PROJECT NUMBER :	**PMG 01-18**	SEASON :	**2018**
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Evaluate the effect of different storage temperatures on the quality parameters of three pomegranate cultivars

OBJECTIVE:

To assess the quality of pomegranates stored at different temperatures.

BACKGROUND:

POMASA needed to investigate the potential of different temperatures as a means to control insect pests (FCM) and provide market access to restricted countries.

As from 1 January 2018, false codling moth has been declared a phytosanitary pest for the European market. Using a 'cold steri' regime, by storing pomegranates at a lower temperature, was investigated as a means to overcome this phytosanitary problem. According to PPECB, the carrying temperature regime for sea export of pomegranates is between 4 °C and 10 °C. From research done by Arendse and Opara (2014), fruit stored for more than 2 months at 5 °C exhibited chilling injury. Browning of fruit was also more severe at 5 °C, however only after 3 months. Cold storage of pomegranates in the industry takes place for about 16 days at sea, with a further 7 days in the harbour before the product is released to the market; considerably less than the 2 month period assessed previously. Since 'cold steri' requires fruit to be kept at a much lower temperature than the norm of 5 °C, it was required to assess the feasibility to store pomegranates at temperatures of 1 °C and 2 °C, without negatively affecting pomegranate quality in terms of chilling injury during storage.

SUMMARY:

Three different pomegranate cultivars (ACCO, Herskowitz and Wonderful) were subjected to three different storage temperatures for 23 days and 30 days, followed by 7 days shelf life at 20 °C. After 23 days, there was no significant incidence of browning scald chilling injury for all treatments and cultivars. This led to the extension of storage to 30 days to exacerbate any signs of chilling injury, at which time no increase in chilling injury was observed. Pomegranates were then stored for 7 days at shelf life; however chilling injury was still at a low severity (<0.3 on a 0-3 scale) for all treatments and cultivars.

Results showed that lower temperatures did not cause significant increases in all types of browning including browning scald related to chilling injury. The one exception was a significant increase of 0.4% in albedo browning on Acco after 23 days when stored at 1 °C when compared to both 2 °C and 5 °C. The other exception was a significant increase of 0.3% in septum browning on Herskowitz at 1 °C for 23 days, when compared to both of the other temperatures. When looking at tendencies across cultivars over time, results indicate the potential of some negative effects at 1 °C storage temperature, which are perhaps less prevalent at 2 °C and 5 °C. Browning disorders were no exacerbated by increasing storage duration to 30 days.

MATERIALS AND METHODS:

Pomegranates of the cultivars Heskowitz, Acco and Wonderful, were harvested by producers and supplied to ExperiCo laboratories in Stellenbosch, after being packed into boxes as for export, within 24h of picking. The cartons of fruit were stored at 1 °C, 2 °C and 5 °C for 23 days (16 days shipping, 7 days in harbour).

Fruit assessed after 23 days cold storage exhibited little or no damage from cold storage (chilling injury) and were subsequently kept for an additional 7 days at the respective temperatures. After 30 days cold storage, no chilling injury was again recorded and hence was kept for 7 days at 20 °C, aiming to exacerbate injury from cold storage during shelf life.

Cultivars:

- ACCO
- Herskowitz
- Wonderful

Storage temperatures:

- 5 °C (reference temperature)
- 2 °C
- 1 °C

Storage examination schedule:

- 23 days cold storage at the respective temperatures
- 30 days cold storage
- 30 days cold storage + 7 days shelf life at 20 °C

Examination parameters:

- Photographs were taken at all storage examinations, as well as at start of trial using (Addendum A).
- Severity of fruit with surface browning, as related to chilling injury (rating 0 – 3, with 0 = none, 1 = slight, 3 = severe), also given as a percentage of each rating.
- Incidence of crown rot, by expressing the number of pomegranates with decay, as a percentage of the sample size.

- Incidence of 'black heart' decay, by expressing the number of pomegranates with internal decay as a percentage of the sample size.
- Incidence of fruit with surface decay (incl. *Botrytis* sp. and *Penicillium* sp.), by expressing the number of pomegranates with surface decay as a percentage of the sample size.
- Severity of fruit with pulp membrane (septum) browning (rating 0 – 3, with 0 = none, 1 = slight, 2 = moderate, 3 = severe), also given as a percentage of each rating.
- Severity of fruit with albedo browning (rating 0 – 3, with 0 = none, 1 = slight, 2 = moderate, 3 = severe), also given as a percentage of each rating.
- Severity of fruit with aril browning (rating 0 – 3, with 0 = red, 1 = a few light brown arils, 2 = less than half of arils dark brown and light brown, 3 = majority of arils are dark brown), also given as a percentage of each rating.
- Skin colour, using a Chroma meter CR-400/410 (Konica Minolta) to determine browning index. Browning index was also determined at maturity on one tray as a reference. Browning index was calculated using the following formula:

$$BI = 100 \times \frac{(x - 0.31)}{0.17}$$

Where x = chromaticity coordinate, calculated from the L*, a*, b* values:

$$x = \frac{(a* + 1.75L*)a*}{(5.645L* + a* - 3.012b*)}$$

RESULTS:

Table 1: Disorders on Acco pomegranates after 23 days storage at various temperatures

Treatment	Parameters				
	Surface browning	Crown rot	Septum browning	Albedo browning	Aril browning
	(rating 0-3)	(% Incid.)	(% Incid.)	(% Incid.)	(% Incid.)
1 °C	0.4	0.1	0.5	0.4 b	0.0 a
2 °C	0.1	0.0	0.0	0.0 a	0.0 a
5 °C	0.0	0.0	0.1	0.0 a	0.3 b
Prob.>F[1]	0.2690	0.3771	0.0504	0.0385	0.0100

1. Values in the same examination parameter followed by different letters indicate significant differences (P<0.05) according to the Tukey HSD test. One-way Anova table

Table 2: Disorders on Herskowitz pomegranates after 23 days storage at various temperatures

Treatment	Parameters				
	Surface browning	Crown rot	Septum browning	Albedo browning	Aril browning
	(rating 0-3)	(% Incid.)	(% Incid.)	(% Incid.)	(% Incid.)
1 °C	0.8	0.0	0.3 b	0.20	0.00
2 °C	0.0	0.0	0.0 a	1.10	0.00
5 °C	0.5	0.0	0.0 a	0.30	0.00
Prob.>F[1]	0.0600	1.0000	0.0336	0.1199	1.0000

1. Values in the same examination parameter followed by different letters indicate significant differences (P<0.05) according to the Tukey HSD test. One-way Anova table

Table 3: Disorders on Wonderful pomegranates after 23 days storage at various temperatures

Treatment	Parameters				
	Surface browning	Crown rot	Septum browning	Albedo browning	Aril browning
	(rating 0-3)	(% Incid.)	(% Incid.)	(% Incid.)	(% Incid.)
1 °C	0.0	0.0	0.0	0.00	0.00
2 °C	0.0	0.0	0.5	0.00	0.00
5 °C	0.0	0.0	0.5	0.00	0.00
Prob.>F[1]	1.0000	1.0000	0.3673	1.0000	1.0000

1. Values in the same examination parameter followed by different letters indicate significant differences (P<0.05) according to the Tukey HSD test. One-way Anova table

Table 4: Disorders on Acco pomegranates after 30 days storage at various temperatures

Treatment	Parameters				
	Surface browning	Crown rot	Septum browning	Albedo browning	Aril browning
	(rating 0-3)	(% Incid.)	(% Incid.)	(% Incid.)	(% Incid.)
1 °C	0.0	0.0	0.9	0.00	0.00
2 °C	0.0	0.1	0.6	0.00	0.21
5 °C	0.0	0.0	0.2	0.00	0.00
Prob.>F[1]	1.0000	0.3771	0.0719	1.0000	0.3771

1. Values in the same examination parameter followed by different letters indicate significant differences (P<0.05) according to the Tukey HSD test. One-way Anova table

Table 5: Disorders on Herskowitz pomegranates after 30 days storage at various temperatures

Treatment	Parameters				
	Surface browning	Crown rot	Septum browning	Albedo browning	Aril browning
	(rating 0-3)	(% Incid.)	(% Incid.)	(% Incid.)	(% Incid.)
1 °C	0.0	0.0	0.7	0.00	0.00
2 °C	0.0	0.0	0.1	0.00	0.00
5 °C	0.0	0.0	0.4	0.00	0.20
Prob.>F[1]	1.0000	1.0000	0.1824	1.0000	0.3811

1. Values in the same examination parameter followed by different letters indicate significant differences (P<0.05) according to the Tukey HSD test. One-way Anova table

Table 6: Disorders on Wonderful pomegranates after 30 days storage at various temperatures

Treatment	Parameters				
	Surface browning	Crown rot	Septum browning	Albedo browning	Aril browning
	(rating 0-3)	(% Incid.)	(% Incid.)	(% Incid.)	(% Incid.)
1 °C	0.0	0.0	0.2	0.0 a	0.00
2 °C	0.0	0.0	0.0	0.0 a	0.00
5 °C	0.0	0.0	0.2	0.8 b	0.00
Prob.>F[1]	1.0000	1.0000	0.6163	0.0332	1.0000

1. Values in the same examination parameter followed by different letters indicate significant differences (P<0.05) according to the Tukey HSD test. One-way Anova table

Table 7a: Mean severity (0-3) and incidence of disorders on Acco pomegranates after 30 days storage at various temperatures and 7 days shelf life

Treatment	Parameters														
	Browning scald					Septum browning					Albedo browning				
	(0-3)	Class 0 (%)	Class 1 (%)	Class 2 (%)	Class 3 (%)	(0-3)	Class 0 (%)	Class 1 (%)	Class 2 (%)	Class 3 (%)	(0-3)	Class 0 (%)	Class 1 (%)	Class 2 (%)	Class 3 (%)
1 °C	0.1	93.7	1.7	4.6	0.0	1.8 b	20.0 a	18.4 a	35.3 b	26.3 b	0.3	77.7	16.29	2.86	3.1
2 °C	0.1	90.6	4.6	0.0	2.0	0.9 a	38.6 ab	38.3 b	16.4 a	6.7 a	0.3	84.7	9.57	2.86	2.9
5 °C	0.2	88.9	5.6	3.2	2.4	0.7 a	52.9 b	30.5 ab	15.1 a	1.6 a	0.1	87.8	9.84	0.79	0.8
Prob.>F[1]	0.2613	0.6887	0.2833	0.1004	0.4205	0.0000	0.0648	0.0402	0.0207	0.0015	0.0581	0.2991	0.3469	0.6170	0.3071

1. Values in the same examination parameter followed by different letters indicate significant differences (P<0.05) according to the Tukey HSD test. One-way Anova table One-way Anova table

Table 7b: Mean severity (0-3) and incidence of disorders on Acco pomegranates after 30 days storage at various temperatures and 7 days shelf life

Treatment	Parameters							
	Aril browning					Incidence (%)		
	(0-3)	Class 0 (%)	Class 1 (%)	Class 2 (%)	Class 3 (%)	Black heart	Crown Rot	Penicillium
1 °C	0.1	92.7	5.14	1.43	0.7	0.10	0.50	0.20
2 °C	0.2	85.7	7.00	2.71	1.7	0.10	1.40	0.10
5 °C	0.1	80.0	4.92	3.17	0.8	0.11	0.33	0.00
Prob.>F[1]	0.3042	0.3540	0.7832	0.5822	0.6927	0.9963	0.1507	0.3865

1. Values in the same examination parameter followed by different letters indicate significant differences (P<0.05) according to the Tukey HSD test. One-way Anova table

Table 8a: Mean severity (0-3) and incidence of disorders on Herskowitz pomegranates after 30 days storage at various temperatures and 7 days shelf life

Treatment	Parameters														
	Browning scald					Septum browning					Albedo browning				
	(0-3)	Class 0 (%)	Class 1 (%)	Class 2 (%)	Class 3 (%)	(0-3)	Class 0 (%)	Class 1 (%)	Class 2 (%)	Class 3 (%)	(0-3)	Class 0 (%)	Class 1 (%)	Class 2 (%)	Class 3 (%)
1 °C	0.2	83.3	15.0	1.7	0.0	0.3	78.3	10.0	11.7	0.00	0.0	96.7	3.33	0.00	0.0
2 °C	0.3	81.7	11.7	6.7	0.0	0.4	80.0	5.0	13.3	1.67	0.0	98.3	1.67	0.00	0.0
5 °C	0.3	83.3	10.0	5.0	1.7	0.2	83.3	13.3	1.7	1.67	0.0	98.3	1.67	0.00	0.0
Prob.>F[1]	0.7455	0.9866	0.8039	0.4845	0.3911	0.4470	0.9436	0.4123	0.4692	0.6163	0.7774	0.7613	0.7613	1.0000	1.0000

1. Values in the same examination parameter followed by different letters indicate significant differences (P<0.05) according to the Tukey HSD test. One-way Anova table

Table 8b: Mean severity (0-3) and incidence of disorders on Herskowitz pomegranates after 30 days storage at various temperatures and 7 days shelf life

Treatment	Parameters							
	Aril browning					Incidence (%)		
	(0-3)	Class 0 (%)	Class 1 (%)	Class 2 (%)	Class 3 (%)	Black heart	Crown Rot	Penicillium
1 °C	0.3	71.7	25.00	3.33	0.0	0.0	2.0	0.0 a
2 °C	0.4	61.7	31.67	6.67	0.0	0.0	4.0	0.0 a
5 °C	0.2	81.7	15.00	3.33	0.0	0.2	3.0	0.7 b
Prob.>F[1]	0.0704	0.1428	0.1371	0.5851	1.0000	0.3911	0.2653	0.0405

1. Values in the same examination parameter followed by different letters indicate significant differences (P<0.05) according to the Tukey HSD test. One-way Anova table

Table 9a: Mean severity (0-3) and incidence of disorders on Wonderful pomegranates after 30 days storage at various temperatures and 7 days shelf life

Treatment	Parameters														
	Browning scald					Septum browning					Albedo browning				
	(0-3)	Class 0 (%)	Class 1 (%)	Class 2 (%)	Class 3 (%)	(0-3)	Class 0 (%)	Class 1 (%)	Class 2 (%)	Class 3 (%)	(0-3)	Class 0 (%)	Class 1 (%)	Class 2 (%)	Class 3 (%)
1 °C	0.1	93.8	2.1	4.2	0.0	2.0 c	6.3 a	27.1	31.3 b	35.4 b	1.4 b	29.2 a	22.9	29.2 c	18.8 b
2 °C	0.0	100.0	0.0	0.0	0.0	0.7 b	52.1 b	29.2	15.5 ab	6.3 a	0.1 a	87.5 b	12.5	0.0 a	0.0 a
5 °C	0.1	94.3	0.0	5.7	0.0	0.2 a	87.1 c	8.1	0.0 a	4.8 a	0.4 a	80.0 b	2.4	10.0 b	7.6 ab
Prob.>F[1]	0.2640	0.3862	0.4103	0.4864	1.0000	0.0000	0.0000	0.0785	0.0025	0.0071	0.0000	0.0000	0.1027	0.0000	0.0210

1. Values in the same examination parameter followed by different letters indicate significant differences (P<0.05) according to the Tukey HSD test. One-way Anova table

Table 9b: Mean severity (0-3) and incidence of disorders on Wonderful pomegranates after 30 days storage at various temperatures and 7 days shelf life

Treatment	Parameters							
	Aril browning					Incidence (%)		
	(0-3)	Class 0 (%)	Class 1 (%)	Class 2 (%)	Class 3 (%)	Black heart	Crown Rot	Penicillium
1 °C	0.2	89.6	6.25	2.08	2.1	0.0	0.0	0.0
2 °C	0.1	93.8	6.25	0.00	0.0	0.0	0.0	0.0
5 °C	0.3	80.5	14.76	4.76	0.0	0.3	0.0	0.0
Prob.>F[1]	0.1717	0.4148	0.3855	0.5041	0.4103	0.0859	1.0000	1.0000

1. Values in the same examination parameter followed by different letters indicate significant differences (P<0.05) according to the Tukey HSD test. One-way Anova table

Table 10: Mean browning index over time for all three cultivars

Treatment	Browning index											
	Acco				Herskowitz				Wonderful			
	0 days	23 days	30 days	37 days	0 days	23 days	30 days	37 days	0 days	23 days	30 days	37 days
1 °C		199.2 ab	174.2 b	127.1		201.4 b	158.4	112.1 a		150.1 a	142.2 a	126.6
2 °C	161.5	180.1 a	181.9 b	123.8	175.0	182.0 ab	151.6	131.7 b	156.8	175.3 b	152.5 ab	127.3
5 °C		189.2 b	153.8 a	121.3		179.0 a	150.5	122.5 b		149.1 a	162.3 b	142.6
Prob.>F[1]		0.0479	0.0012	0.4444		0.0444	0.5194	0.0001		0.0075	0.0393	0.2841

1. Values in the same examination parameter followed by different letters indicate significant differences (P<0.05) according to the Tukey HSD test. One-way Anova table

Table 11: Tendencies in severity differences between 1 °C and 5 °C for different browning disorders

Parameter	Tendencies of severity differences								
	Acco			Herskowitz			Wonderful		
	23 days	30 days	37 days	23 days	30 days	37 days	23 days	30 days	37 days
Surface browning	1 > 5	-	-	1 > 5	-	-	-	-	-
Septum browning	1 > 5	1 > 5	1 > 5	1 > 5	1 > 5	-	5 > 1	-	1 > 5
Albedo browning	1 > 5	-	1 = 5	-	-	-	-	5 > 1	1 > 5
Aril browning	5 > 1	-	-	-	-	-	-	-	-

1. Numbers in red indicate values with significant differences (P<0.05) according to the Tukey HSD test; black values are insignificant and only an indication of tendency

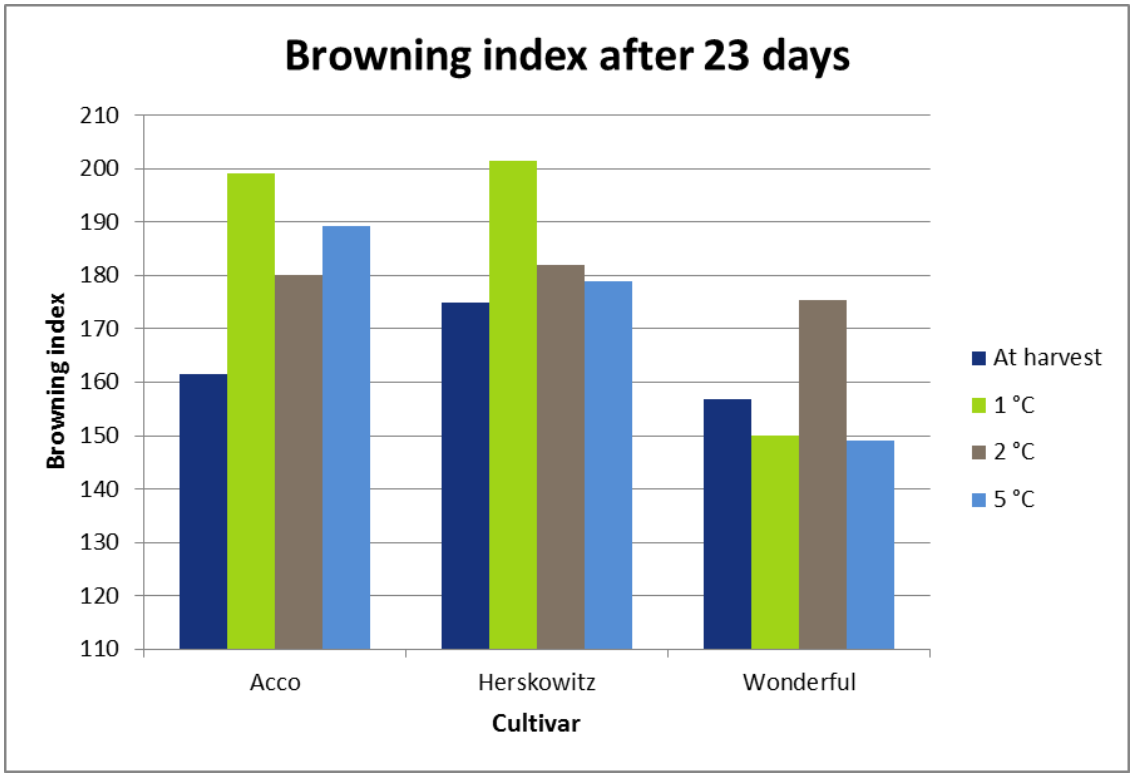

Figure 1: Mean browning index for all storage regimes across cultivars after 23 days of storage

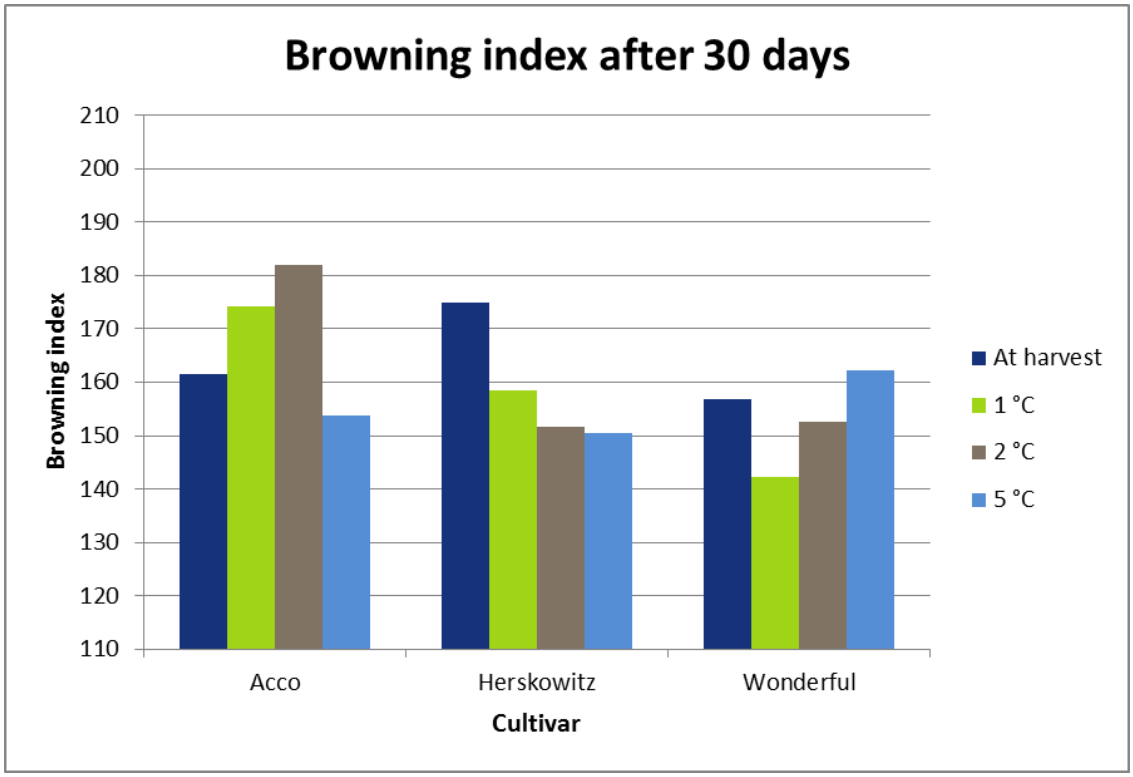

Figure 2: Mean browning index for all storage regimes across cultivars after 30 days of storage

FINDINGS TO DATE:

Surface browning (chilling injury, signified by scald-like symptoms)

Cold storage for 23d

- No significant difference is surface browning occurred on Acco (Table 1), Herskowitz (Table 2) or Wonderful (Table 3) as result of the cold storage temperature. Albeit not significant, surface browning on Acco was highest at 1 °C (rating of 0.4), while lowest at 5 °C (rating of 0).

Cold storage for 30d

- No difference is surface browning occurred on Acco (Table 4), Herskowitz (Table 5) or Wonderful (Table 6) as result of the cold storage temperature regime.

Cold storage for 30d + 7d shelf life at 20 °C

- No significant difference is surface browning (rating of browning) occurred on Acco (Table 7a), Herskowitz (Table 8a) or Wonderful (Table 9a) as result of the cold storage temperature.
- No difference in percentage browning for each of the rating class of 0, 1, 2 or 3 occurred on Acco (Table 7a), Herskowitz (Table 8a) or Wonderful (Table 9a) as result of the cold storage temperature regime.

Tendencies (Table 11)

- When comparing 1 °C and 5 °C for surface browning, the tendency, though statistically insignificant, has been that surface browning has been more severe at the lower temperature than at the control temperature of 5 °C (Acco and Wonderful after 23 days storage).

Septum browning (pulp membrane browning)

Cold storage for 23d

- Septum browning was significantly higher in Herskowitz (Table 2) kept at 1 °C compared to 2 °C or 5 °C. The level of browning was though low across all three the temperature regimes
- No significant differences in septum browning occurred in Acco (Table 1), or Wonderful (Table 3). Albeit not significant, septum browning levels were lower at 5 °C than at 1 °C in Acco, therefore similar to the finding for Herskowitz. The opposite was recorded in Wonderful, with septum browning levels higher at 5 °C than at 1 °C.

Cold storage for 30d

- No significant differences in septum browning occurred in Acco (Table 4), Herskowitz (Table 5) or Wonderful (Table 6).
- Albeit not significant, septum browning levels were lower at 5 °C than at 1 °C in Acco and Herskowitz.

Cold storage for 30d + 7d shelf life at 20 °C

- Septum browning (rating of browning) was significantly higher in Acco (Table 7a) and Wonderful (Table 9a) kept at 1 °C compared to 2 °C or 5 °C.
- No difference is septum browning occurred in Herskowitz (Table 8a).

- The finding of less septum browning at 5 °C than at 1 °C in Acco and Wonderful, was substantiated by the finding of a significantly higher percentage Acco and Wonderful classified as 'class 0' septum browning (zero septum browning) when kept at 5 °C.
- The finding of less septum browning at 5 °C in Acco and Wonderful, than at 1 °C, was further substantiated by the finding of a lower percentage Acco and Wonderful classified as 'class 3' septum browning (severe septum browning), as well as 'class 2' septum browning (moderate septum browning) at 5 °C than 1 °C.

Tendencies (Table 11)

- When comparing 1 °C and 5 °C for septum browning, the tendency, though statistically insignificant, has been that septum browning has been more severe at 1 °C than at the control temperature of 5 °C.

Albedo browning

Cold storage for 23d

- Albedo browning was significantly higher in Acco (Table 1) kept at 1 °C compared to 2 °C or 5 °C.
- No significant differences in septum browning occurred in Herskowitz (Table 2) or Wonderful (Table 3) as result of the cold storage temperature regime.

Cold storage for 30d

- Albedo browning was significantly higher in Wonderful (Table 6) kept at 5 °C compared to 1 °C or 2 °C.
- No significant differences in albedo browning occurred in Acco (Table 4) or Herskowitz (Table 5) as result of the cold storage temperature regime.

Cold storage for 30d + 7d shelf life at 20 °C

- Albedo browning (rating of browning) was significantly higher in Wonderful (Table 9a) kept at 1 °C compared to 2 °C or 5 °C.
- No difference is albedo browning occurred in Acco (Table 7a) or Herskowitz (Table 8a) as result of the cold storage temperature regime.
- The finding of less septum browning at 5 °C in Wonderful than at 1 °C, was substantiated by the finding of a significantly higher percentage Wonderful classified as 'class 0' septum browning (zero septum browning) when kept at 5 °C.
- The finding of less septum browning at 5 °C in Wonderful, was further substantiated by the finding of a lower percentage Wonderful classified as 'class 3' septum browning (severe septum browning), as well as 'class 2' septum browning (moderate septum browning) at 5 °C.
- Albeit not significant, the findings for Acco supported the findings for Wonderful, that a higher percentage Wonderful was classified as 'class 0' septum browning (zero septum browning) when kept at 5 °C, while lower percentage Wonderful was classified as 'class 3' septum browning (severe septum browning), as well as 'class 2' septum browning (moderate septum browning) at 5 °C than at 1 °C.

Tendencies (Table 11)

- When comparing 1 °C and 5 °C for albedo browning, the tendency, though statistically insignificant, has been that albedo browning has been more severe at 1 °C than at the control temperature of 5 °C (excluding Herskowitz, which had little albedo browning at Class 1 for those temperatures).

Aril browning

Cold storage for 23d

- Aril browning was significantly higher in Acco (Table 1) kept at 5 °C compared to 1 °C and 2 °C.
- No significant differences in aril browning occurred in Herskowitz (Table 2) or Wonderful (Table 3) as result of the cold storage temperature regime.

Cold storage for 30d

- No significant differences in aril browning occurred in Acco (Table 4), Herskowitz (Table 5) or Wonderful (Table 6) as result of the cold storage temperature regime.

Cold storage for 30d + 7d shelf life at 20 °C

- No significant differences in aril browning for 'rating of browning' or 'percentage per aril browning class', occurred in Acco (Table 7b), Herskowitz (Table 8b) or Wonderful (Table 9b) as result of the cold storage temperature regime.

Back heart, Crown rot and *Penicillium* rot

Cold storage for 30d + 7d shelf life at 20 °C

- No significant differences in black heart or crown rot occurred in Acco (Table 7b), Herskowitz (Table 8b) or Wonderful (Table 9b) as result of the cold storage temperature regime.
- Penicillium rot was significantly higher in Herskowitz (Table 8b) kept at 5 °C compared to 1 °C and 2 °C.

Browning Index

Cold storage for 30d + 7d shelf life at 20 °C

- Browning index was significantly higher for Acco stored for 23d and 30d (Table 10) at 1 °C compared to 5 °C.
- Browning index was significantly higher for Herskowitz stored for 23d and 30d (Table 10) at 1 °C compared to 5 °C, however, at 37d browning index was significantly higher for Herskowitz stored at 5 °C compared to 1 °C.
- Browning index was significantly higher for Wonderful stored for 30d (Table 10) at 5 °C compared to 1 °C.

RECOMMENDATIONS:

Results indicate that a 2 °C storage regime can be used provided that fruit are not subjected to this temperature regime for longer than 30 days. No considerable negative effect on storability, in terms of chilling injury, on all three cultivars was observed after 30 days. Even though injury incidence was still very low at 1 °C, storing pomegranates at this temperature should be regarded with caution, due to the significant albedo browning and septum browning that was observed. The increased risk of various browning parameters that were measured at 1 °C when compared to 5 °C should be assessed further over additional seasons, growing areas and/or populations.

There is potential for a follow-up project to look at the physiological response of the same pomegranate cultivars at a storage temperature that combines the 'cold steri' treatment (-0.5 °C for 22 days) with additional storage at 5 ° (dual temperature regime) to allow for extended storage durations if required. Additionally a follow-up project could also look at the required duration of a -0.5 °C 'cold steri' treatment and the effect on pomegranate physiology after different treatment lengths.

BENEFIT TO CLIENT:

With no significant increases in chilling injury in the form of browning scald at 1 °C and 2 °C and other parameters like albedo and septum browning at low incidences, however significant between treatments; colder shipping temperatures can be cautiously considered.

ADDENDUM A:

Figure 3: Acco at 5°C for 23 days

Figure 4: Herskowitz at 5°C for 23 days

Figure 5: Wonderful at 5 °C after 23 days

Figure 6: Acco at 2°C for 23 days

Figure 7: Herskowitz at 2°C for 23 days

Figure 8: Wonderful at 2 °C after 23 days

Figure 9: Acco at 1°C for 23 days

Figure 10: Herskowitz at 1°C for 23 days

Figure 11: Wonderful at 1 °C after 23 days

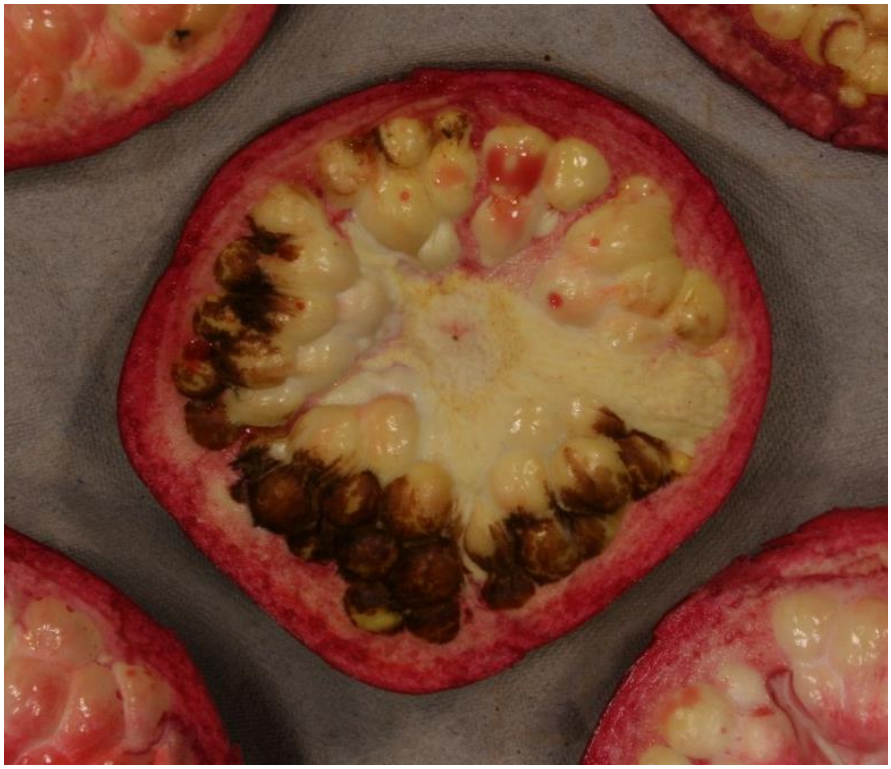

Figure 12: Albedo browning

Figure 13: Septum browning