigerator temperatures for the studied varieties. After 55 days of storage, ethylene production was observed to undergo a rather significant increase which particularly applied to the fruit stored at 5 °C. The Yali variety stored at 20 °C from the beginning produced up to 10 times higher concentration of ethylene than the fruit of the Conference variety. The similar results were achieved by **Arzani et al., (2008)** who monitored the difference during storage of European and Asian pear varieties when the fruit was stored for five months and analysis was conducted after storage month 1, 3 and 5. The Asian fruit was observed to contain 5 times less ethylene than that of European origin. A slight increase in ethylene content occurred during storage in both of the species

At the beginning of the storage period the Conference pears (Figure 8) had two-fold higher flesh firmness than the Yali fruit (Figure 7). The documented changes in the fruit firmness during the storage period make it apparent that the ripening process is greatly influenced by the temperature of storage of pears and was greatly slowed at 1 °C. Far more sensitiveness towards the temperature of post-harvest storage was seen in the Conference pears

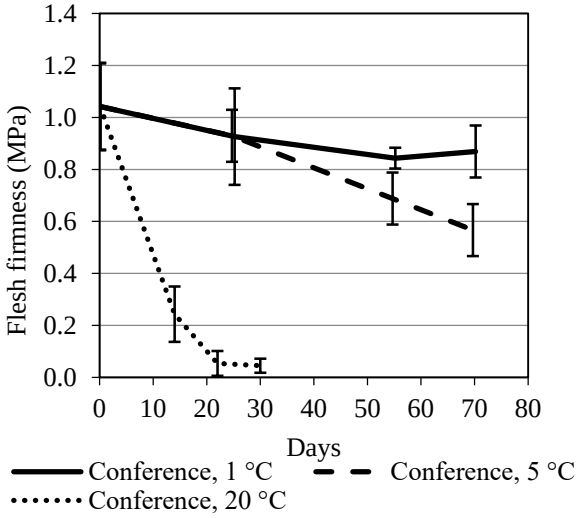

Figure 8 Changed flesh firmness during the period of storing pears of the Conference variety at different temperatures.

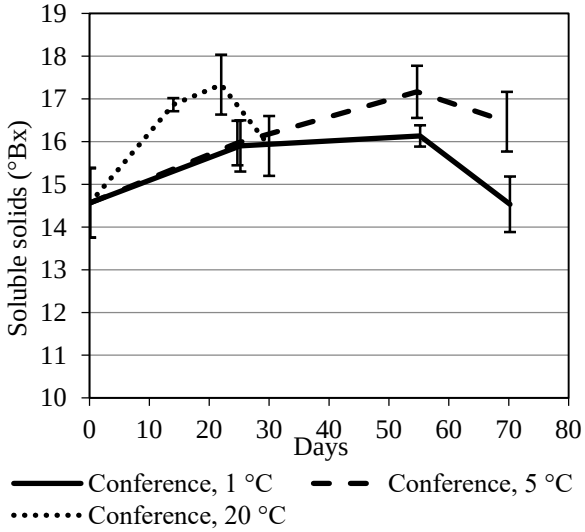

Figure 9 Changed soluble solids during the period of storing pears of the Conference variety at different temperatures.

when it achieved a completely soft structure at the storing temperature of 20 °C after 22 days.

In both varieties soluble solids gradually increased in the early days of storage at all of the monitored temperatures. The Conference pears featured soluble solids of 14.8% immediately after putting into the store (Figure 9). A rapid rise in the content of soluble solids occurred for the pears that were stored at 20 °C; for the temperature of 1 and 5 °C, the increase was gradual until the storage day 50. The Yali pears featured soluble solids of 11% immediately after putting into the store (Figure 10). A gradual rise in the content of soluble solids (55 days) occurred only in the fruit stored at 1 °C. At the end of the storage period there was a decrease of 0.5% approximately.

Chen et al., (2006) noted a similar pattern as regards soluble solids content. The fruit contained 11% soluble solids after storage; over the next two months, the content gradually increased up to 12%; between month 3 and month 4 there was stagnation in terms of content and the

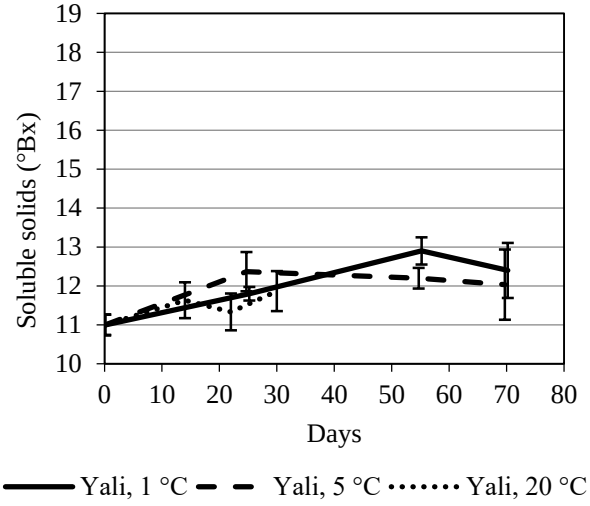

Figure 10 Changed soluble solids during the period of storing pears of the Yali variety at different temperatures.

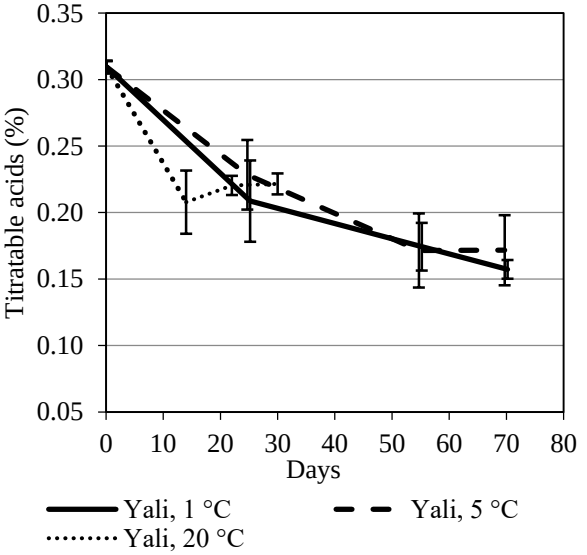

Figure 11 Changed titratable acidity during the period of storing pears of the Yali variety at different temperatures.

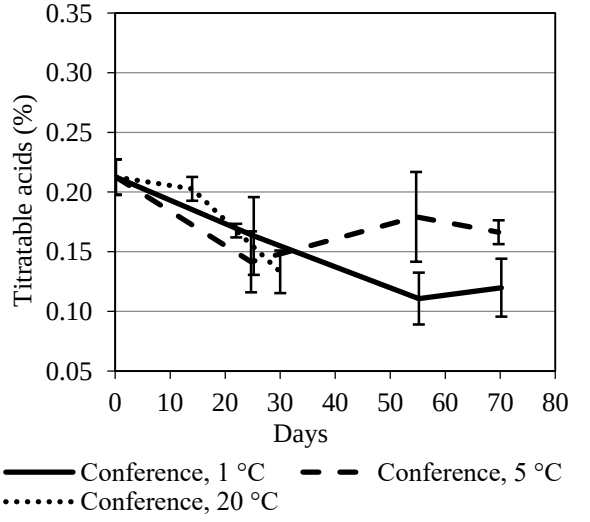

Figure 12 Changed titratable acidity during the period of storing pears of the Conference variety at different temperatures.

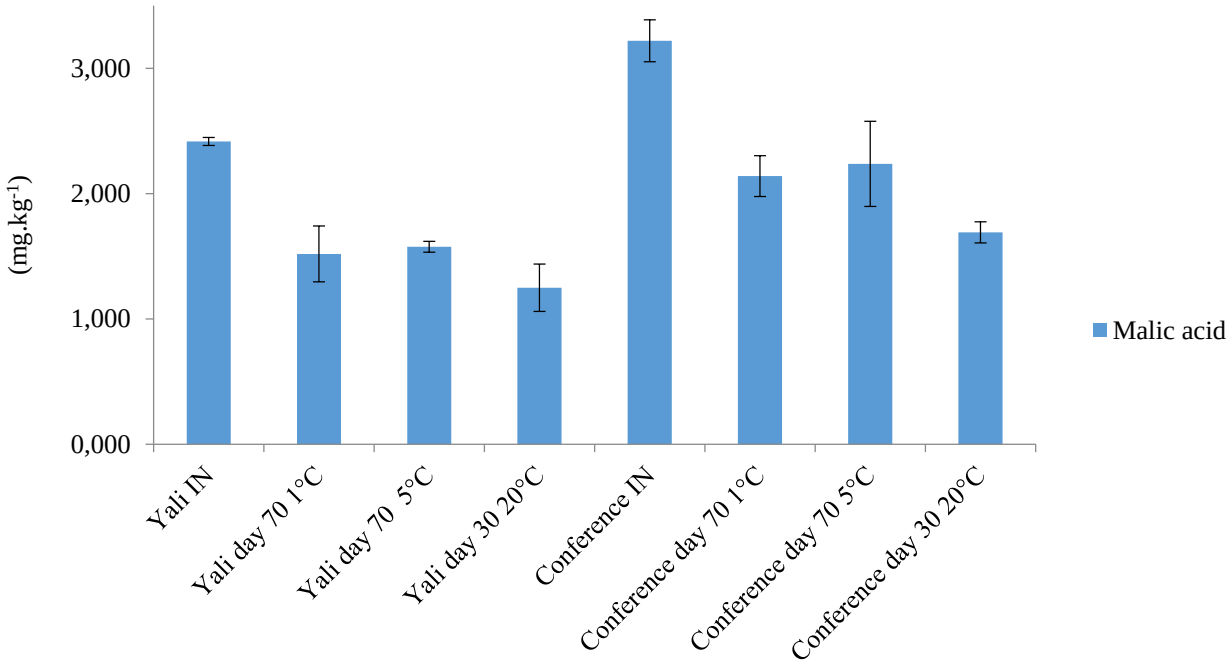

Figure 13 Changes in the content of malic acid at the beginning and the end of the storage period of the pear varieties.

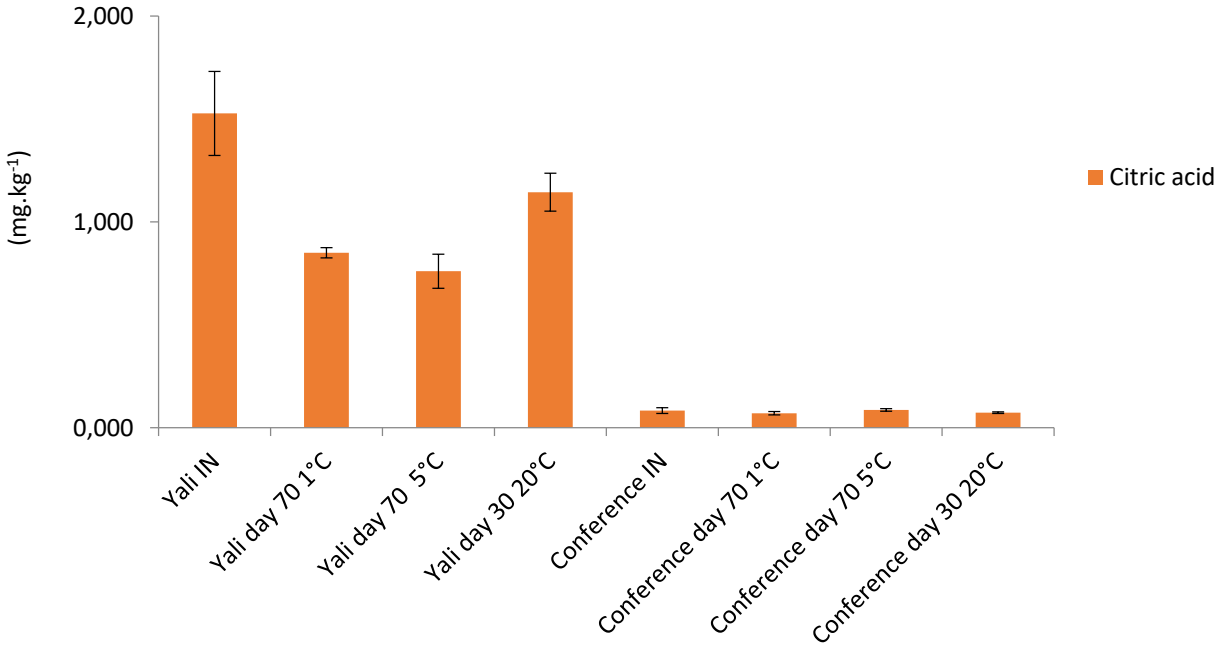

Figure 14 Changes in the content of citric acid at the beginning and the end of the storage period of the pear varieties**.**

last month of storage there was a drop to 11.5%. Immediately after the harvest the fruit flesh firmness was 0.8 MPa while a reduction was seen over the five-month period, the value being approximately identical every month (0.3 MPa). After 5 months of storage, the fruit was measured to show flesh firmness of 0.65 MPa. **Crisosto et al., (1994)** surveyed changes in the content of soluble solids in Asian pears during the storage period of one month. With the figure being around 10% all the time, almost no changes were noted.

A certain increase in soluble solids during storage could be linked to weight loss of fruit while stored. Rather, reducing titratable acidity of the fruit of the pear varieties observed is documented through the trend of ventilating acids during the fruit post-harvest storage period, which particularly applies to the Yali cultivar. The Conference variety contained 0.31% titratable acidity at the beginning of storage period; after 70 days of storage at 1 and 5 °C the content halved (Figure 12). The Yali variety contained 0.20% titratable acidity at the beginning of storing period. A significant reduction of content was seen particularly for fruit stored at 20 °C and 1 °C (Figure 11). A very similar trend as regards the acid content was also reported in the publication of **Arzani et al., (2008)** who monitored titratable acidity in European and Asian pears. At the beginning of storage the Asian pears contained 0.25%

while the European fruit had 0.30%; after month 5 the acidity decreased by almost a half. The decrease in titratable acidity was also seen by **Mahajan and Dhatt (2004)** who monitored titratable acidity of Asian pear varieties during the period of cold storage of 75 days. After putting into the store the acid content was 0.36%; after 75 days of storage it reached 0.15%.

For acidity, malic acid is represented the most in the fruit of both of the studied varieties (Figure 13). Compared with the initial concentration of 3,220 $mg.kg^{-1}$, a half-drop occurred for the Conference variety after 30 days of storage at 20 °C when only 1,691 $mg.kg^{-1}$ was measured. In terms of malic acid concentration, both of the varieties were found to show statistically significant differences between the beginning (IN) and the end of the storage period on all of the three dates (Table 1).

The Yali pears were noticed to show statistically significant differences between the beginning (IN) and the end of the storage period on all of the three dates, in terms of citric acid concentration. The Yali pears contained over ten-fold amount of citric acid than the Conference pears (Figure 14). For the Conference variety no statistically significant differences were found in terms of citric acid content.

The average content of malic acid in the Conference pears was 2,300 $mg.kg^{-1}$. For Williams Pears, i.e. another pear variety, malic acid concentration was monitored by Colaric et al., (2006). The average content was around 2,200 $mg.kg^{-1}$.

CONCLUSION

The study observed changes in the material composition of European (Conference) and Asian (Yali) pears during the storage period at different temperatures. Ethylene, carbon dioxide, flesh firmness, titratable acids, soluble solids and organic acids formed the main monitored parameters. Under refrigerating conditions, the intensity of respiration did not change significantly in the initial 55 days of storage. At the end of the storage period there was a significant increase in carbon dioxide production in both of the two varieties. A similar carbon dioxide content (30 $mg.kg^{-1}.h^{-1}$) was found after 30 days of storing the fruit of both varieties at 20 °C. Generation of ethylene slightly grew during the storage period for the varieties studied. The Yali pears produced higher levels of ethylene than the Conference pears in all of the monitored settings. Increasing of the metabolism through the production of ethylene, fundamentally ranges in values of Q_{10} not very different from the production of CO_2. Temperature quotients Q_{10} for respiration are higher for the cultivar Conference, while the Q_{10} for the production of the ethylene are higher for the cultivar Yali. The fruit of the Conference variety had a stronger flesh; at 20 °C, however, there was a very rapid softening and after 20 days of storage, the structure of these pieces of fruit was entirely soft. The Conference pears featured a higher soluble solids content under all of the storage conditions; the figure was steadily increasing in both of the varieties and a slight decline occurred toward the end of the storage period. The Yali pears had a higher titratable acidity at the beginning of the storage period, which in both varieties dropped below the value found when putting the fruit into the store; this occurred during the storage period under all of the studied conditions. For organic acids, malic acid was represented at the highest concentration in both of the varieties. After 30 days of storing the Conference pears at 20 °C, the content of malic acid decreased by 50% compared with the original concentration. Over a ten-fold amount of citric acid was determined for Yali pears compared with the Conference pears.

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Acknowledgements:
This presentation has been supported by a grant received from the NAZV Agency of the Ministry of Agriculture of the Czech Republic, project ID: QJ1210036.

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