

Supplementary Materials



Figure S1. Cross sections of cranberry (*Vaccinium macrocarpon* Ait.) fruits of different sizes, showing variations in internal structure.

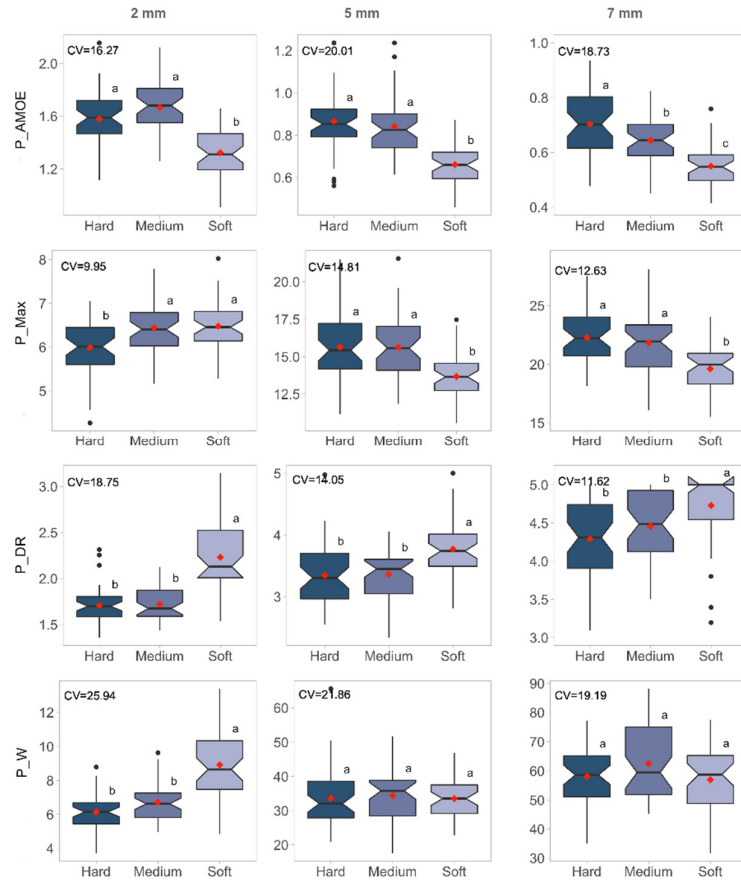


Figure S2. Comparison of firmness difference detection between three cranberry (*Vaccinium macrocarpon* Ait.) cultivars with different levels of firmness by puncture method measurements with 2 mm, 5 mm, and 7 mm diameter probes (n = 45 fruits per cultivar per test). Soft fruit cultivars: Yellow Bell; Intermediate fruit cultivars: Sundance; Hard fruit cultivars: Pilgrim King. Boxplot followed by a common letter are not significantly different by Tukey's honestly significant differences test at the 5% level of significance. The coefficient of variation (CV) for each probe diameter test is shown. P_AMOE: Apparent modulus of elasticity; P_Max: Maximum force; P_DR: Deformation at rupture; P_W: Work.

Table S1. Means and coefficients of variation of texture traits measured in cranberry (*Vaccinium macrocarpon* Ait.) fruits using the double compression, puncture, shearing, single compression and Kramer shear cell methodologies. For double compression, puncture, shearing and single compression three hundred fruits were used to perform this analysis. For Kramer shear cell a total of 45 samples (loads) were used. For all methodologies, the samples were equally composed of fruits of the BG (soft), Sundance (intermediate) and M34 (hard) cultivars.

Double compression		
Trait	Mean	Coefficient of Variation
h1	14.01	27.65
h2	15.35	28.32
dsf1	9.08	22.09

dsf2	10.93	23.03
dW1	9.99	35.54
dW2	10.07	36.18
dRf	1.01	7.54
dRfp	14.18	29.74
M.dist_1	1.5	10.07
M.dist_2	1.31	10.31
sf1	1.37	26.97
sf2	1.63	27.71
W1	65.42	29.21
W2	67.09	29.94
Rf	1.03	7.55
Rfp	14.42	29.77
p.deform	1.1	13.73
pr1	4.12	21.86
pr2	4.67	22.76
sp1	0.06	45.5
sp2	0.17	30.06
A1	27.78	23.45
A2	28.92	24.34
Rp	1.04	6.41
Rpp	4.3	23.87
tsf1	18.09	22.1
tsf2	21.77	23.02
TW1	4.81	41.83
TW2	4.9	41.48
TRf	1.17	3.20
TRfp	16.46	27.69
MCP1	1.18	21.96
MCP2	1.34	22.93
AMOE1	4.84	22.59
AMOE2	6.53	25.28

Puncture		
Trait	Mean	Coefficient of variation
P_AMOE	1.69	21.64
P_Max	6.99	19.24
P_DR	1.92	13.21
P_W	7.85	25.83

Shearing		
Trait	Mean	Coefficient of variation
S_Max	35.88	19.63
S_W	218.86	27.84
S_DF	51.05	18.71

Single compression		
Trait	Mean	Coefficient of variation
SC_RD	6.84	11.56
SC_RF	6562.48	21.98

Kramer shear cell		
Trait	Mean	Coefficient of variation
K_Max	827.37	7.50
K_W	9768.71	6.71

Table S2. Statistical comparison of double compression measurements for three cranberry (*Vaccinium macrocarpon* Ait.) cultivars with soft (Yellow bell), medium (Sundance), and hard (M34) fruits taken at 7.77 and 21.66 °C. For each temperature, 50 fruits of each cultivar were measured. Means, coefficients of variation, and Fisher values were calculated individually for each temperature. The *p*-values of the Tukey tests between temperatures are shown in column 8. The significance of the *p*-values of each ANOVA and Tukey tests are indicated with '*' signifying a *p*-value between .05 and .01, '**' means a *p*-value between .01 and .001 and '***' means a *p*-value less than .001.

Trait	Mean		Coefficient of variation		Differences Detected		<i>p</i> -value	FT ^a
Measurements independent of graph type								
	7.77 °C	21.66 °C	7.77 °C	21.66 °C	7.77 °C	21.66 °C		
h1	13.56	13.31	28.47	23.68	3	3	0.73	-0.13
h2	14.64	14.49	29.07	23.93	3	3	0.85	-0.07
MCP1	1.12	1.1	17.1	15.82	3	3	0.54	-0.12
MCP2	1.25	1.23	18.17	15.67	3	3	0.77	-0.11
M.dist_1	1.51	1.52	8.24	8.31	2	2	0.73	0.04
M.dist_2	1.35	1.34	7.75	9.09	2	2	0.87	-0.02
p.deform	1.01	1.06	16.63	12.49	2	2	0.11	0.35
Force (N) / Distance (mm) graph								
dsf1	8.78	8.66	22.52	17.28	3	3	0.76	-0.09
dsf2	10.34	10.27	23.36	17.79	3	3	0.88	-0.04
dW1	9.53	9.41	35.28	30.22	3	2	0.85	-0.09
dW2	9.23	9.28	36.45	30.23	3	3	0.95	0.03
dRf	0.97	0.99	2.98	2.32	2	2	***	0.14
dRfp	13.4	13.54	29.78	23.92	3	3	0.99	0.07
Force (N) / Strain (%) graph								
sf1	1.34	1.32	28.8	22.49	3	3	0.81	-0.10
sf2	1.56	1.54	29.41	22.97	3	3	0.89	-0.09
W1	62	61.12	28.72	24.07	3	3	0.80	-0.10
W2	61.02	61.32	29.87	24.24	3	3	0.93	0.03

Rf	0.98	1	3	2.38	2	2	***	0.14
Rfp	13.54	13.7	29.78	23.95	3	3	0.99	0.08
Force (N) / Time (seconds) graph								
tsf1	17.49	17.25	22.54	17.28	3	3	0.75	-0.09
tsf2	20.59	20.45	23.45	17.85	3	3	0.88	-0.04
tW1	4.79	4.73	35.24	30.22	3	2	0.86	-0.09
tW2	4.65	4.67	36.27	30.1	3	3	0.95	0.03
tRf	0.97	0.99	2.87	2.36	2	2	**	0.14
tRfp	13.16	13.14	29.62	23.81	3	3	0.98	-0.01
Stress (N/) / Strain (%)								
pr1	3.81	3.76	17.17	15.17	3	3	0.70	-0.09
pr2	4.26	4.19	18.05	15.66	3	3	0.96	-0.11
sp1	0.15	0.13	43.42	44.54	2	2	0.05	-0.95
sp2	0.17	0.15	25.19	51.58	2	2	0.06	-0.84
A1	25.64	25.14	17.73	15.96	3	3	0.58	-0.14
A2	25.64	25.8	18.59	16.78	3	3	0.86	0.04
Rp	1	1.03	3.36	2.57	2	2	***	0.21
Rpp	3.81	3.86	18.37	16.15	3	2	0.72	0.09

^aFirmness-temperature coefficient

Table S3. The Fisher values of ANOVA tests performed on texture measurements collected using different combinations of speed and strain for parallel plate double compression tests run on cranberry (*Vaccinium macrocarpon* Ait.) fruit in a central composite design experiment for three different cranberry cultivars that vary in firmness. Fruits of the BG, Stevens and A9 cultivars were considered as soft, intermediate and hard respectively. The *p*-values associated with each ANOVA are indicated after each Fisher value with '*' signifying a *p*-value between .05 and .01, '***' signifying a *p*-value between .01 and .001 and '***' signifying a *p*-value less than .001.

Strain	Speed	h1	h2	MCP1	MCP2	M.dist_1	M.dist_2	p.defor m	AMOE1	AMOE2
22.5	1	1.88	1.28	40.4***	23.94***	12.4***	3.75*	16.56***	23.82***	6.11**
35	3.05	2.44***	2.24***	10.51***	7.09**	11.1**	5.66**	16.07***	4.55*	2.48
5	8	32.55***	30.87***	12.36***	11.54***	17.91***	15.99***	1.74**	5.18	4.98
40	8	10.37***	6.77***	4.24**	2.5	12.82***	2.79***	12.62**	14.14	3.8
35	12.95	2.23***	0.67***	10.42**	12.05**	9.42***	3.71***	1.79*	8.88*	9.2**
22.5	15	11.05***	8.78***	22.6**	15.47**	8.85***	5.58***	0.82*	12	6.68*
22.5	8	1.39***	0.74***	8.07***	3.94***	3.17***	1.68***	9.9***	5.01**	2.23
22.5	8	19.31	16.88	13.93***	5.45**	7.13***	6.91**	14.27***	3.19*	0.84
22.5	8	9.03***	9.46***	8.7***	8.22***	19.46***	9.08***	6.14	2.24**	1.55**
22.5	8	25.33***	23.28**	6.64*	2.92	14.95***	7.6	7.21***	0.61***	0.06*
22.5	8	23.36	21.62	6.55***	7.25***	23.41***	25.87*	4.04	3.95***	5.08***
10	3.05	17.98***	16.74***	5.24***	6.4***	16.92***	19.76**	4.04	1.71***	4.55**
10	12.95	22.73	19.06	17.46***	9.65*	12.52*	21.09	9.6***	7.11**	1.78
Strain	Speed	dsf1	dsf2	dW1	dW2	dRf	dRfp	sf1	sf2	W1
22.5	1	15.09***	7.5***	2.25	3.43*	2.75	3.37*	1.3	0.63	2.61
35	3.05	1.15***	1.6***	5.13*	3.22*	3.69	3.79	1.68***	1.25***	5.72*

5	8	21.49	19.31	32.57*	27.34***	1.55*	23.82**	27.3***	25.05***	34.42
40	8	2.62***	1.54***	3.83***	1.24**	1.7*	2.28	6.06***	0.68***	2.07***
35	12.95	3.41***	4.32***	0.36*	0.52***	0.13	0.12**	0.75***	0.65***	0.09
22.5	15	15.51***	12.35***	1.91***	2.77***	1.66	1.61***	9.23***	7.2***	1.9***
22.5	8	4.16***	2.17***	3.05***	0.34***	2.27	1.47***	1.07***	0.47***	2.74***
22.5	8	20.09	12.52	3.39**	4.05*	2.1*	1.43*	17.92	14.05	3.18**
22.5	8	1.9***	1.68***	3.11***	8.08***	3.82	6.72***	7.86***	8.69***	2.54***
22.5	8	19.67	17.95	13.39*	7.12	3.95	0.85	22.26**	21.83	10.9
22.5	8	14.51*	9.59*	4.8	13.95	2.29	6.83	22.13	18.76	2.35
10	3.05	12.28***	11.95***	16.49	19.45	1.91	19.85	17.03***	15.01**	13.85
10	12.95	33.75*	14.95	14.16	20.65	2.05	20.37	24.96	15.38	13.55
Strain	Speed	W2	Rf	Rfp	tsf1	tsf2	TW1	TW2	tRf	tRfp
22.5	1	4.7*	2.78	3.27*	15.08***	7.47**	2.24	3.4*	2.72	3.36*
35	3.05	1.7	3.65	3.78	1.12***	1.58***	4.91*	1.71**	4.06	4.06
5	8	26.55*	1.73*	23.74**	25.17	21.02	27.85*	13.06***	3.22*	5.04**
40	8	0.31*	1.6*	2.2	2.61***	1.44***	4.01***	1.5***	1.77*	2.4
35	12.95	0.03***	0.15	0.13**	2.96***	3.66***	0.86**	2.05***	0.03	0.19***
22.5	15	1.9***	1.69	1.64***	14.4***	11.52***	7.64***	9.15***	0.15	4.54***
22.5	8	0.01***	2.33	1.51***	3.94***	2.02***	3.04***	0.38***	2.17	1.1***
22.5	8	2.57	2.19*	1.47*	20.56	12.54	4.08**	5.89	1.79*	1.81*
22.5	8	4.55***	3.78	6.71***	2.02***	1.84***	3.6***	9.65***	3.96*	7.45**
22.5	8	4.53	3.95	0.88	20.33	18.24	14.91*	10.15	3.39	0.68
22.5	8	8.52	2.29	6.7	15.03	10.16*	5.96	15.99	1.97	8.71
10	3.05	17.14	1.78	19.75	12.51***	12.16***	11.47***	13.18***	1.88	11.42*
10	12.95	24.57	1.9	20.01	30.9*	15.86	19.23	23.73	0.77	20.5
Strain	Speed	pr1	pr2	sp1	sp2	A1	A2	Rp	Rpp	
22.5	1	39.96***	25.34***	11.54***	23.71***	30.88***	14.13***	6.43**	12.57***	
35	3.05	9.35***	8.63**	12.92***	15.88***	19.61	2.13**	7.98	5.98	
5	8	12.43***	11.81***	8.13***	7.02***	13.32**	10.5	0.58*	9.36	
40	8	5.79**	5.95*	23.87***	22.98***	3.48	1.16	8.49	9.27	
35	12.95	11.99**	14.48**	25.33***	21.86***	2.99	8.49*	2.39	3.03*	
22.5	15	22.08**	18.97**	14.22**	23.44***	2.27*	2.43	1.27*	0.46*	
22.5	8	8.83***	5.88***	10.16	7.48***	0.34**	1.71***	0.87	1.69*	
22.5	8	13.45***	5.41***	14.49***	24.01***	1.15***	4.89	1.05***	0.83**	
22.5	8	8.55***	7.53***	29.09***	17.09**	5.3***	0.25***	3.2	1.59***	
22.5	8	6.76**	4.42**	21.69***	18.63***	0.76*	3.06	0.81***	1.37***	
22.5	8	6.87***	5.76***	14.52***	43.62***	1.41	3.8***	2.12	3.73	
10	3.05	5.28***	7.09***	7.15***	18.11***	3.35	3.06	3.78	4.31	
10	12.95	18.24***	10.33**	0.8***	8.6**	7.2	16.35	0.26	4.25	