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EFFECT OF 1-METHYLCYCLOPROPENE ON 'BOSC KOBAK' PEARS

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1-Methylcyclopropene (1-MCP) is the active component of the SmartFresh Quality System. By the application of the 1-MCP compound, quality of the harvested pears can be preserved longer during the normal cold storage. In our work, the effectiveness of the SmartFresh Quality System was investigated on 'Bosc Kobak' pears (*Pyruscommunis* L.) harvested at different times. The rheological changes and storage losses were measured. The effectiveness of 1-MCP depends on many variables, but our results show that the optimal harvest date and the condition of the harvested fruit are the most influential factors.

Keywords: 1-Methylcyclopropene, Bosc Kobak, pear, ripening, ethylene, firmness

1-Methylcyclopropene (1-MCP) is an ethylene action inhibitor that has been used after harvest to retard ripening in a range of fruits (Sisler & Serek, 2003; Watkins, 2006). In pear fruit, 1-MCP treatment has been reported to decrease softening, colour development, respiration rates, and ethylene production (Baritelle et al., 2001; Argenta et al., 2003; Hiwasa et al., 2003; Calvo & Sozzi, 2004; Trinchero et al., 2004; Mwaniki et al., 2005).

'Bosc Kobak' is one of the three most important winter pear cultivars grown in Hungary. 'Bosc Kobak' pears are normally harvested in Hungary from middle September to middle October, and cool-stored until marketing, generally for 90–120 days, to avoid losses due to the development of superficial and senescent scald and internal breakdown. Ethylene produced by the fruit during storage can exacerbate the incidence of these physiological disorders, and 1-MCP is highly effective to control or reduce their incidences (Du & Bramlage, 1994; Watkins et al., 1995; Bower et al., 2003; Ekman et al., 2004; Gapper et al., 2006; Hitka et al., 2006).

Although postharvest application of 1-MCP provides valuable benefits, it is challenging to obtain normal softening and ripening in 1-MCP-treated 'Bosc Kobak' pears if the treatment was performed immediately after harvest. The 1-MCP treatment appears to reinforce the natural characteristics of European pears, which are resistant to ripening after harvest, and require a certain period of cold storage or ethylene exposure to induce ripening (Villalobos-Acuña et al., 2011).

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1. Materials and methods

1.1. Plant material

‘Bosc Kobak’ pears (mean fruit weight =163.2 g) were harvested from a commercial orchard in Bodrogköz area, Hungary. There were 2 different harvest dates (mm.dd.yyyy.) from the first and the last days of harvest time: 09.11.2012. and 09.16.2012. Pears were sorted for uniformity, appearance, and absence of physical defects. Thirty fruits were used to analyse different maturity indices (firmness, soluble solids content, and starch degradation) at the beginning of the experiment.

1.2. 1-MCP application and fruit storage.

Fruit bins were forced-air cooled from 20 to 5 °C (core temperature) after harvest within 24 h. The 1-MCP treatments were performed 2 days after the harvests in a 260 m^3 volume cold storage room at Kiskunfélegyháza, Hungary. Core temperature of the pears was below 5 °C during the treatment, while the room temperature was set to a constant 1 °C. Fruits were exposed to 1-MCP (SmartFresh®, AgroFresh, Philadelphia, USA) for 24 h, the concentration of 1-MCP was 625–650 ppb (standard commercial application rate). 1-MCP treatments were carried out in airtight storage rooms with continuous ventilation, as described in the requirements of the SmartFresh Quality System. Some of the samples received a red mark, indicating that they did not get 1-MCP treatment (Control), while the green marked group meant the treated samples (SF). The fruit of Control group were in a different storage room under the same conditions as the treated ones during the 24-h long 1-MCP treatment. After treatments, all the samples were stored in the same storage rooms.

After the treatments, fruit were immediately transferred and kept at 20 °C for 10 days (for post-application shelf life test) or stored at −0.5 °C and 95% RH for 60, 120, or 180 days. During the cold storage, carbon-dioxide level was no higher than 1.5 v/v %. After cold storage, fruits were transferred to a room at 20 °C for 1 or 7 d for further ripening and fruit firmness, soluble solids content, and ethylene production measurements. Laboratory works were carried out at the Department of Postharvest Science and Sensory Evaluation.

1.3. Fruit quality assessment

1.3.1. Starch–iodine test. The starch–iodine test was performed at harvest on 30 fruits, taking a slice from the equatorial region of the fruit and dipping it in a solution of iodine crystals plus potassium-iodide (Kingston, 1992). Then, each sample was rated using a chart (1–6) for comparison (LeLezec & Belouin, 1994).

1.3.2. Ethylene production. Ethylene production was assessed by placing six pears in a 4 litre tightly sealed plastic container for 2 hours at 20 °C. Ethylene was quantified with an ICA-56 ethylene analyzer (International Controlled Atmosphere Ltd., UK). Results were expressed as microlitre of ethylene produced per kilogram of fruit in 1 h. Three independent samples were analysed in each group.

1.3.3. Fruit firmness. Fruit firmness was determined by measuring the force required to penetrate each pear, with the skin removed, using a penetrometer (FT327, TR Turoni srl, Forli, Italy). Two spots located on opposite sides of the equatorial region of each fruit were punctured to a depth of 10 mm using a 7.9 mm round-surfaced cylindrical probe. The average of those two measurements was considered as one replicate. Results were expressed as kg·cm^{-2}. Twenty pears were evaluated in each group.

1.3.4. Soluble solids content. The juice that was released by the firmness test was used to measure soluble solids content (SSC) with a hand-held temperature-compensated refractometer (Atago Co. Ltd., Tokyo, Japan) and expressed as %. Twenty pears were evaluated in each group.

1.3.5. Rate of black seeds. Rate of black seeds can give information about the ethylene accumulation of the pears. It was calculated in each group by cutting 20 pears in half at the equatorial region and counting the rate of black and white seeds. Results were expressed as %.

1.3.6. Incidence of disease and disorders. Hundred fruits from each group were used for assessment of storage disease and disorders. Superficial and Senescent scald, Bitter pit, and Botrytis Rot (Grey mould) were observed during the storage period. Each fruit was assessed visually and classified as 'yes' or 'no' disorder regardless of degree of severity. Incidence of disorder was expressed as percentage of affected fruit.

1.4. Statistical analysis

Differences between the parameters of objects were estimated by using one-way analysis of variance (ANOVA, SPSS, ver. 11.0.1., SPSS Inc, USA).

2. Results and discussion

Table 1 shows the postharvest quality of 'Bosc Kobak' pears at two different harvesting times. Percentage of black seeds indicates the action of ethylene in the fruit. Higher ethylene production leads to maturation, which can also be determined by the measurement of starch content. While firmness was similar for the two harvesting times, sugar content, starch content, percentage of black seeds, and ethylene productions show us that pears harvested later were in higher maturity stage. Using the SmartFresh Quality System after 10 days of shelf-life the fruits retained their firmness and their ethylene production was blocked.

Table 2 represents the quality of control and 1-MCP (SF) treated 'Bosc Kobak' pears after 2, 4, and 6 months of storage and then 7 days shelf-life. During the storage period, firmness decreased only by 2–3 kg·cm^{-2}. The real differences came from the shelf-life time between the treated and control groups. Fruits from the first harvest date were in better condition at the end of storage. After 4 months of storage, ethylene production started again in the SmartFresh fruits, which means that storage time could be extended by minimum 2 and maximum 4 months at this cultivar using 1-MCP. Another benefit of using SmartFresh Quality system was the decrease in storage disorders, it meant 20% more 1st class quality pears after a long storage time. Only 5 days difference in the harvest time can lead to 3 kg·cm^{-2} difference in firmness after the shelf-life. So if it were necessary to keep the firmness during the shelf-life (sell the product to fruit trader) it is better to choose an earlier harvest time. But on the other hand, if you wished to sell the pears to the fresh market, the firmness is better to be closer to ready-to-eat quality, so in this situation it is advisable to choose the second harvest time for storage in spite of knowing that the percentage of disorders can be higher.

Table 1. Quality of the pears at harvest time and after 10 days of shelf-life

		Avg. Firm. kg·cm^{-2}	SSC %	Black seed %	Starch (1–6)	Disorders %	Ethylene prod (ul kg^{-1} h^{-1})
Harvest date: 09.11.2012. Application date: 09.13.2012. Shelf-life date: 09.24.2012.	Initial	14.22	14.39	28%	1.3	0%	–
	Shelf Life Control	2.92 b	15.42 a	100%	–	0%	2.47 a
	Shelf life SF	13.26 a	14.46 b	100%	–	0%	0.09 b
Probability		***	***				***
Harvest date: 09.16.2012. Application date: 09.18.2012. Shelf-life date: 09.29.2012.	Initial	14.52	13.60	58%	2.45	–	–
	Shelf Life Control	6.88 b	13.87 b	100%	–	0%	4.98 a
	Shelf life SF	11.22 a	14.39 a	100%	–	0%	0.18 b
Probability		***	***				***

Levels of statistical significance are *P < 0.05, **P < 0.01 and ***P < 0.001
Values within a given column not followed by the same letter are significanly different at P=0.05 (at the same measurement time)

Table 2. Quality of the pears after 2, 4 and 6 months of storage and 7 d shelf-life.

	Harvest date: 09.11.2012.				Harvest date: 09.16.2012			
2, 4, and 6 months storage (ST) + 7 days Shelf Life (SL)	Avg. Firm. kg·cm^{-2}	SSC %	Disorders%	Ethylene prod. (ul kg^{-1} h^{-1})	Avg. Firm. kg·cm^{-2}	SSC %	Disorders%	Ethylene prod (ul kg^{-1} h^{-1})
2M Storage Control	11.92 b	14.85 b	0%	3.01 b	10.82 b	14.83 b	0%	2.59 b
2M Storage SF	13.34 a	15.44 a	0%	0.24 c	12.80 a	14.49 b	0%	0.25 c
2M ST + SL Control	2.6 c	14.00 c	0%	11.47 a	2.02 d	15.42 a	0%	5.44 a
2M ST + SL SF	11.22 b	15.46 a	0%	0.81 c	7.76 c	15.40 a	0%	0.63 c
Probability	***	*		***	**	*		***
4M Storage Control	9.66 b	14.19 c	0%	4.74 b	11.68 b	14.53 b	0%	4.06 b
4M Storage SF	12.38 a	14.99 ab	0%	0.85 c	12.90 a	15.18 a	0%	0.75 d
4M ST + SL Control	3.82 c	15.51 a	10%	7.62 a	3.22 d	14.68 b	40%	6.94 a
4M ST + SL SF	9.4 b	15.24 a	0%	1.31 c	6.44 c	15.05 a	25%	2.38 c
Probability	*	*		***	**	*		***
6M Storage Control	11.74 a	14.44 c	30%	4.41 c	11.02 a	14.64 b	32.5%	4.43 b
6M Storage SF	11.82 a	15.52 b	0%	1.08 d	12.2 a	16.57 a	7.5%	2.46 c
6M ST + SL Control	4.36 c	14.25 c	30%	8.44 a	3.88 c	14.19 b	30%	6.12 a
6M ST + SL SF	7.74 b	16.43 a	10%	6.57 b	4.32 b	16.21 a	10%	4.42 b
Probability	*	*		***	*	*		**

Levels of statistical significance are *P < 0.05, **P < 0.01 and ***P < 0.001.
Values within a given column not followed by the same letter are significanly different at P=0.05 (at the same measurement time)

3. Conclusions

Selecting the optimal harvest time leads to better firmness, less storage disorders, and better shelf-life quality. The starch content and the percentage of black seeds of fruit are key indicators of the long-term storage. We suggest that the optimal firmness should not be lower than 14 $kg \cdot cm^{-2}$, the starch content not higher than 2 (1–6 scale), and the percentage of black seeds should not be higher than 30% for long-term storage. Using SmartFresh Quality system the ethylene production can be blocked for 2–4 months, which can result in better fruit quality after storage and also longer shelf-life.

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