Storage and Shelf-life Behaviour of New Apple Cultivars

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Abstract

In 2016, two new apple cultivars 'Dalinsweet' and 'WUR 037' were investigated for storage and shelf-life behaviour at the Competence Centre for Fruit Growing at Lake Constance (KOB). Both cultivars are scab resistant and of interest for organic production. 'Dalinsweet' and 'WUR 037' were stored for 4, 6 or 8 months under different storage regimes. 'Dalinsweet' maintained good fruit firmness in storage and seems to store well for up to 6 months under CA conditions. Incidence of rots and flesh browning make 'WUR 037' unsuitable for long term storage.

Keywords: 'Dalinsweet', 'WUR 037', organic production, storage disorders

Introduction

For organic apple production, 'Topaz' was the standard cultivar in Germany until its scab resistance seems to be broken. This has led to a great interest to find alternative apple cultivars suitable for organic production. 'Dalinsweet' and 'WUR 037' are new scab resistant cultivars which could be the alternatives to 'Topaz' as their breeding programmes have focused on disease resistance, eating quality, yield and tree growth habit. But little attention has been given to storability which also plays a major role in the economic evaluation of a new apple cultivars and their acceptance by the fruit industry. This study investigates storage and shelf-life behaviour.

Material and Methods

Cultivars and storage conditions

'Dalinsweet' was stored for 4 and 6 months and 'WUR 037' was stored for 4 and 8 months. The storage conditions were 1 or 3°C and RA (20.9kPa O_2 + <0.1kPa CO_2 or CA (1.0 kPa O_2 + <0.7 kPa CO_2 or 1.0 kPa O_2 + 2.5 kPa CO_2).

Fruit analyses

Fruit (8 x 3 replicates) of both cultivars were analysed at-harvest and a ripening index (Streif-Index) was calculated [fruit firmness (FF) / total soluble solids (TSS) x starch index (1-10)]., In addition, the skin ground colour and titratable acidity (TA) were determined at-harvest as well as at the end of storage and after 7 d shelf-life at 20°C. Physiological disorders were assessed at the end of shelf-life.

FF was measured by first peeling the apple skin of each fruit at the equatorial plane on the border between the sunny side and shady side using a semi-automatic penetrometer (Fruit Texture Analyser, Güss, South Africa). The results presented are given in N.

TSS was assessed by juicing the apples, combining the juice from one replication measuring the °Brix using a refractometer (PR32α Atago, Japan). TA in mEq/100ml was assessed from 10ml of fruit juice per repetition using a semi-automatic titrator (Tiamo Methrohm, Germany). The skin ground colour on individual fruit was assessed as °hue-angle using a chroma meter (CR300 Konica Minolta, Germany). The lower the °hue angle, the more yellow (around 90)

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and riper the fruit, higher values (around 120) indicate greener ground colours and less ripe fruit.

Results and Discussion

The maturity parameters for ‘Dalinsweet’ and ‘WUR 037’ are given in Table 1. ‘Dalinsweet’, shows a lower Ripening-Index (by Streif) of 0.08 when compared to ‘WUR 037’.

Table 1: Fruit quality parameters per cultivar at-harvest, ±standard deviation (n=24).

Cultivar	Harvest date	Firmness [N]	TSS [°Brix]	Starch [1 to 10]	Ripening-Index
‘Dalinsweet’	2016-10-27	84.7 ± 14.5	14.5 ± 0.3	6.9 ± 1.0	0.08
‘WUR 037’	2016-09-16	92.4 ± 7.4	12.5 ± 0.2	6.4 ± 1.2	0.12

In storage, the higher CO_2-level (2.5 kPa) resulted for ‘WUR 037’, in less rots, when combined with low temperature compared to CA storage at 3°C or RA (Fig. 1). After 6 months RA storage period at 3°C up to 32% rots occurred, mainly caused by *Neofabraea alba* and *N. perennans* (syn. *Gloeosporium spp*.).

In contrast to ‘Dalinsweet’, ‘WUR 037’ stored at 1°C and 2.5 kPa CO_2 showed up to 50% incidence of flesh browning after 8 months storage. Skin browning was a problem after 8 months storage at 3°C plus 7 d shelf-life (Figure 1).

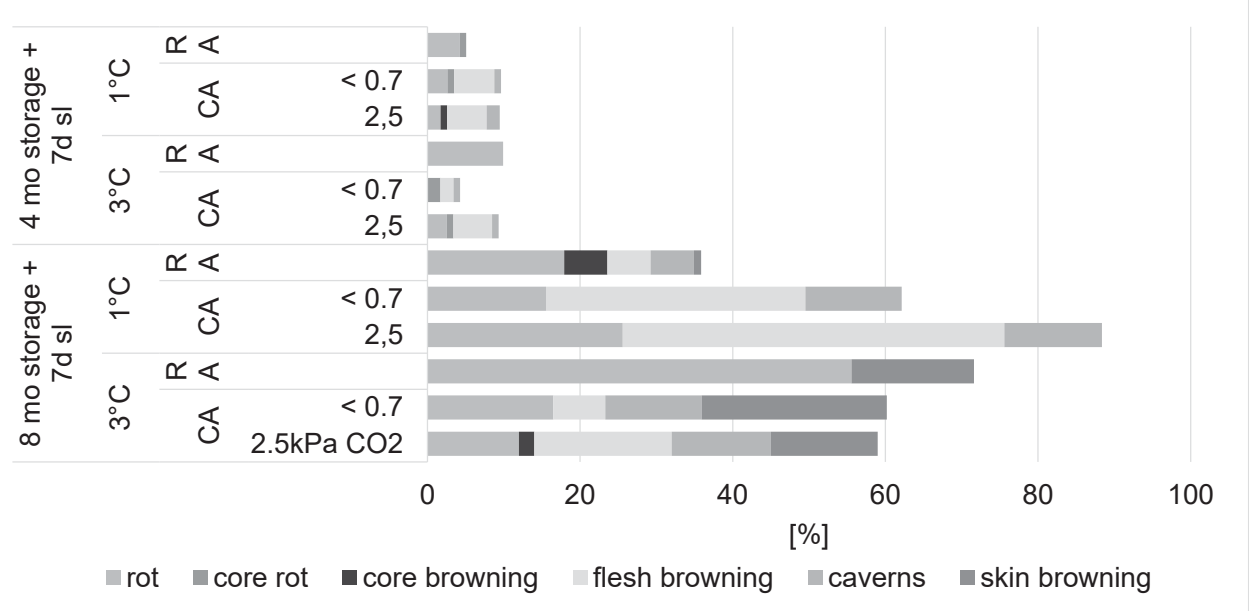

Figure 1: ‘WUR 037’ incidence of storage disorders after 4 or 8 months storage + 7 days shelf life.

After storage ‘Dalinsweet’ showed a good maintenance of flesh firmness when stored in CA (Table 2).

Table 2: Fruit Firmness [N] of ‘Dalinsweet’ after 4 or 6 months under RA or CA (1.0 kPa O_2, <0.7 kPa or 2.5 kPa CO_2) at 1°C or 3°C and 7 d shelf-life at 20°C.

Fruit Firmness [N]								
At-harvest					84.69	±	14.45	ab [x].
after removal	4 months storage	1°C	RA		69.75	±	11.65	efgh
			CA	< 0.7kPa	83.20	±	8.24	abc
				2.5kPa	84.85	±	7.09	a
		3°C	RA		66.35	±	5.98	ghi
			CA	< 0.7kPa	82.13	±	10.05	abcd
				2.5kPa	80.83	±	7.84	abcd
	6 months storage	1°C	RA		68.48	±	9.17	fgh
			CA	< 0.7kPa	80.45	±	7.00	abcd
				2.5kPa	80.84	±	5.59	abcd
		3°C	RA		65.49	±	5.72	ghi
			CA	< 0.7kPa	76.21	±	9.01	bcdef
				2.5kPa	75.82	±	6.76	cdef
after shelf - life	4 months storage	1°C	RA		64.32	±	8.22	hi
			CA	< 0.7kPa	80.32	±	7.82	abcd
				2.5kPa	83.52	±	6.88	abc
		3°C	RA		62.66	±	5.24	hi
			CA	< 0.7kPa	77.42	±	7.13	abcde
				2.5kPa	77.02	±	7.55	abcdef
	6 months storage	1°C	RA		58.29	±	7.13	i
			CA	< 0.7kPa	81.18	±	8.57	abcd
				2.5kPa	79.89	±	6.79	abcd
		3°C	RA					
			CA	< 0.7kPa	69.70	±	6.97	efgh
				2.5kPa	73.71	±	6.67	defg

[x] Same letters indicate no statistical differences between variants by Tukey-Test (p≤0.05).

Since ‘Dalinsweet’ doesn’t seem to be sensitive to chilling injury, it is recommended to store it at 1°C for periods over 4 months. All in all, ‘Dalinsweet’ stores well with no obvious physiological problems until March. For more than 4 months, CA storage, higher CO_2-levels and a lower temperature (1°C) is advisable to extend shelf-life.

When ‘WUR 037’ apples were stored in CA at 2.5 kPa CO_2, differences in the maintenance of flesh firmness after shelf-life was similar when compared to the other storage variants (Table. 3). Storage at an elevated CO_2-level didn’t show any advantage (Fig. 1).

Table 3: Fruit Firmness [N] of ‘WUR 037’ after 4 or 8 months RA or CA (1.0 kPa O_2, 0.7kPa or 2.5 kPa CO_2) storage at 1°C or 3°C and 7 d shelf-life at 20°C.

Fruit Firmness [N]								
At-harvest					92.38	±	7.44	a[x]
after removal	4 months storage	1°C	RA		69.00	±	8.45	ijk
			CA	< 0.7kPa	90.46	±	6.34	a
				2.5kPa	88.12	±	8.64	abc
		3°C	RA		58.14	±	5.18	lmn
			CA	< 0.7kPa	86.43	±	7.16	abcd
				2.5kPa	89.32	±	5.92	ab
	8 months storage	1°C	RA		57.17	±	7.51	lmn
			CA	< 0.7kPa	81.96	±	6.78	bcdef
				2.5kPa	80.20	±	10.07	cdefg
		3°C	RA		50.78	±	5.33	no
			CA	< 0.7kPa	70.74	±	7.49	hij
				2.5kPa	78.71	±	4.72	defgh
after shelf-life	4 months storage	1°C	RA		59.80	±	7.22	lm
			CA	< 0.7kPa	76.85	±	6.21	efghi
				2.5kPa	84.77	±	5.36	abcde
		3°C	RA		54.32	±	6.06	mno
			CA	< 0.7kPa	74.68	±	8.67	fghi
				2.5kPa	84.08	±	11.22	abcde
	8 months storage	1°C	RA		50.29	±	6.00	no
			CA	< 0.7kPa	73.11	±	10.61	ghij
				2.5kPa	77.21	±	9.43	efghi
		3°C	RA		47.86	±	5.39	o
			CA	< 0.7kPa	62.35	±	10.31	klm
				2.5kPa	65.00	±	7.40	jkl

. [x] Same letters indicate no statistical differences between variants by Tukey-Test ($p \leq 0.05$).

First results indicate ‘WUR 037’ as a temperature and CO_2 sensitive cultivar. In future experimental storage studies with ‘WUR 037’ should investigate delayed CA-conditions and optimal harvest date to decrease the incidence of flesh browning.