

Supplementary Materials

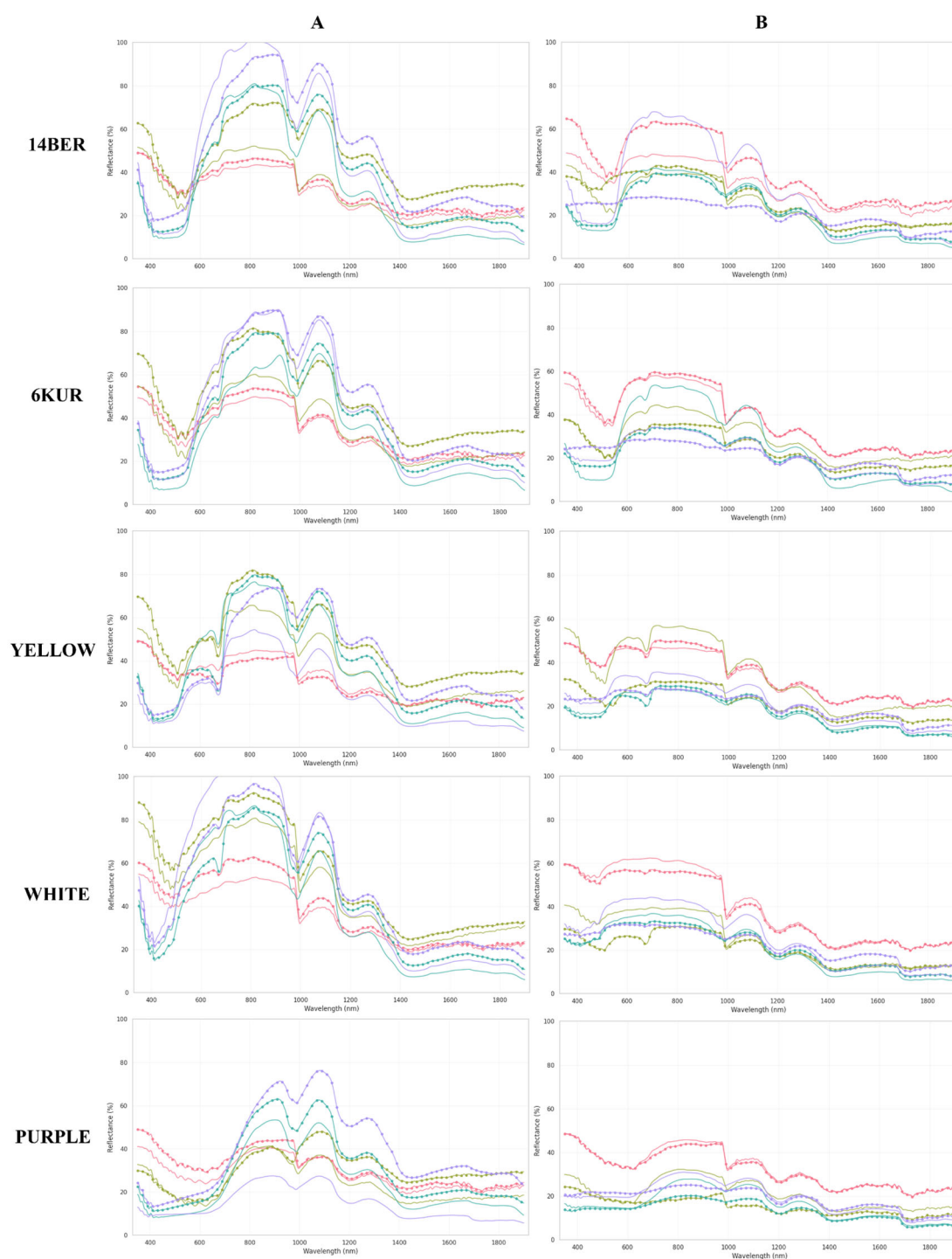


Figure S1. Spectral signature of five carrot genotypes subjected to two postharvest treatments (refrigeration and room temperature), evaluated in two tissue zones: A) external surface and B) cross-section. Solid lines represent samples stored under refrigeration, while dotted lines correspond to samples stored at room temperature.

Table S1. Three-way factorial ART ANOVA results (Genotype \times Storage treatment \times Storage time), including F-values, p-values, and effect sizes (η^2), for postharvest quality attributes in carrot genotypes/varieties.

Variable	Effect	Df	Df.res	F_value	P_value	η^2	Size
Firmness	Genotype (G)	4.0	80.0	20.4359	<0.001 ***	0.5053	Large
	Treatment (T)	1.0	80.0	1.8738	0.175	0.0228	Small
	Week (W)	3.0	80.0	7.5737	<0.001 ***	0.2211	Large
	G+T	4.0	80.0	1.9354	0.113	0.0882	Medium
	G+W	12.0	80.0	3.5586	<0.001 ***	0.3480	Large
	T+W	3.0	80.0	18.1376	<0.001 ***	0.4048	Large
	G+T+W	12.0	80.0	1.7681	0.068	0.2096	Large
Fresh weight	Genotype (G)	4.0	80.0	109.0009	<0.001 ***	0.8449	Large
	Treatment (T)	1.0	80.0	238.2296	<0.001 ***	0.7486	Large
	Week (W)	3.0	80.0	33.8428	<0.001 ***	0.5592	Large
	G+T	4.0	80.0	18.6202	<0.001 ***	0.4821	Large
	G+W	12.0	80.0	11.7839	<0.001 ***	0.6386	Large
	T+W	3.0	80.0	18.5100	<0.001 ***	0.4097	Large
	G+T+W	12.0	80.0	22.4331	<0.001 ***	0.7709	Large
TSS	Genotype (G)	4.0	80.0	17.4604	<0.001 ***	0.4661	Large
	Treatment (T)	1.0	80.0	192.0167	<0.001 ***	0.7059	Large
	Week (W)	3.0	80.0	88.5882	<0.001 ***	0.7686	Large
	G+T	4.0	80.0	14.6632	<0.001 ***	0.4230	Large
	G+W	12.0	80.0	7.5245	<0.001 ***	0.5302	Large
	T+W	3.0	80.0	50.2625	<0.001 ***	0.6533	Large
	G+T+W	12.0	80.0	6.5978	<0.001 ***	0.4974	Large
Respiration	Genotype (G)	4.0	80.0	9.2124	<0.001 ***	0.3153	Large
	Treatment (T)	1.0	80.0	224.4979	<0.001 ***	0.7372	Large
	Week (W)	3.0	80.0	6.8414	<0.001 ***	0.2041	Large
	G+T	4.0	80.0	2.9106	0.027 *	0.1270	Medium
	G+W	12.0	80.0	3.6851	<0.001 ***	0.3559	Large
	T+W	3.0	80.0	9.6350	<0.001 ***	0.2654	Large

	G+T+W	12.0	80.0	4.7038	<0.001 ***	0.4136	Large
a*	Genotype (G)	4.0	80.0	153.0825	<0.001 ***	0.8844	Large
	Treatment (T)	1.0	80.0	13.9723	<0.001 ***	0.1487	Large
	Week (W)	3.0	80.0	8.4709	<0.001 ***	0.2410	Large
	G+T	4.0	80.0	5.8469	<0.001 ***	0.2262	Large
	G+W	12.0	80.0	3.5558	<0.001 ***	0.3478	Large
	T+W	3.0	80.0	2.4993	0.065	0.0857	Medium
	G+T+W	12.0	80.0	2.2731	0.015 *	0.2543	Large
b*	Genotype (G)	4.0	80.0	104.2590	<0.001 ***	0.8390	Large
	Treatment (T)	1.0	80.0	14.5486	<0.001 ***	0.1538	Large
	Week (W)	3.0	80.0	11.8877	<0.001 ***	0.3083	Large
	G+T	4.0	80.0	23.2493	<0.001 ***	0.5375	Large
	G+W	12.0	80.0	6.9903	<0.001 ***	0.5118	Large
	T+W	3.0	80.0	1.5781	0.201	0.0558	Small
	G+T+W	12.0	80.0	2.4548	0.009 **	0.2691	Large
L*	Genotype (G)	4.0	80.0	127.9927	<0.001 ***	0.8648	Large
	Treatment (T)	1.0	80.0	0.4126	0.522	0.0051	Small
	Week (W)	3.0	80.0	1.7448	0.164	0.0614	Medium
	G+T	4.0	80.0	4.8476	0.001 **	0.1950	Large
	G+W	12.0	80.0	1.6708	0.089	0.2003	Large
	T+W	3.0	80.0	3.7829	0.014 *	0.1242	Medium
	G+T+W	12.0	80.0	0.7352	0.713	0.0993	Medium

Table S2. Three-way factorial ART ANOVA results (Genotype × Storage treatment × Storage time) for spectral indices (mARI, NDVI, CRI1, and CRI2) measured in carrot roots during postharvest storage. Plants were subjected to two storage conditions (refrigeration and room temperature) and evaluated over four weeks. Measurements were conducted on the external tissue of the roots. Different letters indicate statistically significant differences among genotype × treatment combinations within each storage time, based on post hoc pairwise comparisons adjusted using the false discovery rate (FDR) method ($p < 0.05$).

Variable	Effect	Df	Df.res	F_value	P_value	η^2	Size
CRI1	Genotype (G)	4.0	80.0	38.7829	<0.001 ***	0.6654	Large
	Treatment (T)	1.0	80.0	85.3292	<0.001 ***	0.5224	Large
	Week (W)	3.0	80.0	70.7988	<0.001 ***	0.7314	Large
	G+T	4.0	80.0	32.1527	<0.001 ***	0.6224	Large
	G+W	12.0	80.0	21.7759	<0.001 ***	0.7701	Large
	T+W	3.0	80.0	34.9260	<0.001 ***	0.5732	Large
	G+T+W	12.0	80.0	18.4699	<0.001 ***	0.7396	Large
CRI2	Genotype (G)	4.0	80.0	70.2907	<0.001 ***	0.7828	Large
	Treatment (T)	1.0	80.0	101.9757	<0.001 ***	0.5666	Large
	Week (W)	3.0	80.0	69.7993	<0.001 ***	0.7286	Large
	G+T	4.0	80.0	22.9636	<0.001 ***	0.5407	Large
	G+W	12.0	80.0	19.0961	<0.001 ***	0.7460	Large
	T+W	3.0	80.0	24.3683	<0.001 ***	0.4838	Large
	G+T+W	12.0	80.0	9.1542	<0.001 ***	0.5847	Large
mARI	Genotype (G)	4.0	80.0	75.3164	<0.001 ***	0.7943	Large
	Treatment (T)	1.0	80.0	78.5713	<0.001 ***	0.5018	Large
	Week (W)	3.0	80.0	28.1749	<0.001 ***	0.5200	Large
	G+T	4.0	80.0	18.3226	<0.001 ***	0.4844	Large
	G+W	12.0	80.0	12.1429	<0.001 ***	0.6513	Large
	T+W	3.0	80.0	20.701 4	<0.001 ***	0.4432	Large
	G+T+W	12.0	80.0	7.6589	<0.001 ***	0.5409	Large
NDVI	Genotype (G)	4.0	80.0	42.4879	<0.001 ***	0.6854	Large
	Treatment (T)	1.0	80.0	0.2387	0.626	0.0030	Small
	Week (W)	3.0	80.0	19.9263	<0.001 ***	0.4338	Large

G+T	4.0	80.0	15.0366	<0.001 ***	0.4353	Large
G+W	12.0	80.0	4.37486	<0.001 ***	0.4022	Large
T+W	3.0	80.0	4.00691	0.010 *	0.1335	Medium
G+T+W	12.0	80.0	6.59662	<0.001 ***	0.5036	Large

Table S3. Evolution total carotenoid content (expressed as β -carotene) in five carrot genotypes (14BER, 6KUR, purple, yellow, and white) stored at room temperature and under refrigeration for four weeks. The table shows absolute concentration (ppm), relative percentage compared to Week 1 (initial value), and cumulative loss percentage. A logarithmic exploratory model was fitted to describe the degradation trend, with parameters estimated for each genotype and storage condition (β -carotene concentration = $a + b \cdot \ln(\text{time})$, where a and b represent the model coefficients).

Material	Treatment	Week	ppm (Mean \pm SD)	Loss percentage	Model	Parameter A	Parameter B	R ²
14BER	Room temperature	1	70.30 \pm 2.15	0	Logarithmic	-40.29ln(x)	66.73	0.96
		2	31.85 \pm 1.72	54.69				
		3	31.85 \pm 1.60	68.63				
		4	14.70 \pm 0.98	79.09				
6KUR	Room temperature	1	71.28 \pm 2.40	0	Logarithmic	-46.62ln(x)	67.11	0.96
		2	26.95 \pm 1.55	62.19				
		3	14.70 \pm 1.02	79.37				
		4	7.35 \pm 0.65	89.69				
Purple	Room temperature	1	4.91 \pm 0.30	0	Logarithmic	-1.909ln(x)	4.8946	0.96
	data	2	3.68 \pm 0.25	25.05				
	data	3	2.46 \pm 0.18	49.9				
	data	4	2.46 \pm 0.17	49.9				
Yellow	Room temperature	1	7.35 \pm 0.45	0	Logarithmic	-5.017ln(x)	7.2959	0.97
		2	3.43 \pm 0.28	53.33				
		3	2.46 \pm 0.20	66.53				
	data	4	0.00 \pm 0.00	100			data	
White	Room temperature	1	5.00 \pm 0.35	0	Logarithmic	-3.556ln(x)	5.00	1.00
		2	2.50 \pm 0.22	50				
		3	1.20 \pm 0.15	76				
		4	0.01 \pm 0.01	99.8				
14BER	Refrigeration	1	83.28 \pm 2.80	0	Logarithmic	-39.71ln(x)	77.48	0.89
		2	39.19 \pm 1.95	52.94				
		3	22.05 \pm 1.33	61.76				
		4	29.40 \pm 1.45	64.7				
6KUR	Refrigeration	1	81.57 \pm 2.65	0	Logarithmic	-36.49ln(x)	81.965	0.99
		2	56.34 \pm 2.30	30.93				

		3	44.58 ± 1.85	45.34				
		4	29.40 ± 1.40	63.96				
		1	7.35 ± 0.50	0				
		2	4.91 ± 0.35	33.2				
Purple	Refrigeration	3	4.91 ± 0.32	33.2	Logarithmic	$-1.925\ln(x)$	6.99	0.83
		4	0.00 ± 0.00	36.6				
		1	9.80 ± 0.60	0				
		2	7.35 ± 0.45	53.33				
Yellow	Refrigeration	3	4.91 ± 0.35	66.53	Logarithmic	$-5.017\ln(x)$	7.2959	0.97
		4	0.00 ± 0.00	100				
		1	6.00 ± 0.40	0				
		2	3.50 ± 0.28	41.67				
White	Refrigeration	3	2.00 ± 0.20	66.67	Logarithmic	$-3.556\ln(x)$	5.00	1.00
		4	0.01 ± 0.01	99.83				
		1	6.00 ± 0.40	0				
		2	3.50 ± 0.28	41.67				