

Supplementary Data

Supplementary Table I (a): Malting quality data from 34 doubled haploid progeny of Golden Promise x Full Pint, the parents, and CDC Copeland. Grain stored for 1 month (ST-1) post-harvest prior to malting and brewing.

Genotype	AA	BG	DP	FAN	KI	MC	ME	SP	TP	VC
120020	41	1244	120	99	31.7	1.3	74.9	4.2	13.3	2.2
120031	54.8	713	186	171	33.8	1.3	75.9	4.9	14.6	1.8
120058	46	288	133	113	36.5	1.2	76	4.5	12.3	1.6
120089	57.4	288	141	161	40.8	1.3	77.6	5.2	12.8	1.6
120090	43.2	659	149	126	30.6	1.8	74.7	4.3	14	1.8
120145	47.6	189	143	116	37.2	1.2	72.7	4.4	11.7	1.7
120156	36.4	875	123	100	28.6	1.1	74.3	3.7	12.8	1.8
120166	40	248	120	111	31.9	1.3	72.5	3.9	12.2	1.5
120285	59.8	338	178	180	37	1.4	77.9	4.7	12.7	1.6
120314	66.2	456	129	166	39.2	1.4	77.2	4.9	12.6	1.8
120329	34.9	686	100	101	27.3	1.6	75.6	3.4	12.5	1.6
120330	36.7	555	150	105	30	1.2	73.6	4.5	14.9	1.7
120331	30.6	799	112	90	28.3	1	75.2	3.8	13.4	1.9
120341	57.1	482	113	179	37.5	1.2	77.5	4.5	11.9	1.8
120363	68	127	156	100	37.8	1.4	75.9	5.3	14	1.5
120365	38.6	895	107	149	33.1	1.3	74.8	4.5	13.6	1.9
120366	52.3	206	156	124	38.3	1.6	77.1	5.1	13.3	1.6
120374	57.5	620	134	137	36.2	1.2	76.5	4.5	12.4	1.8
120381	45.6	444	127	109	29.9	1.2	75.2	4.3	14.3	1.7

AA: alpha-amylase; BG: beta-glucan; DP: diastatic power; MC: malt color; ME: malt extract; SP: soluble protein; KI: Kolbach Index; TP: total protein; FAN: free amino nitrogen; VC: viscosity

Supplementary Table I (b): Malting quality data from 34 doubled haploid progeny of Golden Promise x Full Pint, the parents, and CDC Copeland. Grain stored for 1 month (ST-1) post-harvest prior to malting and brewing. (Continued).

Genotype	AA	BG	DP	FAN	KI	MC	ME	SP	TP	VC
120384	39.1	533	100	95	30.7	1.4	73.2	4	13.1	1.7
120510	29.8	884	114	125	29.8	1.1	73.3	4	13.6	2
120516	38.7	484	121	180	32	1.2	73.8	4.3	13.3	1.8
120520	53.6	305	148	103	36.4	1.5	74.9	5.2	14.2	1.7
120521	35	945	90	205	29.4	1.2	73	3.9	13.2	2.1
120529	73.5	184	213	98	38	1.5	74.7	5.3	13.8	1.7
120536	32.9	555	136	112	27.9	1.5	75	4	14.2	1.8
120543	38.9	279	126	200	31.1	1.2	73.9	4.1	13.1	1.7
120657	63.4	259	128	103	40.5	1.6	76.6	5.3	13	1.7
120661	36.9	618	116	133	32.2	1.2	74.3	4	12.4	1.9
120671	48.5	114	172	167	31	1.4	74.8	4.4	14.1	0
120691	51	974	134	129	34.8	1.2	74.9	4.7	13.5	2
120709	42.5	881	132	110	29.3	1.3	73.3	4.4	15	1.9
120715	37.1	736	133	117	32.1	1.5	74.8	4.1	12.7	1.7
120731	40	381	129	211	30.5	1.2	75.9	4.1	13.5	1.7
Golden Promise	43.6	491	162	122	32.4	1.3	74.7	4.2	13.1	1.6
Full Pint	78.3	402	170	175	41	1.2	77.3	4.8	11.7	1.7
CDC Copeland	60.5	253	138	179	36.2	1.2	77.7	4.9	13.6	1.6

AA: alpha-amylase; BG: beta-glucan; DP: diastatic power; MC = malt color; ME: malt extract; SP: soluble protein; KI: Kolbach Index; TP: total protein; FAN: free amino nitrogen; VC: viscosity

Supplementary Table II (a): Malting quality data from 34 doubled haploid progeny of Golden Promise x Full Pint, the parents, and CDC Copeland. Grain stored for 5 months (ST-2) prior to malting and brewing.

Genotype	AA	BG	DP	FAN	KI	MC	ME	SP	TP	VC
120020	55.1	188	108	184	42	1.7	76.3	4.5	12.7	1.5
120031	48.6	287	152	126	41.6	1.4	74.2	4.3	12.4	1.5
120058	35.5	336	116	121	31.9	1.6	74.1	4.2	13.1	1.6
120089	36.6	1308	117	122	26.8	1.7	75	3.8	14.2	2
120090	53.1	752	176	176	31.3	1.6	76.2	4.7	15.1	1.8
120145	59	306	142	174	35.6	1.6	78.5	5	14	1.8
120156	43.2	698	148	137	28.6	1.8	75.5	4.2	14.7	1.8
120166	33.7	877	119	114	25.2	1.7	74.7	3.6	14.2	1.8
120285	64.4	397	159	189	39.3	1.6	78.5	4.9	12.5	1.7
120314	68	557	112	180	37.1	1.7	77.5	4.8	12.8	1.8
120329	28.9	1129	88	103	24.5	1.7	76	3.1	12.6	2
120330	34.8	674	150	130	28.5	1.5	74.5	4.2	14.6	1.6
120331	30.9	896	114	116	23.5	1.5	75.8	3.2	13.6	2
120341	63.2	560	106	149	32.8	1.6	78.5	4.2	12.9	1.8
120363	68	156	147	211	37.4	1.7	76.6	5.4	14.4	1.6
120365	50.3	1812	113	130	28.7	1.5	75.3	4.1	14.3	2.7
120366	58.5	399	154	165	35.6	1.7	77.8	4.8	13.6	2.8
120374	44.6	672	121	150	34.2	1.5	77.2	4.5	13.2	1.8
120381	48.8	452	124	127	31.5	1.5	75.7	4.2	13.5	1.6

AA: alpha-amylase; BG: beta-glucan; DP: diastatic power; MC = Malt color; ME: malt extract; SP: soluble protein; KI: Kolbach Index; TP: total protein; FAN: free amino nitrogen; VC: viscosity

Supplementary Table II (b): Malting quality data from 34 doubled haploid progeny of Golden Promise x Full Pint, the parents, and CDC Copeland. Grain stored for 5 months (ST-2) prior to malting and brewing. (Continued).

Genotype	AA	BG	DP	FAN	KI	MC	ME	SP	TP	VC
120384	37.5	657	98	97	28.9	1.6	74.2	3.9	13.6	1.7
120510	30.8	1001	111	99	27.8	1.7	73.9	4.1	14.6	1.9
120516	38.7	543	126	105	30.6	1.4	74.3	4.1	13.3	1.7
120520	54.4	400	139	156	33.8	1.6	76	4.9	14.5	1.6
120521	35.7	1074	91	92	27.8	1.5	73	3.9	14	1.9
120529	77.9	228	198	178	34.9	1.7	75.3	5.1	14.7	1.5
120536	29.5	676	145	104	25.1	1.6	76	3.5	14	1.7
120543	35.1	249	113	122	30.1	1.5	74.7	4	13.2	1.6
120657	65.1	336	127	186	39.7	1.6	77.3	5.1	12.8	1.6
120661	37.4	814	111	107	28.2	1.5	75.1	3.6	12.6	1.9
120671	44.4	268	156	154	28.9	1.7	75.4	4.4	15.1	1.6
120691	54	972	142	165	34.2	1.6	75.8	4.5	13.3	1.9
120709	45.5	928	134	130	27.6	1.6	74	4.1	14.8	1.8
120715	33.5	793	123	109	28.3	1.6	75.6	3.8	13.5	1.8
120731	23.3	513	122	119	28.5	1.6	75.5	3.8	13.4	1.6
Golden Promise	34.7	488	136	176	35.3	1.6	73	4.9	13.8	1.7
Full Pint	77.4	292	162	173	38.9	1.6	78.1	5.1	13.2	1.7
CDC Copeland	61.9	377	140	134	31.8	1.9	78.5	4.2	13.2	1.7

AA: alpha-amylase; BG: beta-glucan; DP: diastatic power; MC = malt color; ME: malt extract; SP: soluble protein; KI: Kolbach Index; TP: total protein; FAN: free amino nitrogen; VC: viscosity

Supplementary Table III (a): Malting quality data from 34 doubled haploid progeny of Golden Promise x Full Pint, the parents, and CDC Copeland. Grain stored for 10 months (ST-3) prior to malting and brewing.

Genotype	AA	BG	DP	FAN	KI	MC	ME	SP	TP	VC
120020	55.1	68	102	157	42	1.6	76.3	5.4	12.7	1.5
120031	48.6	58	135	144	41.6	1.5	74.2	5.2	12.4	1.5
120058	49.1	55	116	133	39.3	1.5	74.3	5.1	13.1	1.4
120089	50.7	605	117	144	33.1	1.6	75	4.9	14.7	1.7
120090	59.5	202	176	192	35.5	1.7	76.1	5.5	15.4	1.6
120145	61	73	142	194	42.3	1.7	78.8	5.7	13.4	1.5
120156	59.2	172	148	153	34.2	1.6	75.6	4.8	14.2	1.6
120166	45.9	199	119	130	33.5	1.6	74.9	4.5	13.4	1.5
120285	63.1	61	159	209	43.2	1.7	78.8	5.6	12.9	1.5
120314	59.4	83	112	186	41.3	1.8	78	5.6	13.5	1.5
120329	41.7	335	88	114	32	1.6	76.3	4.2	13.1	1.7
120330	47	128	150	141	32.6	1.5	74.8	5	15.3	1.5
120331	42.2	231	114	119	29.3	1.5	76.2	4.2	14.3	1.6
120341	50.3	165	106	169	39.5	1.7	78.3	5.1	13	1.6
120363	73.8	51	170	226	40.8	1.9	76.7	5.8	14.3	1.5
120365	56.6	265	149	148	33.6	1.7	75.8	4.9	14.6	1.6
120366	65	64	177	188	40.2	1.9	77.5	5.6	13.9	1.5
120374	72	217	168	169	36.6	1.6	77.6	5	13.8	1.6
120381	61.1	112	164	153	34.1	1.6	75.9	4.9	14.3	1.5

AA: alpha-amylase; BG: beta-glucan; DP: diastatic power; MC = malt color; ME: malt extract; SP: soluble protein; KI: Kolbach Index; TP: total protein; FAN: free amino nitrogen; VC: viscosity

Supplementary Table III (b): Malting quality data from 34 doubled haploid progeny of Golden Promise x Full Pint, the parents, and CDC Copeland. Grain stored for 10 months (ST-3) prior to malting and brewing (Continued).

Genotype	AA	BG	DP	FAN	KI	MC	ME	SP	TP	VC
120384	53.4	288	143	114	31.7	1.6	74.7	4.3	13.5	1.6
120510	46.5	365	150	129	32.7	1.6	74.9	4.6	14	1.6
120516	55.4	129	165	134	33.9	1.6	75	4.7	13.8	1.5
120520	65	86	160	192	36.8	1.8	75.9	5.4	14.7	1.5
120521	60.5	426	137	117	29.6	1.6	74	4.2	14.2	1.7
120529	69.9	67	212	215	35.5	1.8	75.6	5.7	16	1.5
120536	59.3	217	172	111	30.7	1.5	76.5	4.3	14.2	1.6
120543	49.2	77	138	146	36.3	1.6	75.3	4.8	13.2	1.5
120657	67.6	78	153	217	44.4	1.8	76.9	5.7	12.9	1.5
120661	53.9	60	180	168	34.5	1.8	75.6	5.1	14.9	1.5
120671	60.7	443	156	200	37.3	1.7	76.3	5.2	14.1	1.6
120691	60.3	362	164	178	31.8	1.7	74.9	5	15.6	1.6
120709	51.3	198	156	124	33.7	1.6	76.4	4.6	13.6	1.6
120715	50.9	104	145	117	34.7	1.7	76.9	4.5	13	1.6
120731	51.9	244	136	92	33.6	1.6	75.5	4.1	12.3	1.6
Golden Promise	49.2	174	156	142	34.3	1.6	75.4	4.6	13.4	1.5
Full Pint	69.8	141	184	247	40.3	1.6	77.9	5.5	13.6	1.5
CDC Copeland	65.4	65	160	233	42.4	1.6	76.2	5.6	13.2	1.5

AA: alpha-amylase; BG: beta-glucan; DP: diastatic power; MC = malt color; ME: malt extract; SP: soluble protein; KI: Kolbach Index; TP: total protein; FAN: free amino nitrogen; VC: viscosity

Supplementary Table IV: Malting protocol used to produce three levels of malt modification at the Canadian Malting Barley

Technical Centre, Winnipeg, CA. In the steeping step, the digit refers to the number of hours and W = wet; D = dry.

Treatment	Steeping	Germination	Kilning
MT-1	6W-12D-6W-18D-1W-2D @ 14°C	96 Hours @15°C	24 Hour with 4 Hours @ 85
MT-2	8W-16D-8W-10D-1W-2D@ 14°C	96 Hours @15°C	24 Hour with 4 Hours @ 85
MT-3	8W-16D-10W-8D-3W-2D@ 14°C	96 Hours @15°C	24 Hour with 4 Hours @ 85

Supplementary Table V (a): Beer sensory descriptor values (Best linear unbiased predictors (BLUPs)) for 34 doubled haploid progeny of Golden Promise x Full Pint, the parents, and CDC Copeland. Grain stored for 1 month (ST-1) prior to malting and brewing.

Genotype	BD	BT	CL	CH	CO	FL	FR	GR	GS	HN	MT	RO	SF	ST	TO	TF
120020	2.8	3.7	3.6	4.5	2.3	4.4	4.6	4.5	4.6	4.0	4.8	3.5	4.1	4.2	4.7	4.4
120031	2.8	3.5	3.9	4.2	2.8	4.4	4.8	4.7	4.6	3.9	3.6	3.5	4.0	4.4	3.7	3.5
120058	2.8	3.5	3.2	4.3	2.9	4.2	4.5	4.3	4.6	3.9	4.5	3.5	3.9	4.8	4.2	4.0
120089	2.9	4.2	3.7	4.2	2.9	4.3	4.3	4.2	4.6	3.3	3.9	3.5	4.2	4.3	3.3	3.4
120090	2.9	4.2	3.4	4.2	2.5	4.3	3.6	4.6	4.6	3.4	4.5	3.4	4.2	4.1	2.7	3.1
120145	2.9	4.3	3.6	3.5	2.8	4.4	4.5	4.5	4.6	3.4	3.9	3.5	3.9	4.8	3.3	3.8
120156	2.8	4.1	3.6	4.0	2.5	4.4	3.5	4.5	4.6	4.3	5.0	3.5	4.0	4.8	4.1	4.6
120166	2.9	4.0	4.0	3.9	2.6	4.3	4.4	4.4	4.6	3.4	3.6	3.5	4.2	4.6	3.9	4.6
120285	2.9	4.1	3.8	4.2	3.7	4.4	4.7	4.5	4.6	3.3	3.6	3.5	4.0	4.3	3.4	3.4
120314	2.9	4.1	3.9	4.2	2.8	4.3	3.2	4.3	4.6	3.4	4.5	3.5	4.1	3.9	3.6	3.2
120329	3.0	4.2	3.6	4.0	2.5	4.2	4.3	4.6	4.6	4.3	5.4	3.5	3.9	4.5	4.1	4.6
120330	2.9	4.2	3.8	4.1	3.2	4.4	4.3	4.2	4.6	3.3	4.8	3.5	4.1	3.9	3.6	3.4
120331	2.8	4.1	3.4	4.1	2.6	4.4	4.8	4.5	4.6	3.2	2.9	3.5	3.9	3.6	2.6	2.8
120341	2.8	4.0	3.8	4.2	2.3	4.2	3.4	4.6	4.6	3.4	5.4	3.5	4.1	4.3	4.4	4.9
120363	2.9	4.2	3.6	4.4	3.3	4.1	4.1	4.3	4.6	3.3	4.5	3.5	3.8	4.7	4.4	4.7
120365	2.9	4.1	4.1	4.1	2.8	4.3	4.6	4.3	4.6	3.4	4.9	3.5	3.8	4.7	3.9	4.6
120366	2.8	3.2	3.9	4.5	3.3	4.2	3.7	4.1	4.6	4.6	5.2	3.5	4.0	4.8	5.4	5.0
120374	2.9	3.2	3.6	4.8	3.0	4.2	3.8	4.2	4.6	4.6	5.5	3.5	4.3	4.2	5.3	5.3
120381	2.8	3.0	3.2	4.6	2.5	4.3	4.8	4.0	4.6	4.5	2.9	3.5	4.2	3.7	3.9	3.3
<i>LSD (0.05)</i>	<i>0.7</i>	<i>0.6</i>	<i>0.6</i>	<i>0.4</i>	<i>0.8</i>	<i>0.6</i>	<i>0.8</i>	<i>0.5</i>	<i>0.4</i>	<i>0.6</i>	<i>0.7</i>	<i>0.5</i>	<i>0.5</i>	<i>0.7</i>	<i>0.6</i>	<i>0.7</i>

BD: body; BT: bitter; CL: cereal; CH: chemical; CO: color; FL: floral; FR: fruit; GR: grain; GS: grass; HN: honey; MT: malt; RO: roasted; SF: sulfur; ST: sweet; TO: toasted; TF: toffee.

Supplementary Table V (b): Beer sensory descriptor values (Best linear unbiased predictors (BLUPs)) for 34 doubled haploid progeny of Golden Promise x Full Pint, the parents, and CDC Copeland. Grain stored for 1 month (ST-1) prior to malting and brewing. (Continued).

Genotype	BD	BT	CL	CH	CO	FL	FR	GR	GS	HN	MT	RO	SF	ST	TO	TF
120384	2.8	3.0	3.5	4.3	2.8	4.4	4.9	4.3	4.6	4.6	3.2	3.5	3.8	4.2	4.1	3.6
120510	2.8	3.4	3.5	4.9	2.5	4.2	3.0	4.3	4.6	4.6	3.5	3.5	4.4	3.7	4.6	3.6
120516	2.8	3.2	3.2	4.9	2.5	4.4	3.2	4.0	4.6	4.4	3.1	3.5	3.8	3.2	3.5	3.0
120520	2.8	3.3	3.3	4.4	3.5	4.4	2.9	4.0	4.6	4.5	4.7	3.5	3.5	4.4	4.0	3.6
120521	2.7	3.3	3.0	4.9	2.3	4.2	4.8	4.3	4.6	4.4	2.5	3.4	4.1	3.8	3.7	3.0
120529	2.7	3.1	3.2	4.7	2.8	4.4	4.2	3.9	4.6	4.5	3.8	3.5	3.7	4.1	4.7	3.5
120536	2.7	3.2	3.1	4.9	2.5	4.3	4.2	4.1	4.6	4.7	3.5	3.5	3.8	3.9	4.4	3.5
120543	2.8	3.4	3.2	4.8	2.5	4.3	4.8	4.4	4.6	4.5	3.2	3.4	4.0	4.2	4.2	3.4
120657	2.8	3.4	3.6	4.7	3.6	4.2	3.8	4.4	4.6	4.7	5.1	3.5	3.8	4.9	5.3	4.9
120661	2.7	3.7	3.1	5.4	2.6	4.2	5.1	3.8	4.6	4.4	2.8	3.4	4.0	3.3	3.9	3.1
120671	2.9	3.4	3.7	4.4	3.0	4.4	5.0	4.5	4.6	3.8	4.4	3.5	3.8	4.6	3.8	3.6
120691	2.9	3.3	3.9	3.9	3.0	4.3	3.9	4.8	4.6	3.9	5.2	3.5	3.9	4.0	5.0	4.8
120709	2.8	3.3	3.5	4.6	2.7	4.3	4.8	4.2	4.6	3.9	2.8	3.4	3.8	3.7	3.2	3.1
120715	2.9	3.6	4.1	4.2	2.8	4.3	4.8	4.6	4.6	4.0	3.6	3.5	4.3	3.9	4.0	3.8
120731	2.9	3.5	3.4	4.6	3.0	4.3	4.5	4.5	4.6	3.9	4.9	3.4	4.0	4.2	3.2	3.0
Golden Promise	3.0	3.5	3.9	4.0	4.5	4.5	5.0	4.4	4.6	3.0	3.5	3.5	4.1	4.2	3.3	2.6
Full Pint	3.0	3.3	5.0	4.1	4.6	3.2	3.1	4.5	4.6	3.8	5.0	3.5	4.1	4.8	4.0	3.8
CDC Copeland	2.9	3.5	3.5	4.5	3.5	4.3	4.6	4.2	4.6	3.9	3.8	3.5	4.2	3.9	3.9	4.0
<i>LSD (0.05)</i>	<i>0.7</i>	<i>0.6</i>	<i>0.6</i>	<i>0.4</i>	<i>0.8</i>	<i>0.6</i>	<i>0.8</i>	<i>0.5</i>	<i>0.4</i>	<i>0.6</i>	<i>0.7</i>	<i>0.5</i>	<i>0.5</i>	<i>0.7</i>	<i>0.6</i>	<i>0.7</i>

BD: body; BT: bitter; CL: cereal; CH: chemical; CO: color; FL: floral; FR: fruit; GR: grain; GS: grass; HN: honey; MT: malt; RO: roasted; SF: sulfur; ST: sweet; TO: toasted; TF: toffee.

Supplementary Table VI (a): Beer sensory descriptor values (Best linear unbiased predictors (BLUPs)) for 34 doubled haploid progeny of Golden Promise x Full Pint, the parents, and CDC Copeland. Grain stored for 5 months (ST-2) prior to malting and brewing.

Genotype	BD	BT	CL	CH	CO	FL	FR	GR	GS	HN	MT	RO	SF	ST	TO	TF
120020	3.5	3.5	3.5	3.5	3.5	3.5	4.9	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
120031	2.0	3.7	5.0	4.3	2.0	3.7	3.7	4.7	4.3	4.2	4.7	3.5	4.3	4.0	3.5	3.8
120058	2.8	3.3	4.0	4.5	2.2	4.0	4.0	5.2	5.2	4.8	5.0	3.3	4.3	4.0	4.5	4.2
120089	1.3	2.8	2.0	4.7	1.0	4.8	4.8	2.5	4.5	4.5	1.8	3.5	4.3	3.7	2.0	2.0
120090	2.7	2.7	3.8	3.8	2.2	3.0	4.5	5.2	4.8	4.0	4.8	3.3	4.5	3.3	4.0	3.7
120145	2.8	3.0	4.7	4.3	3.0	3.7	5.3	4.7	5.2	3.8	2.8	3.5	4.2	5.7	4.7	3.8
120156	3.3	3.0	3.5	4.0	2.5	2.8	3.5	4.7	3.7	4.8	5.2	3.8	4.0	4.8	4.7	5.0
120166	2.7	3.5	3.9	4.5	2.1	3.8	4.1	4.8	4.9	4.3	3.7	3.5	3.8	4.1	3.0	3.7
120285	3.0	3.3	4.3	4.0	4.7	4.5	4.5	5.0	4.3	4.0	4.7	4.0	4.3	4.5	3.8	3.8
120314	2.8	3.2	3.2	3.8	3.2	4.7	5.2	4.5	4.7	4.8	4.9	3.3	3.8	5.2	4.0	4.0
120329	2.8	4.3	2.7	4.2	2.0	3.8	4.2	3.5	5.2	4.7	3.0	3.3	4.3	3.3	3.8	4.2
120330	2.2	3.3	4.0	4.8	2.2	3.3	4.3	4.5	5.0	4.3	4.5	3.7	4.3	3.2	3.3	2.7
120331	3.7	4.3	4.2	4.2	3.5	3.7	3.7	4.3	4.7	3.5	4.3	3.5	4.3	3.5	3.3	3.3
120341	2.8	3.8	4.0	4.7	2.3	2.0	3.2	5.2	4.3	4.3	5.0	4.0	4.5	4.0	3.0	4.0
120363	4.3	3.5	5.2	4.2	3.7	5.0	4.0	5.3	5.0	4.8	5.1	3.3	4.0	4.7	4.5	5.0
120365	3.3	4.3	4.3	4.2	5.0	5.2	5.1	4.5	4.5	5.5	4.8	4.0	3.8	5.3	5.0	5.2
120366	2.2	3.5	2.8	4.5	1.7	3.0	3.3	3.8	5.2	3.7	5.2	3.5	4.5	3.8	2.7	4.0
120374	3.8	3.0	5.0	3.8	3.7	4.3	4.7	5.0	4.7	4.3	5.2	3.5	3.8	5.1	4.8	4.7
120381	2.7	3.3	3.0	4.0	2.2	3.7	5.0	3.5	4.8	4.3	3.2	4.0	4.2	4.7	3.5	4.2
<i>LSD (0.05)</i>	<i>0.8</i>	<i>0.7</i>	<i>0.8</i>	<i>0.5</i>	<i>1.1</i>	<i>0.7</i>	<i>0.7</i>	<i>0.6</i>	<i>0.5</i>	<i>0.7</i>	<i>0.8</i>	<i>0.6</i>	<i>0.5</i>	<i>0.7</i>	<i>0.8</i>	<i>0.7</i>

BD: body; BT: bitter; CL: cereal; CH: chemical; CO: color; FL: floral; FR: fruit; GR: grain; GS: grass; HN: honey; MT: malt; RO: roasted; SF: sulfur; ST: sweet; TO: toasted; TF: toffee.

Supplementary Table VI (b): Beer sensory descriptor values (Best linear unbiased predictors (BLUPs)) for 34 doubled haploid progeny of Golden Promise x Full Pint, the parents, and CDC Copeland. Grain stored for 5 months (ST-2) prior to malting and brewing. (Continued).

Genotype	BD	BT	CL	CH	CO	FL	FR	GR	GS	HN	MT	RO	SF	ST	TO	TF
120384	2.0	3.0	3.3	4.0	1.8	4.2	5.0	3.7	4.5	3.5	3.3	3.3	4.0	4.2	4.0	4.3
120510	3.5	3.3	3.5	4.3	3.0	3.8	5.1	4.0	4.7	4.7	3.6	3.8	4.0	4.8	3.0	4.0
120516	2.5	2.5	3.2	4.3	2.0	5.0	5.0	4.8	4.7	4.8	2.8	3.0	3.7	4.7	3.2	2.8
120520	2.3	2.5	3.0	4.2	1.3	3.0	5.0	4.8	5.2	4.0	4.8	3.3	4.2	3.7	3.3	4.0
120521	2.5	3.3	4.3	4.0	1.8	4.3	5.7	4.3	4.8	3.2	3.7	3.2	4.3	3.7	3.0	3.0
120529	3.0	3.5	3.8	4.3	2.8	4.2	4.9	4.8	4.3	5.2	3.3	3.2	3.8	3.5	4.0	4.3
120536	2.5	2.5	2.2	5.5	1.3	4.0	4.9	4.3	4.7	3.3	2.5	3.3	3.7	2.3	2.3	3.2
120543	3.3	3.3	4.0	4.0	1.2	5.0	5.0	4.8	4.8	5.2	4.0	3.8	4.0	4.2	4.0	4.3
120657	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
120661	3.7	4.3	4.8	3.8	5.2	4.2	4.9	5.2	4.7	5.2	3.2	3.8	4.2	4.3	4.8	5.3
120671	1.6	2.7	2.7	4.5	1.3	4.0	4.0	4.3	4.2	3.7	2.7	3.3	4.7	3.3	3.3	3.5
120691	2.7	2.7	3.3	4.5	2.7	4.2	5.2	3.7	4.5	4.3	5.2	2.3	4.5	4.5	4.7	4.8
120709	2.7	2.8	3.0	4.7	2.0	3.7	3.7	4.5	4.2	3.5	3.5	2.8	4.3	3.2	2.5	3.5
120715	2.3	2.7	3.6	4.3	3.3	4.2	4.3	4.4	4.7	4.2	3.8	3.0	4.3	3.8	3.4	3.5
120731	2.2	2.3	3.0	4.7	1.7	4.7	4.5	4.0	4.5	5.0	3.3	2.7	5.0	4.2	3.0	4.2
Golden Promise	2.7	3.0	2.5	4.3	2.5	4.5	5.2	3.7	5.0	2.8	2.7	2.7	4.3	3.2	3.2	3.2
Full Pint	2.3	2.7	3.7	4.0	2.2	3.7	3.0	4.3	5.1	4.5	5.2	3.0	4.2	3.5	4.2	4.5
CDC Copeland	2.3	2.8	3.2	4.3	1.7	3.0	3.5	4.2	4.2	4.0	3.5	3.2	4.3	4.2	3.2	3.3
<i>LSD (0.05)</i>	<i>0.8</i>	<i>0.7</i>	<i>0.8</i>	<i>0.5</i>	<i>1.1</i>	<i>0.7</i>	<i>0.7</i>	<i>0.6</i>	<i>0.5</i>	<i>0.7</i>	<i>0.8</i>	<i>0.6</i>	<i>0.5</i>	<i>0.7</i>	<i>0.8</i>	<i>0.7</i>

BD: body; BT: bitter; CL: cereal; CH: chemical; CO: color; FL: floral; FR: fruit; GR: grain; GS: grass; HN: honey; MT: malt; RO: roasted; SF: sulfur; ST: sweet; TO: toasted; TF: toffee.

Supplementary Table VII (a): Beer sensory descriptor values (Best linear unbiased predictors (BLUPs)) for 34 doubled haploid progeny of Golden Promise x Full Pint, the parents, and CDC Copeland. Grain stored for 10 months (ST-3) prior to malting and brewing.

Genotype	BD	BT	CL	CH	CO	FL	FR	GR	GS	HN	MT	RO	SF	ST	TO	TF
120020	3.0	3.3	4.0	4.5	2.8	4.0	4.8	4.8	4.3	4.0	4.0	3.5	4.5	4.2	3.7	3.5
120031	2.3	3.2	3.3	4.5	2.8	3.5	3.2	4.0	4.8	3.7	3.5	3.3	4.3	3.3	3.8	3.3
120058	2.3	3.2	2.8	4.7	1.7	4.0	2.9	4.0	4.5	3.5	5.2	3.0	4.7	2.7	3.0	2.7
120089	2.8	2.7	3.7	4.2	3.5	4.0	2.9	4.2	4.3	4.3	5.0	3.0	4.5	5.0	4.0	3.7
120090	2.7	2.7	3.0	4.3	2.2	4.8	4.3	4.5	4.7	4.0	3.2	3.2	4.3	4.3	3.8	3.3
120145	2.7	3.0	3.5	4.5	2.0	3.3	4.6	4.7	5.0	4.2	3.8	3.0	4.3	4.3	3.8	3.8
120156	2.5	3.0	3.8	4.3	2.2	3.8	2.7	4.0	4.8	5.1	5.4	3.5	4.2	5.4	5.2	5.2
120166	2.3	3.3	3.2	4.8	2.2	5.2	4.7	3.8	4.5	3.8	3.8	3.2	4.8	4.8	4.2	3.7
120285	3.0	2.8	4.5	4.5	2.8	4.7	4.7	4.2	5.0	5.2	4.7	4.0	3.8	4.8	4.2	4.5
120314	3.0	3.2	4.5	4.3	2.8	3.8	3.2	5.2	4.8	5.1	5.2	3.7	4.0	5.3	5.0	5.2
120329	3.2	3.5	3.8	3.8	2.0	4.0	4.9	5.2	4.8	4.7	4.0	3.7	4.0	3.7	4.0	4.0
120330	3.2	2.7	3.7	4.7	2.2	3.1	2.7	4.3	5.0	5.2	5.1	3.0	4.7	5.0	4.8	5.1
120331	2.3	3.3	3.6	4.7	3.0	3.8	4.0	3.8	4.7	4.0	4.0	3.2	4.0	4.2	4.3	4.2
120341	3.3	3.7	3.8	4.2	2.7	3.8	3.5	4.3	4.3	4.5	5.2	3.3	3.7	5.0	4.7	5.0
120363	3.2	3.0	4.2	3.8	2.0	4.7	2.8	4.2	5.0	4.8	5.2	3.3	3.7	5.0	5.1	5.2
120365	3.2	3.0	3.8	4.0	3.7	4.8	4.0	4.0	4.3	4.3	5.0	3.0	4.7	4.0	4.3	4.3
120366	2.3	3.5	3.8	4.8	2.3	3.5	3.2	4.3	4.5	3.7	4.3	3.3	5.3	4.2	3.8	4.0
120374	2.7	3.2	3.8	4.2	2.8	4.0	3.8	3.8	4.8	4.3	4.3	3.2	4.0	4.2	4.0	4.3
120381	2.5	3.2	3.5	4.7	2.5	4.9	5.1	4.0	4.7	4.0	3.5	3.8	4.0	4.8	3.3	3.2
<i>LSD (0.05)</i>	<i>0.3</i>	<i>0.6</i>	<i>0.6</i>	<i>0.5</i>	<i>0.7</i>	<i>0.4</i>	<i>0.7</i>	<i>0.4</i>	<i>0.1</i>	<i>0.6</i>	<i>0.8</i>	<i>0.2</i>	<i>0.4</i>	<i>0.6</i>	<i>0.7</i>	<i>0.7</i>

BD: body; BT: bitter; CL: cereal; CH: chemical; CO: color; FL: floral; FR: fruit; GR: grain; GS: grass; HN: honey; MT: malt; RO: roasted; SF: sulfur; ST: sweet; TO: toasted; TF: toffee.

Supplementary Table VII (b): Beer sensory descriptor values (Best linear unbiased predictors (BLUPs)) for 34 doubled haploid progeny of Golden Promise x Full Pint, the parents, and CDC Copeland. Grain stored for 10 months (ST-3) prior to malting and brewing. (Continued).

Genotype	BD	BT	CL	CH	CO	FL	FR	GR	GS	HN	MT	RO	SF	ST	TO	TF
120384	2.8	4.0	3.8	4.7	3.7	4.8	5.2	4.3	4.3	4.0	3.2	3.2	4.7	3.7	4.2	3.5
120510	2.3	3.5	4.8	4.3	2.8	4.0	4.9	4.0	4.8	4.0	5.0	3.0	4.2	4.5	4.8	4.7
120516	2.2	3.5	3.7	4.8	3.0	3.8	4.7	4.5	5.0	3.6	3.5	2.8	4.0	2.7	3.7	3.3
120520	2.7	2.5	4.7	4.7	1.8	5.0	5.1	4.2	4.8	4.9	5.1	3.3	4.5	4.8	5.0	5.0
120521	3.2	4.2	3.8	4.8	2.3	5.0	5.0	4.8	5.2	3.7	3.7	3.3	4.7	4.7	4.2	3.3
120529	3.2	3.0	3.5	4.6	1.7	3.8	4.9	4.2	4.7	4.3	4.3	3.2	4.2	3.3	3.8	4.0
120536	2.3	3.2	3.5	4.8	2.0	4.6	4.7	4.2	4.3	4.2	4.3	3.7	4.8	3.2	4.0	4.3
120543	3.7	3.0	3.7	4.2	2.2	3.7	4.8	4.5	5.0	4.2	3.2	3.3	4.2	3.7	4.0	3.7
120657	3.2	3.5	3.8	4.5	4.2	3.8	3.8	4.3	5.0	4.4	4.3	3.2	3.8	4.0	4.0	3.8
120661	2.7	3.5	3.8	4.8	2.5	4.9	5.0	4.5	5.3	4.0	3.7	3.2	4.3	4.9	3.8	3.7
120671	2.7	3.3	3.8	4.8	2.3	4.3	4.0	3.8	4.5	3.5	4.0	3.5	4.5	3.7	4.3	3.5
120691	2.8	2.8	3.3	4.8	3.5	4.5	3.7	3.7	4.8	4.8	5.1	2.7	5.2	5.1	5.0	5.1
120709	3.2	3.7	3.0	4.8	2.2	4.8	4.2	4.0	4.5	4.3	2.8	3.7	4.3	4.6	3.8	3.7
120715	2.8	3.2	3.3	5.0	2.0	4.3	4.1	4.0	5.2	5.0	3.7	3.3	4.2	4.2	3.8	4.2
120731	3.5	3.7	3.0	4.0	3.0	3.7	4.7	3.8	4.2	3.7	3.3	3.3	4.3	4.2	3.3	3.0
Golden Promise	3.2	3.0	3.3	4.3	2.5	4.2	5.1	4.2	4.2	3.5	3.1	3.1	4.2	3.5	3.7	3.3
Full Pint	3.9	3.2	4.7	4.5	2.8	3.0	2.7	5.0	5.0	5.0	5.4	3.8	4.3	5.2	5.1	5.1
CDC Copeland	3.0	3.3	3.2	4.8	2.0	4.0	3.7	4.2	4.3	3.8	3.3	3.5	4.7	4.2	3.3	3.2
<i>LSD (0.05)</i>	<i>0.3</i>	<i>0.6</i>	<i>0.6</i>	<i>0.5</i>	<i>0.7</i>	<i>0.4</i>	<i>0.7</i>	<i>0.4</i>	<i>0.1</i>	<i>0.6</i>	<i>0.8</i>	<i>0.2</i>	<i>0.4</i>	<i>0.6</i>	<i>0.7</i>	<i>0.7</i>

BD: body; BT: bitter; CL: cereal; CH: chemical; CO: color; FL: floral; FR: fruit; GR: grain; GS: grass; HN: honey; MT: malt; RO: roasted; SF: sulfur; ST: sweet; TO: toasted; TF: toffee.

Supplementary Table VIII: Key Terms in the ANOVA of Beer Sensory Descriptor Data across Breweries

Effect	Body	Chemical	Color	Floral	Fruit	Honey	Malt	Sweet	Toasted	Toffee
Brewery (B)	***	***	***	***	0.9	***	***	***	***	***
Panelist[Brewery] (P)	***	***	***	***	***	***	***	***	***	***
Variety (V)	*							*		*
Modification Treatment (MT)			*							
V x T	*				*					
V x B					*					
MT x B			**	*						
V x T x B	*		*							
V x P				**	*					*
T x P			*					*		**
V x T x P							**			*

Supplementary Table IX. P-values (top) and F-statistics (bottom) from Analysis of Variance of sensory data on three malting treatments (under-, well-, and over-modified) of CDC Copeland and Full Pint assessed at the Deschutes Brewery in Bend, OR USA.

Source	AS	BT	BD	CH	CL	CO	FL	FR	GR	GS	HN	MT	RO	SF	ST	TO	TF	VG
Panelist (P)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
	6.96	13.24	51.39	18.32	16.18	94.34	36.00	25.77	24.12	31.02	17.06	19.81	39.33	19.14	14.05	10.58	6.74	24.19
Variety (V)	0.61	0.66	0.00	0.89	0.92	0.05	0.29	0.14	0.27	1.00	0.00	0.67	0.35	0.42	0.48	0.37	0.04	0.01
	0.79	0.74	4.30	0.44	0.39	2.15	1.26	1.63	1.30	0.14	3.54	0.73	1.15	1.04	0.96	1.13	2.25	2.97
Treatment (T)	0.80	0.87	0.76	0.55	0.51	0.52	0.33	0.15	0.89	0.37	0.34	0.55	0.12	0.26	0.32	0.36	0.61	0.89
	0.06	0.03	0.28	0.35	0.44	0.43	1.13	2.09	0.02	0.80	0.92	0.36	2.47	1.31	0.99	0.86	0.26	0.02
V x T	0.28	0.72	0.75	0.16	0.11	0.90	0.33	0.50	0.01	0.24	0.12	0.18	0.17	0.04	0.57	0.11	0.89	0.05
	1.31	0.33	0.29	1.93	2.33	0.11	1.14	0.70	5.37	1.49	2.19	1.76	1.87	3.61	0.57	2.31	0.11	3.27
V x P	0.94	0.45	0.45	0.87	0.23	0.41	0.82	0.61	0.07	0.74	0.30	0.17	0.63	0.45	0.14	0.26	0.01	0.14
	0.49	1.03	1.03	0.60	1.31	1.06	0.66	0.86	1.73	0.74	1.20	1.44	0.85	1.02	1.50	1.26	2.43	1.52
T x P	0.65	0.39	0.82	0.89	0.80	0.66	0.39	0.22	0.03	0.28	0.41	0.66	0.70	0.05	0.75	0.93	0.26	0.13
	0.44	0.95	0.20	0.12	0.23	0.43	0.97	1.57	3.67	1.30	0.92	0.42	0.35	0.95	0.30	0.07	1.37	2.13
V x T x P	0.90	0.13	0.05	0.74	0.62	0.02	0.99	0.13	0.08	1.00	0.71	0.34	0.15	0.51	0.34	0.52	0.14	0.54
	0.56	1.53	1.85	0.74	0.86	2.16	0.34	1.54	1.71	0.21	0.77	1.15	1.49	0.96	1.15	0.96	1.50	0.93
Rep	0.32	0.09	0.02	0.55	0.69	0.33	0.82	0.81	0.36	0.37	0.50	0.14	0.01	0.02	0.32	0.50	0.61	0.02
	1.00	3.10	5.77	0.35	0.16	0.96	0.05	0.06	0.87	0.80	0.47	2.23	8.54	0.90	0.99	0.45	0.26	0.89

AS: astringent; BT: bitter; BD: body; CL: cereal; CH: chemical; CO: color; FL: floral; FR: fruit; GR: grain; GS: grass; HN: honey; MT: malt; RO: roasted; SF: sulfur; ST: sweet; TO: toasted; TF: toffee; VG: vegetable.

Supplementary Table X: P-values (top) and F-statistics (bottom) from Analysis of Variance of sensory data on three malting treatments (under-, well-, and over-modified) of CDC Copeland and Full Pint assessed at the New Glarus Brewing Co. in New Glarus, WI USA.

Source	AS	BT	BD	CH	CL	CO	FL	FR	GR	GS	HN	MT	RO	SF	ST	TO	TF	VG
Panelist (P)	0.55	0.23	0.07	.	<.001	<.001	0.57	0.05	0.01	0.01	<.001	0.03	.	0.02	0.01	<.001	.	0.07
	0.61	1.61	3.29	.	14.17	26.17	0.59	3.66	6.13	6.96	30.29	4.46	.	5.00	7.43	40.00	.	3.12
Variety (V)	0.05	0.11	0.23	.	0.55	0.24	0.33	0.07	0.00	0.68	0.12	0.62	.	0.64	0.08	0.13	.	0.03
	4.72	2.81	1.58	.	0.37	1.50	1.01	3.72	13.57	0.18	2.65	0.26	.	0.23	3.52	2.50	.	0.88
Treatment (T)	0.30	0.81	0.84	.	0.20	0.47	0.72	0.32	0.23	0.21	0.28	0.92	.	0.50	0.97	0.55	.	0.10
	1.32	0.22	0.12	.	1.78	0.79	0.34	1.22	1.62	1.74	1.40	0.09	.	0.73	0.04	0.63	.	2.74
V x T	0.30	0.61	0.60	.	0.35	0.13	0.11	0.67	0.34	0.74	0.53	0.78	.	0.32	0.64	0.55	.	0.63
	1.32	0.52	0.53	.	1.12	2.38	1.01	0.41	1.17	0.31	0.66	0.26	.	1.24	0.46	0.63	.	0.48
V x P	0.00	0.09	0.88	.	0.70	0.62	0.57	0.12	0.01	0.31	0.00	0.72	.	0.23	0.03	0.12	.	0.91
	7.97	2.91	0.13	.	0.37	0.50	0.59	2.50	6.80	1.25	11.47	0.34	.	1.63	4.68	2.50	.	0.10
T x P	0.76	0.90	0.72	.	0.37	0.04	0.79	0.78	0.32	0.62	0.17	0.70	.	0.99	0.96	0.65	.	0.60
	0.47	0.27	0.53	.	1.16	3.35	0.42	0.44	1.28	0.67	1.84	0.56	.	0.06	0.14	0.63	.	0.70
V x T x P	0.36	0.86	0.41	.	0.58	0.78	0.99	0.43	0.96	0.45	0.03	0.93	.	0.49	0.44	0.65	.	0.86
	1.18	0.32	1.05	.	0.74	0.44	0.08	1.02	0.15	0.98	3.53	0.21	.	0.89	0.99	0.63	.	0.33
Rep	0.21	0.70	0.68	.	0.18	0.43	0.74	0.64	0.57	0.05	0.30	0.26	.	0.17	0.00	<.001	.	0.17
	1.70	0.15	0.18	.	2.02	0.67	0.11	0.23	0.34	4.46	1.18	1.40	.	2.10	0.93	40.00	.	2.04

AS: astringent; BT: bitter; BD: body; CL: cereal; CH: chemical; CO: color; FL: floral; FR: fruit; GR: grain; GS: grass; HN: honey; MT: malt; RO: roasted; SF: sulfur; ST: sweet; TO: toasted; TF: toffee; VG: vegetable.

Supplementary Table XI: P-values (top) and F-statistics (bottom) from Analysis of Variance of sensory data on three malting treatments (under-, well-, and over-modified) of CDC Copeland and Full Pint assessed at the Canadian Malting Barley Technical Centre (CMBTC) in Winnipeg, MB Canada.

Source	AS	BT	BO	CH	CL	CO	FL	FR	GR	GS	HN	MT	RO	SF	ST	TO	TF	VG
Panelist (P)	<.001	<.001	<.001	0.01	<.001	<.001	<.001	<.001	<.001	<.001	0.02	<.001	<.001	<.001	<.001	<.001	<.001	<.001
	9.04	4.75	17.64	2.60	5.81	8.30	6.69	6.70	3.86	23.77	2.42	9.18	4.25	20.89	6.07	4.16	9.66	18.45
Variety (V)	0.18	0.93	0.01	0.02	0.82	<.0001	0.00	0.42	0.00	0.01	0.91	0.21	0.33	0.47	0.46	0.02	0.00	0.02
	1.77	0.08	4.95	4.28	0.20	13.72	8.21	0.88	8.01	4.58	0.09	1.60	1.13	0.77	0.78	0.99	3.09	4.49
Treatment (T)	0.00	0.15	0.02	0.11	0.64	0.01	0.36	0.51	0.02	0.11	0.73	0.02	0.20	0.68	0.18	0.18	0.59	0.13
	6.03	1.98	4.35	2.33	0.44	5.54	1.04	0.68	4.01	2.32	0.32	4.10	1.64	0.39	1.77	1.75	0.53	2.13
V x T	0.31	0.81	0.09	0.43	0.55	0.50	0.01	0.03	0.26	0.34	0.94	0.35	0.27	0.00	0.75	0.41	0.01	0.85
	1.20	0.60	1.77	1.04	0.88	0.95	2.73	2.23	1.29	1.15	0.39	1.14	1.27	3.57	0.67	1.06	2.83	0.54
V x P	0.39	0.30	0.50	0.92	0.71	0.35	0.31	0.33	0.58	0.10	0.84	0.00	0.30	0.38	0.89	0.94	0.19	0.06
	1.09	1.19	0.98	0.57	0.79	1.12	1.17	1.15	0.91	1.54	0.66	2.45	1.19	1.09	0.61	0.53	1.35	1.72
T x P	0.03	0.14	0.27	0.01	0.48	<.001	0.02	0.06	0.14	0.53	0.05	0.04	0.38	0.05	0.31	0.47	0.41	0.82
	0.87	2.26	1.23	0.92	0.51	14.48	0.90	3.56	2.27	0.39	0.83	0.85	0.79	4.20	1.03	0.54	0.70	0.05
V x T x P	0.09	0.39	0.11	0.01	0.00	0.39	0.01	0.52	0.15	0.08	0.98	0.65	0.58	<.001	0.96	0.83	0.22	0.20
	1.77	1.09	1.67	2.89	3.64	1.09	2.72	0.93	1.54	1.81	0.28	0.78	0.86	5.03	0.35	0.57	1.38	1.41
Rep	0.07	0.58	0.03	0.50	0.27	0.07	0.10	0.10	0.27	0.02	0.82	0.34	0.38	0.11	0.40	0.03	0.21	0.82
	3.51	0.31	4.68	0.47	1.25	3.42	2.88	2.72	1.22	0.90	0.05	0.93	0.79	2.69	0.72	4.85	1.58	0.05

AS: astringent; BT: bitter; BD: body; CL: cereal; CH: chemical; CO: color; FL: floral; FR: fruit; GR: grain; GS: grass; HN: honey; MT: malt; RO: roasted; SF: sulfur; ST: sweet; TO: toasted; TF: toffee; VG: vegetable.

Supplementary Table XII: Barley quality traits for CDC Copeland and Full Pint grown in 2015 at Lebanon, OR USA and used for the malting treatments at the Canadian Malting Barley Technical Centre (CMBTC) in Winnipeg, MB Canada.

Genotype	Moist. (%)	Prot. (%)	Germ. 4 mL (%)	Germ. 8 mL (%)	TKWT (g)	Sizing (%)		
						>6/64	>5/64	Thin
CDC								
Copeland	11.1	8.6	100	100	43.59	90.85	8.09	0.49
Full Pint	10.9	10.1	99.5	98.5	47	91.49	7.79	0.34
<i>Mean</i>	<i>11</i>	<i>9.35</i>	<i>99.75</i>	<i>99.25</i>	<i>45.3</i>	<i>91.17</i>	<i>7.94</i>	<i>0.42</i>

Moist = Moisture; Prot = Protein; Germ = Germination; TKWT = Thousand Kernel weight.

Supplementary Table XIII: Germination data for CDC Copeland and Full Pint across the three malting treatments (under-, well-, and over-modified) at the Canadian Malting Barley Technical Centre (CMBTC) in Winnipeg, MB Canada.

Genotype	Malting Treatment	Cast Moist. (%)	Chitting (%)	Germ-out Moist. (%)	Length (cm) of Acrospires at 96 hrs (%)				
					0-1/4	1/4-1/2	1/2-3/4	3/4-1	>1
CDC Copeland	Under-	42.1	100	38.4	0	0	55	40	0
	Well-	44.1	100	40.6	0	5	5	90	0
	Over-	45.9	100	42.7	0	0	5	75	20
	<i>Mean</i>	<i>44.0</i>	<i>100</i>	<i>40.6</i>	<i>0</i>	<i>1.7</i>	<i>21.7</i>	<i>68.3</i>	<i>6.7</i>
Full Pint	Under-	42.8	100	39	0	0	35	65	0
	Well-	44.2	100	41	0	0	10	80	10
	Over-	44.3	100	42.8	0	0	5	85	10
	<i>Mean</i>	<i>43.8</i>	<i>100</i>	<i>40.9</i>	<i>0</i>	<i>0</i>	<i>16.7</i>	<i>76.7</i>	<i>6.7</i>

Moist = Moisture; Germ = Germination.

Supplementary Table XIV (a): Correlation matrix of malting quality and beer sensory traits from Experiment I storage treatment 1 (ST-1).

	AA	BG	MC	DP	FAN	ME	KI	VC	BD	CH	CO	FL	FR	GS	HN	MT	ST	TO	TF
AA	1.00																		
BG	-0.52	1.00																	
MC	0.22	-0.24	1.00																
DP	0.63	-0.47	0.28	1.00															
FAN	0.65	-0.30	0.16	0.30	1.00														
ME	0.87	-0.53	0.16	0.44	0.63	1.00													
S/T	0.17	-0.13	-0.24	0.02	0.30	0.17	1.00												
VC	-0.18	0.61	-0.21	-0.39	-0.11	-0.07	-0.10	1.00											
BD	0.55	-0.40	0.11	0.52	0.42	0.52	0.06	-0.24	1.00										
CH	-0.11	0.04	-0.02	-0.14	-0.05	-0.15	0.20	0.14	-0.23	1.00									
CO	-0.32	0.05	-0.12	-0.03	-0.22	-0.36	0.01	-0.19	-0.10	0.01	1.00								
FL	-0.42	0.09	0.06	-0.05	-0.32	-0.37	-0.20	-0.06	-0.39	-0.04	0.36	1.00							
FR	-0.27	0.05	-0.07	-0.11	-0.19	-0.24	-0.30	0.20	-0.01	-0.06	0.00	0.40	1.00						
GS	0.36	-0.06	0.25	0.10	0.46	0.38	-0.07	-0.11	0.23	-0.35	-0.50	-0.25	0.03	1.00					
HN	0.27	-0.03	0.15	0.01	0.18	0.31	-0.21	0.07	0.03	0.28	-0.29	-0.20	-0.15	0.46	1.00				
MT	-0.14	0.07	0.13	-0.19	-0.16	-0.17	-0.10	0.14	-0.25	0.66	-0.17	-0.06	-0.49	-0.07	0.60	1.00			
ST	0.26	-0.01	0.14	-0.11	0.27	0.33	-0.23	-0.01	-0.01	-0.20	-0.29	-0.21	-0.09	0.71	0.76	0.17	1.00		
TO	0.38	-0.37	0.27	0.25	0.26	0.43	-0.12	-0.34	0.36	-0.52	-0.12	-0.25	-0.21	0.62	0.30	-0.15	0.59	1.00	
TF	0.22	-0.15	0.09	0.14	0.27	0.19	0.10	-0.30	0.53	-0.65	-0.06	-0.24	-0.26	0.43	-0.22	-0.58	0.15	0.36	1.00

AA = Alpha-amylase; BG = Beta-glucan; MC = Malt color; DP = Diastatic Power; FAN = Free amino nitrogen; ME = Malt extract; KI = Kolbach Index; VC = Viscosity; BD = Body; CH = Chemical; CO = Color; FL = Floral; FR = Fruit; GS = Grass; HN = Honey; MT = Malty; ST = Sweet; TO = Toasted; TF = Toffee. (**Bold**) significant p-value at $\alpha = 0.05$.

Supplementary Table XIV (b): Correlation matrix of malting quality and beer sensory traits from Experiment I storage treatment 2 (ST-2).

	AA	BG	MC	DP	FAN	ME	KI	VC	BD	CH	CO	FL	FR	GS	HN	MT	ST	TO	TF
AA	1.00																		
BG	-0.44	1.00																	
MC	0.26	-0.12	1.00																
DP	0.52	-0.44	0.16	1.00															
FAN	0.66	-0.32	0.34	0.25	1.00														
ME	0.74	-0.63	0.01	0.37	0.44	1.00													
S/T	0.79	-0.51	0.28	0.56	0.56	0.77	1.00												
VC	-0.06	0.62	0.03	-0.18	0.11	-0.26	-0.14	1.00											
BD	0.26	0.15	-0.15	-0.06	0.24	0.27	0.30	0.19	1.00										
CH	-0.31	0.14	0.04	0.15	-0.14	-0.41	-0.29	0.07	-0.47	1.00									
CO	-0.24	0.06	-0.28	-0.26	-0.37	-0.09	-0.13	-0.06	0.12	-0.18	1.00								
FL	-0.19	0.19	-0.30	-0.18	-0.33	-0.04	-0.07	0.02	0.24	-0.08	0.54	1.00							
FR	-0.17	0.20	-0.24	-0.05	-0.06	-0.18	-0.12	-0.10	-0.14	0.17	0.13	0.11	1.00						
GS	0.42	0.05	-0.06	0.19	0.33	0.39	0.38	0.18	0.28	-0.27	-0.39	-0.27	0.07	1.00					
HN	0.32	-0.07	-0.11	0.07	0.21	0.31	0.32	0.00	0.59	-0.56	0.11	0.18	0.03	0.47	1.00				
MT	0.09	0.14	-0.03	-0.02	0.03	-0.06	-0.08	0.08	0.25	-0.13	0.01	0.31	0.04	0.22	0.45	1.00			
ST	0.28	-0.04	0.02	0.02	0.21	0.20	0.21	0.15	0.48	-0.38	-0.07	0.06	0.01	0.52	0.78	0.52	1.00		
TO	0.22	0.06	-0.05	-0.20	0.25	0.22	0.12	0.18	0.45	-0.41	0.24	0.26	0.01	0.27	0.58	0.47	0.48	1.00	
TF	0.17	-0.04	-0.05	-0.14	0.15	0.18	0.28	0.01	0.71	-0.45	0.06	0.13	-0.12	0.33	0.53	0.24	0.54	0.35	1.00

AA = Alpha-amylase; BG = Beta-glucan; MC = Malt color; DP = Diastatic Power; FAN = Free amino nitrogen; ME = Malt extract; KI = Kolbach Index; VC = Viscosity; BD = Body; CH = Chemical; CO = Color; FL = Floral; FR = Fruit; GS = Grass; HN = Honey; MT = Malty; ST = Sweet; TO = Toasted; TF = Toffee. (**Bold**) significant p-value at $\alpha = 0.05$.

Supplementary Table XIV (c): Correlation matrix of malting quality and beer sensory traits from Experiment I storage treatment 3 (ST-3).

	AA	BG	MC	DP	FAN	ME	KI	VC	BD	CH	CO	FL	FR	GS	HN	MT	ST	TO	TF
AA	1.00																		
BG	-0.27	1.00																	
MC	0.57	-0.26	1.00																
DP	0.66	-0.24	0.37	1.00															
FAN	0.43	-0.33	0.43	0.07	1.00														
ME	0.47	-0.61	0.41	0.03	0.56	1.00													
S/T	0.76	-0.37	0.60	0.48	0.52	0.71	1.00												
VC	-0.23	0.83	-0.18	-0.25	-0.11	-0.60	-0.43	1.00											
BD	-0.03	0.33	-0.01	-0.13	-0.04	-0.02	-0.06	0.23	1.00										
CH	0.02	-0.13	-0.11	0.27	-0.16	-0.11	-0.03	-0.23	-0.16	1.00									
CO	-0.16	0.24	-0.03	0.06	-0.14	-0.33	-0.32	0.11	-0.06	0.14	1.00								
FL	0.05	0.26	0.17	0.10	-0.22	-0.34	-0.17	0.21	-0.04	0.17	0.49	1.00							
FR	0.19	0.20	0.24	0.24	0.10	0.08	0.22	-0.13	-0.18	0.15	-0.03	-0.07	1.00						
GS	0.24	-0.11	0.22	-0.05	0.20	0.17	0.33	-0.06	0.08	-0.24	-0.59	-0.22	0.12	1.00					
HN	0.17	0.17	0.25	0.03	0.16	-0.06	0.26	0.17	0.13	-0.20	-0.35	-0.04	0.28	0.68	1.00				
MT	0.22	-0.15	0.25	0.03	0.43	0.12	0.29	0.06	0.00	-0.20	-0.34	-0.11	0.41	0.59	0.67	1.00			
ST	0.24	-0.04	0.32	0.10	0.39	0.04	0.31	0.07	0.03	-0.21	-0.40	-0.15	0.29	0.75	0.90	0.83	1.00		
TO	0.18	0.11	0.29	-0.03	0.29	0.04	0.28	0.17	0.09	-0.12	-0.30	0.11	0.24	0.42	0.62	0.60	0.62	1.00	
TF	0.18	-0.03	0.15	0.02	0.23	0.17	0.26	0.08	0.09	-0.42	-0.04	-0.19	0.05	0.02	0.17	0.35	0.18	0.25	1.00

AA = Alpha-amylase; BG = Beta-glucan; MC = Malt color; DP = Diastatic Power; FAN = Free amino nitrogen; ME = Malt extract; KI = Kolbach Index; VC = Viscosity; BD = Body; CH = Chemical; CO = Color; FL = Floral; FR = Fruit; GS = Grass; HN = Honey; MT = Malty; ST = Sweet; TO = Toasted; TF = Toffee. (**Bold**) significant p-value at $\alpha = 0.05$.

Supplementary Table XV: Correlation matrix of malting quality and beer sensory traits from Experiment II, combined across malting treatments.

	AA	BG	DP	FAN	S/T	MC	ME	VC	BD	CH	CO	FL	FR	GS	HN	MT	ST	TO	TF
AA	1.00																		
BG	0.40	1.00																	
DP	0.98	0.42	1.00																
FAN	0.43	-0.58	0.39	1.00															
S/T	-0.62	-0.92	-0.68	0.37	1.00														
MC	0.01	-0.86	-0.08	0.82	0.78	1.00													
ME	-0.90	-0.64	-0.95	-0.08	0.86	0.37	1.00												
VC	0.35	0.98	0.40	-0.64	-0.94	-0.91	-0.65	1.00											
BD	-0.04	0.05	-0.01	-0.04	-0.11	-0.20	0.01	0.01	1.00										
CH	-0.81	-0.39	-0.74	-0.28	0.50	0.01	0.67	-0.27	-0.41	1.00									
CO	0.43	-0.49	0.31	0.80	0.41	0.86	-0.03	-0.57	-0.42	-0.28	1.00								
FL	0.07	0.80	0.20	-0.71	-0.81	-0.95	-0.49	0.89	0.04	0.07	-0.79	1.00							
FR	-0.20	0.67	-0.20	-0.60	-0.44	-0.74	0.01	0.62	0.35	0.01	-0.72	0.58	1.00						
GS	0.05	-0.71	0.08	0.75	0.52	0.72	0.15	-0.65	-0.47	0.35	0.61	-0.50	-0.68	1.00					
HN	0.38	0.76	0.30	-0.51	-0.62	-0.49	-0.46	0.71	-0.18	-0.47	-0.07	0.37	0.30	-0.69	1.00				
MT	0.50	-0.49	0.40	0.87	0.35	0.85	-0.12	-0.55	-0.40	-0.29	0.99	-0.74	-0.75	0.69	-0.15	1.00			
ST	0.46	0.54	0.40	-0.35	-0.50	-0.27	-0.51	0.53	-0.37	-0.42	0.16	0.24	-0.11	-0.43	0.91	0.09	1.00		
TO	0.87	0.18	0.86	0.63	-0.42	0.15	-0.71	0.10	0.33	-0.82	0.37	-0.11	-0.12	0.11	0.02	0.47	0.02	1.00	
TF	0.85	-0.08	0.83	0.76	-0.21	0.41	-0.63	-0.14	0.20	-0.76	0.59	-0.32	-0.46	0.31	-0.06	0.68	0.08	0.93	1.00

AA = Alpha-amylase; BG = Beta-glucan; MC = Malt color; DP = Diastatic Power; FAN = Free amino nitrogen; ME = Malt extract; KI = Kolbach Index; VC = Viscosity; BD = Body; CH = Chemical; CO = Color; FL = Floral; FR = Fruit; GS = Grass; HN = Honey; MT = Malty; ST = Sweet; TO = Toasted; TF = Toffee. (**Bold**) significant p-value at $\alpha = 0.05$.

Name: _____

Oregon Promise – Madras (Storage Treatments)

Date: _____

Instructions: Look at, smell and then taste each beer sample.

Sample #: _____

Evaluate each beer sample in the order provided, and indicate the magnitude of flavor difference of samples from reference beer for the following descriptors. No significant difference can be indicated with a mark in the reference box.

COLOR	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	LIGHTER				REFERENCE				DARKER
GRAINY	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
CEREAL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
MALTY	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
TOASTED	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
TOFFEE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
HONEY	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
COCOA	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
ROASTED	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
FRUIT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
FLORAL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
GRASS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
VEGETABLE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
SULFUR	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
DIACETYL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
CHEMICAL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
SWEETNESS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
BITTERNESS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
ASTRINGENT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	WEAKER				REFERENCE				STRONGER
MOUTHFEEL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	THIN				REFERENCE				FULL

Supplementary Figure 1: Compare-to-Reference sensory ballot consisting of 20 robust descriptors used for assessment of genotypes in Experiment I (Golden Promise, Full Pint, 34 doubled haploid progeny, and CDC Copeland) and Experiment II (CDC Copeland and Full Pint).