

The impact of packaging and storage conditions on quality of carrots for distant export markets

DAF - Gatton Smart Farm project (AS20007)

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**Hort
Innovation**

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Queensland
Government

moffatt
fresh produce
EST. 1924



Queensland
Government

Rationale

- Sea freight of fresh carrots to distant export destinations requires extended produce storage capability to ensure adequate quality and shelf life (SL) at the importing country
- Limited info on produce suitability for industry to draw upon
- This work investigated the impact of packaging and storage on quality and SL of carrots under typical sea freight and post-arrival conditions faced during export from south-east Queensland to the Middle East (ME)
- Aim was to identify viable export handling options for desired produce outcomes

Procedures

- Premium carrots, cv 'Stefano', commercially grown, harvested, and packed by Moffatt Fresh Produce (MFP) at Tarome, QLD on 12/04/2022
- Samples delivered to DAF's Gatton Research Facility in a refrigerated truck the next day, held overnight at 5°C and divided into 3 packaging types:
 - (i) Loose into 10 kg cartons lined with the standard 'orange' plastic liner ('**Liner**')
 - (ii) Loose into 10 kg cartons repacked into the same cartons lined with a novel laser-perforated modified atmosphere packaging liner ('**MAP**') instead the 'orange' liner
 - (iii) Pre-packed in 1.0 kg ventilated plastic bags packed 17 kg plastic bulk bags ('**Bag**').

Liner



MAP



Bag



Procedures (2)

- To simulate the maximum expected supply chain from Tarome to ME, samples, except control, were held at 0.5°C (optimum), 3.0°C or 5.0°C for 50 days
- To simulate post-arrival conditions samples were handled as shown on Table 1

Table 1 Summary of handling procedure during shelf life assessments in the trial

Stage	Temperature	Duration (days)	Packaging condition	Simulation
A	5°C	2	<u>Liner/MAP</u> : close lid/wrapped liner <u>Bags</u> : inside bulk bag	Distribution to retail
B	20°C	1	<u>Line/MAP</u> : open lid/unwrapped liner (MAP repacked into liner) <u>Bags</u> : removed from bulk bag	Retail display
C	5°C	Up to 18	<u>Cartons</u> : open lid/wrapped liner <u>Bags</u> : removed from bulk bag	Domestic storage up to consumption

Procedures (3)

- Sub-samples taken and assessed: on arrival at GRF, at removal from storage, after stages A and B, then every 2–3 days during stage C up to 18 days or until sample was deemed not acceptable, i.e. reaching the end of shelf life (ESL)
- ESL: overall visual quality of each carrot reached a level below 3 on a 1–5 scale (Table 2)
- A separate batch stored at 0.5°C was held for further 13 days at 5°C before being assessed to simulate potential in-country delays to market
- For each quality assessment time, three batches (replicates) of 10 carrots (~1.0 kg depending on average size) were randomly taken from cartons or bags

Procedures (4)

Subjective (visual) assessments:

Table 2 Rating scale and descriptors for the subjective assessments of carrots used in the trial

Visual quality scores and description					
	1	2	3	4	5
	Very poor	Poor	Fair	Good	Excellent
Overall visual quality	Extremely poor look; very severe white bloom and defects; moderate diseases and sprouting; unsalable	Poor look; pale orange; severe white bloom and defects; slight diseases or sprouting; unsalable	Dull orange; moderate white bloom and defects; no diseases or sprouting	Good, but not as fresh, lightly dull with slight white bloom and defects; no diseases or sprouting	Field fresh; turgid; bright orange; shiny; no film; no defects; no diseases or sprouting
	4	3	2	1	0
Defects severity	Very severe and often widespread	Severe and, at times, widespread	Moderate signs; evident, but not severe or too widespread	Slight signs on small areas	Nil

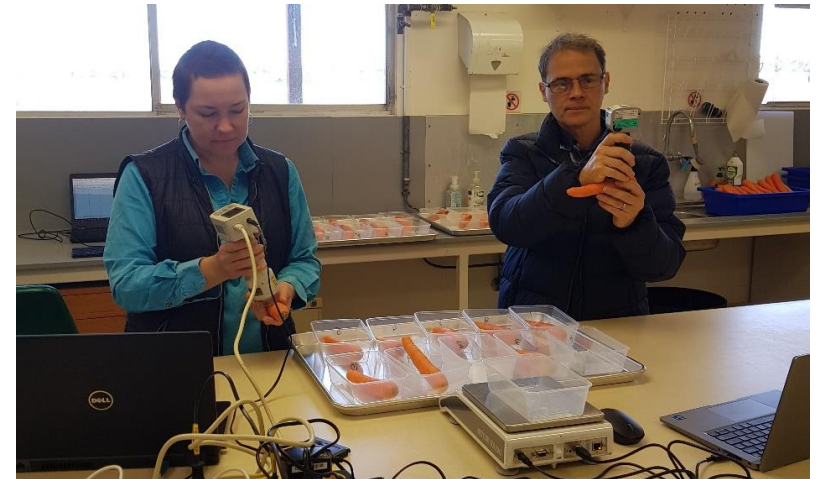
Defects:

- Field defects
- Mechanical damage
- White bloom (scaling)
- Green shoulder
- Sprouting
- Diseases (rots)

Procedures (5)

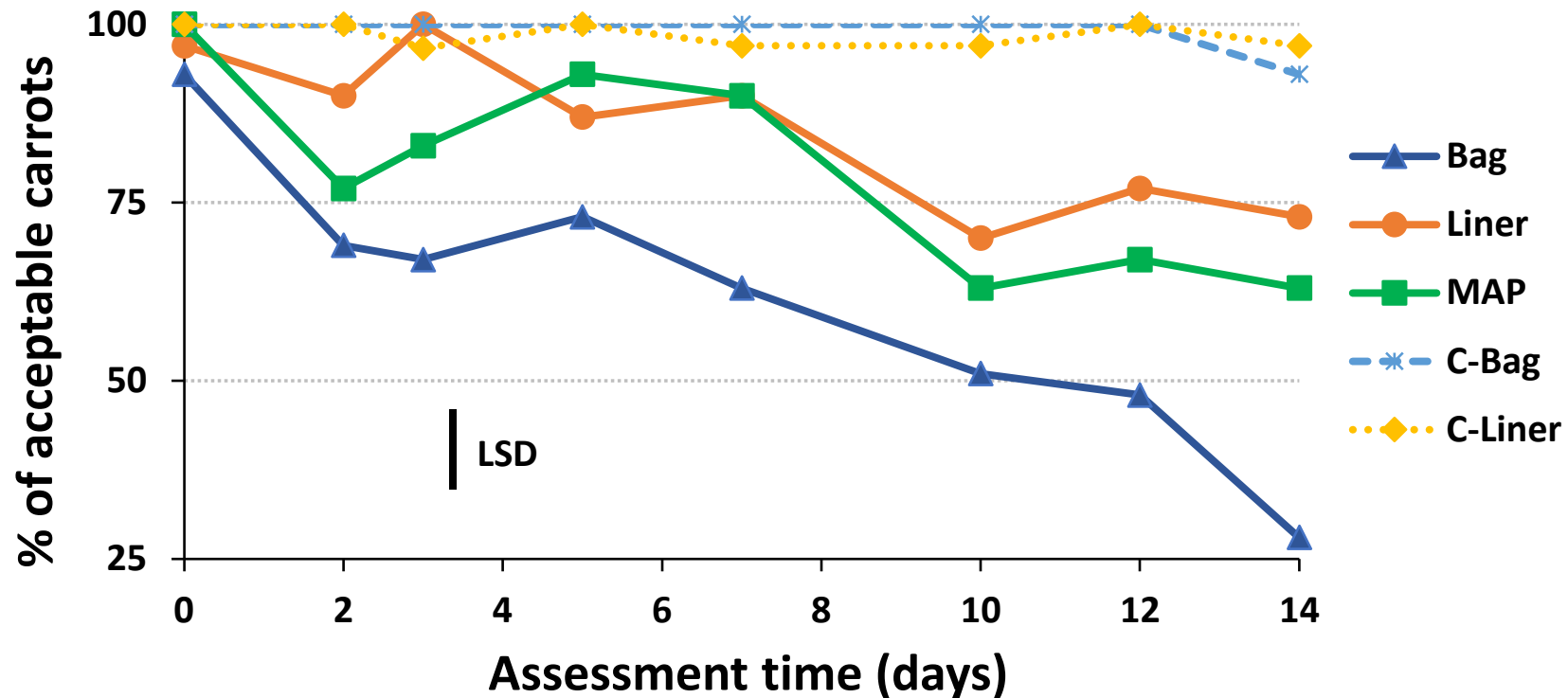
Objective assessments:

- External colour (Minolta colorimeter)
- Firmness (Bareiss firmness meter)
- Brix (Atago refractometer)
- Weight loss: additional sub-samples weighed serially



Results - Storage at 0.5°C for 50 days

Overall visual quality and acceptability



Results - Storage at 0.5°C for 50 days

At removal

3 DAS

7 DAS

10 DAS

14 DAS

Liner

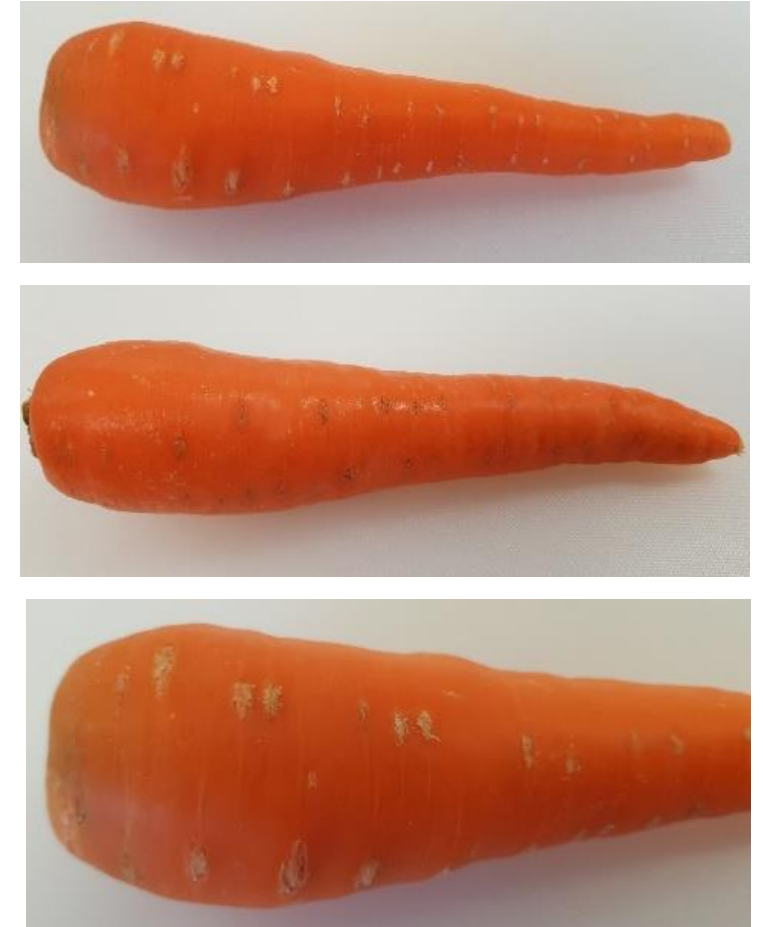
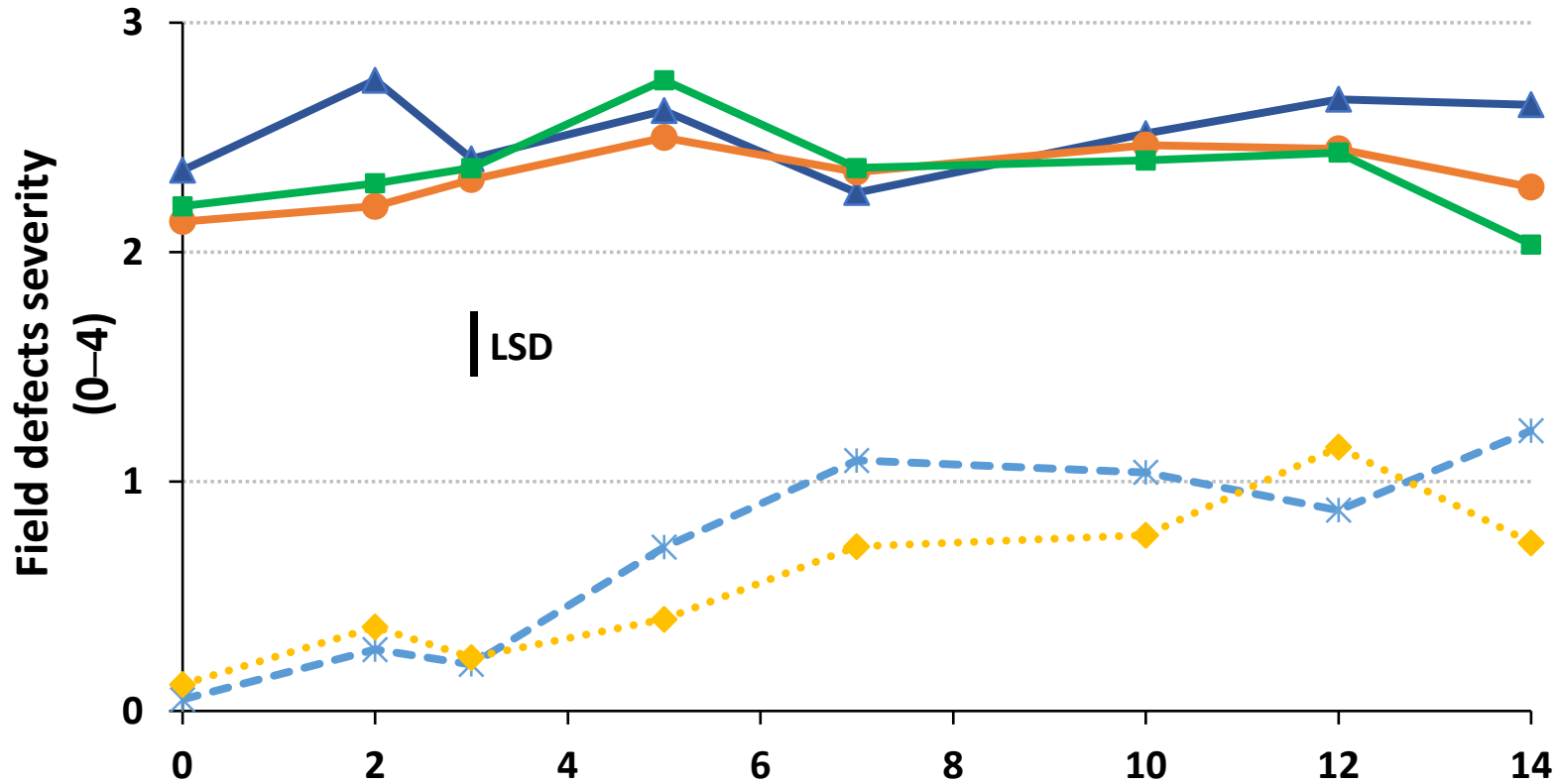


Bag



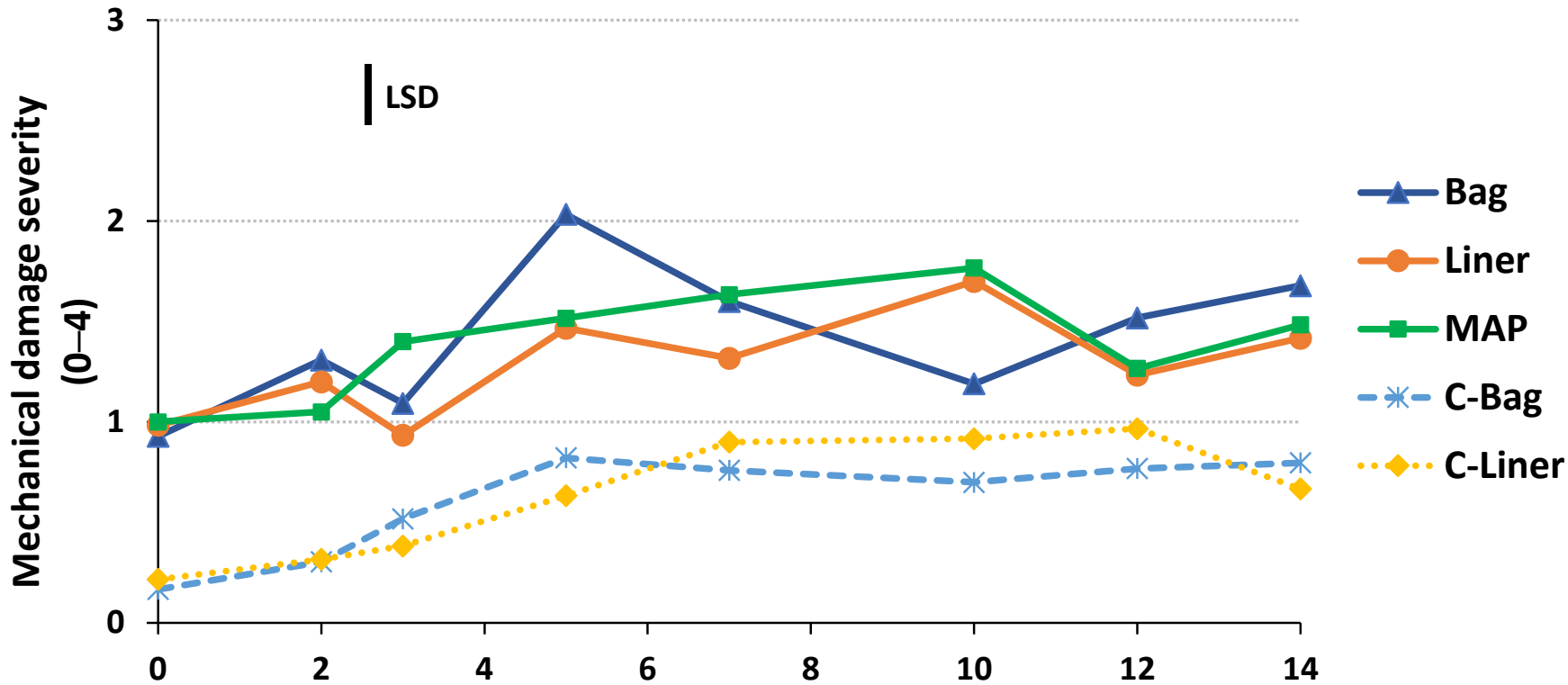
Results - Storage at 0.5°C for 50 days

Main defects severity: **field defects**, i.e. small white or dark transversal cracks



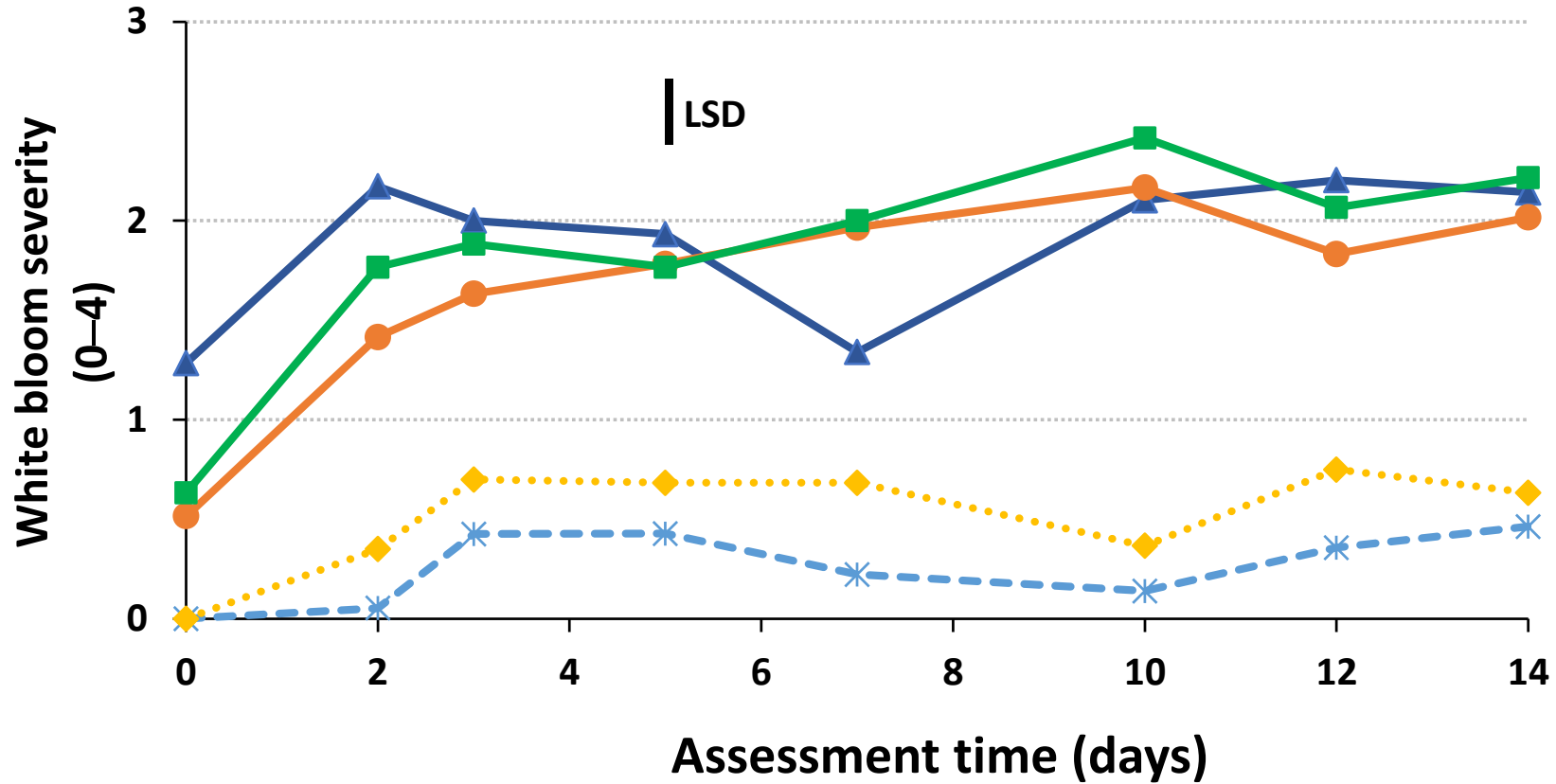
Results - Storage at 0.5°C for 50 days

Main defects severity: **mechanical damage**



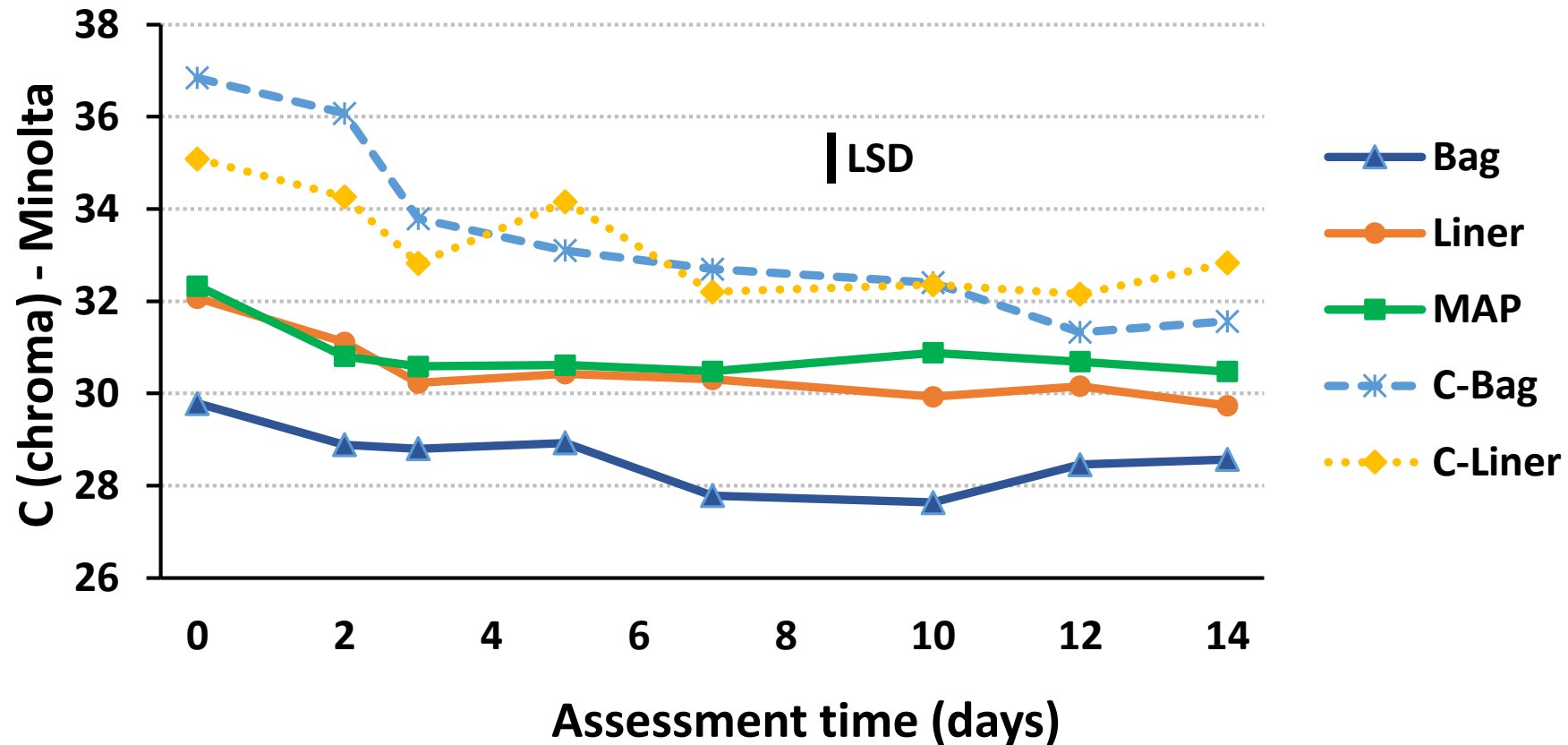
Results - Storage at 0.5°C for 50 days

Main defects severity: **white bloom** (scaling)



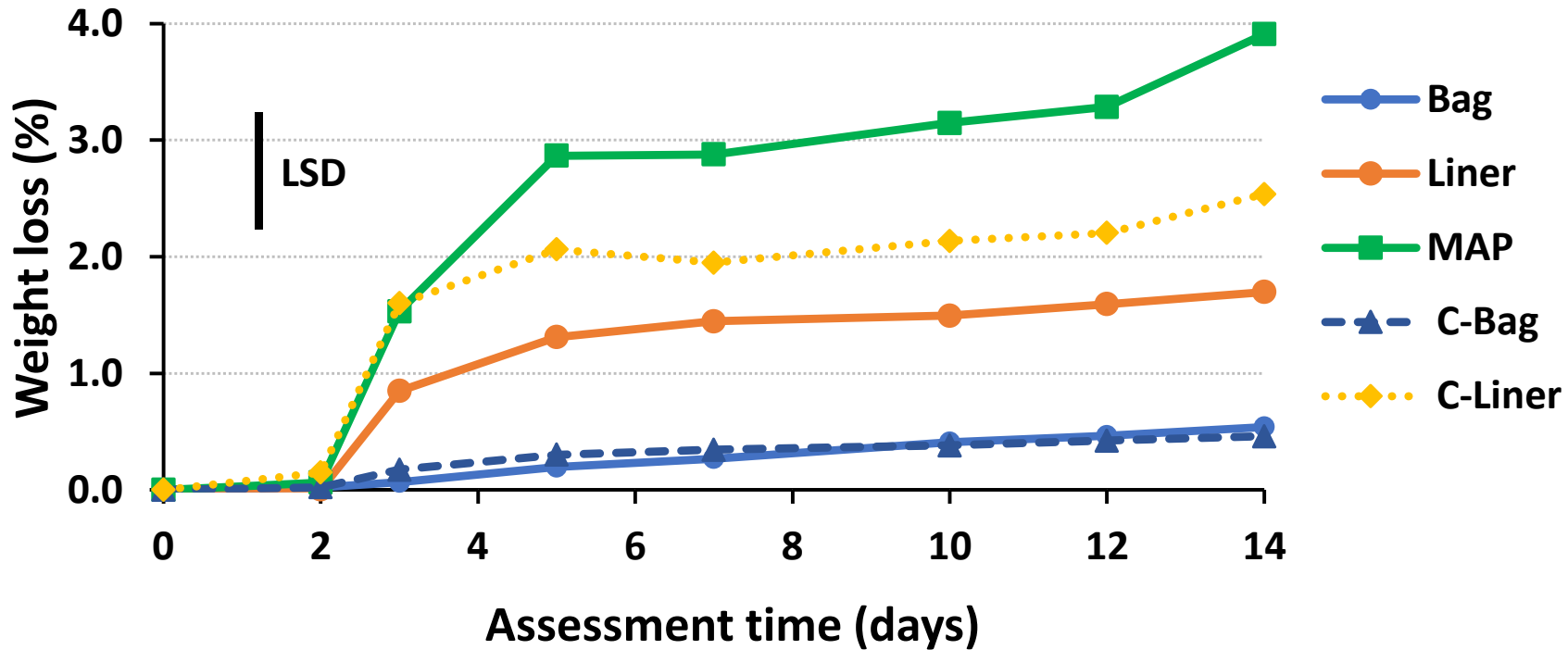
Results - Storage at 0.5°C for 50 days

Colour (Minolta colorimeter): higher C values associated with brighter orange colour



Results - Storage at 0.5°C for 50 days

Weight loss: reduced with Bag compare to Liner or MAP



Firmness (Bareiss):

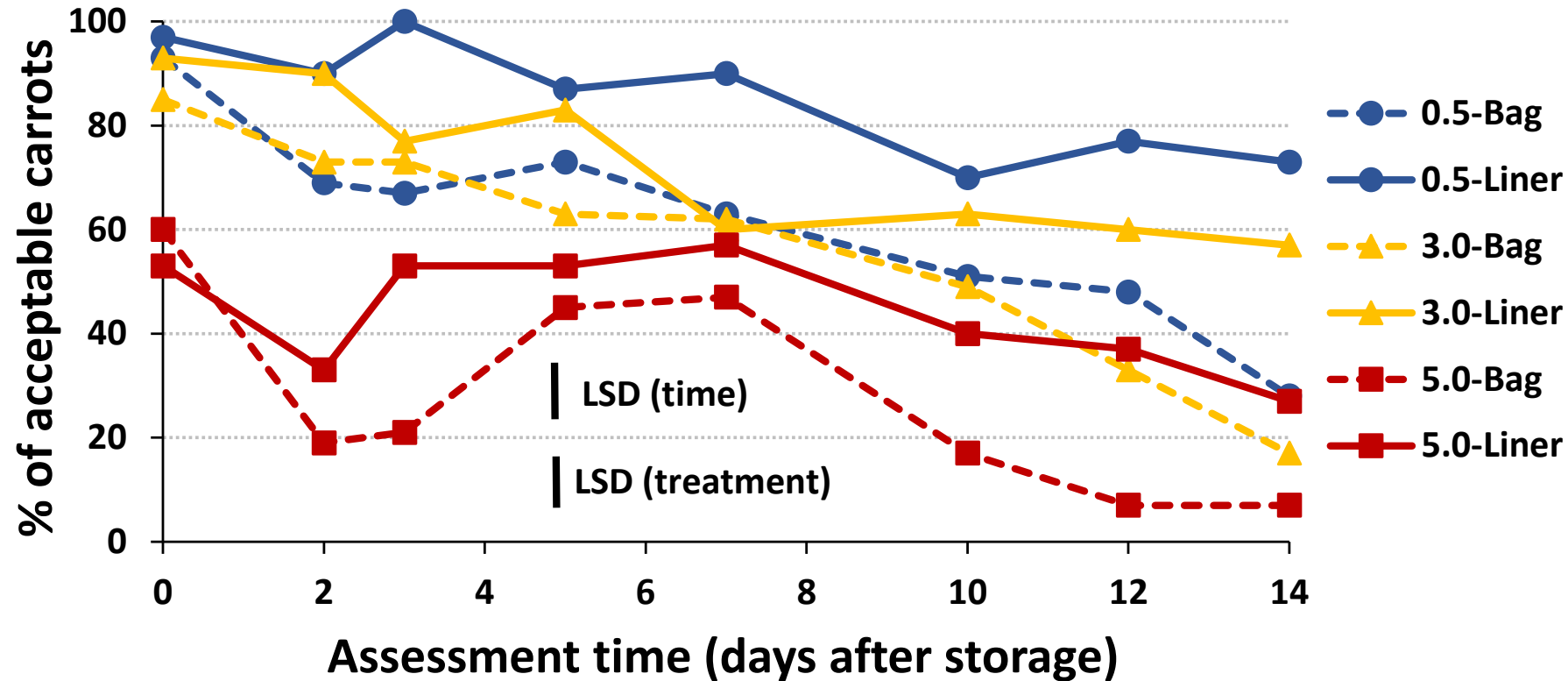
- Little loss of over time
- Inconsistent results

Brix (TSS):

- No packaging effect
- Slight increase over time
- Average: 8.9%

Results - Storage at 3°C and 5°C for 50 days

Overall visual quality and acceptability



Results - Storage at 3°C and 5°C for 50 days

0.5°C

3.0°C

5.0°C

Sprouting

3 days
after
removal

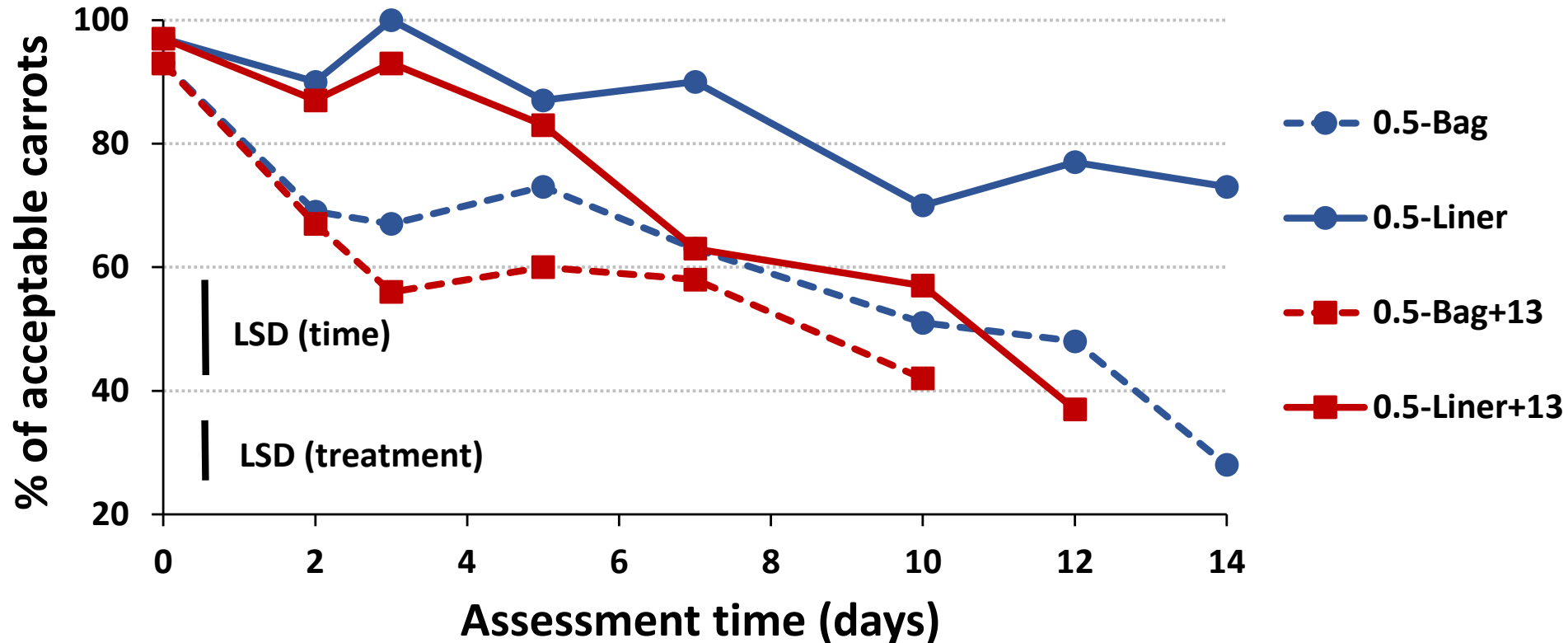


10 days
after
removal



Results - Storage at 0.5°C for 50 days plus 13 days holding at 5°C

Overall visual quality and acceptability



Conclusions and recommendations

- Compared with pre-packed 1.0 kg bags, carrots packed loose into 10 kg cartons lined with the standard orange liner ('Liner') would be a preferred packaging option, potentially resulting in higher overall visual quality and extended SL
- The 'Liner' packaging appears to be suitable for export to long destinations, with carrots showing high levels of acceptable quality and SL up to 14 days after storage at 0.5°C for 50 days
- Deviations from the optimum temperature range of 0–1.0°C for storage of fresh carrots, especially if above 3.0°C, will likely reduce quality and SL after a prolonged sea journey, highlighting the importance of effective monitoring to prevent and rapidly correct potential cold chain issues

Conclusions and recommendations

- Potential delays to market at the importing country should be avoided, as they will likely reduce quality and thus shorten SL of fresh carrots following a prolonged sea journey
- Commercial conditions during shipping and handling after arrival will tend to be more challenging than the static and more controlled conditions tested in the trial, so it is important to monitor and collect data under real supply chain conditions to confirm trial results
- The above results should be cautiously interpreted given the limitations of the work, i.e a single harvest and sampling time with one cultivar, plus one holding temperature during most of quality and SL assessments, so further research would be warranted to allow more robust recommendations to be made.