

Report of the Malting and Brewing trials with the Quality Scoop Barley Samples of 2008 Harvest

Summary

Quality scoop (QS) samples (blend of quality from all over the selection areas for 2008 harvest) of AC Metcalfe, CDC Copeland, CDC Kendall, Newdale, Legacy and Tradition barleys were provided by the CWB to CMBTC. CMBTC conducted routine barley analysis, pilot malting and brewing trials with these QS barley samples. The objective of these trials was to examine the malting and brewing performance of a composite of the newly harvested barley samples from all the selection areas of the Prairies. Additionally, the data generated would be used for developing the processing guidelines for the 2008 crop for customers of Canadian malting barley.

All six barley varieties from the 2008 harvest recorded good germination energy and exhibited no sign of significant water sensitivity. The barley samples all reported moderate protein content (11.2 – 12.9%), very good 1000 kernel weight and good plumpness, as well as a showing no staining or weathering.

For 2008 AC Metcalfe barley, the two QS barley samples both performed well in the pilot malting trials. Both produced malts with satisfactory quality as indicated by the friability, extract levels, soluble protein content, enzymes, FAN content and the malt color. **In comparison with the 2007 QS AC Metcalfe barley samples, the malts generated from 2008 QS AC Metcalfe samples showed higher extract level, higher diastatic power, lower malt color and significantly lower beta-glucan content. The overall malting performance for 2008 QS AC Metcalfe was better than the 2007 QS AC Metcalfe.**

The two 2008 CDC Copeland QS barley samples performed well in steeping and germination and produced malt with a well balanced quality profile. The produced malts exhibited very high friability and extract level, good soluble protein content, high enzymes, adequate FAN content and low malt color, as well as very low beta-glucan content. **In comparison with the 2007 QS CDC Copeland samples, the malts generated from the 2008 QS CDC Copeland barley showed higher friability, higher extract level, higher enzymes, lower malt colour and significantly lower beta-glucan content. The overall malting performance of 2008 QS CDC Copeland was better than the 2007 QS CDC Copeland.**

The two 2008 CDC Kendall QS barley samples performed well in steeping and germination. Barley sample #1 produced malt with a balanced quality profile, while sample #2 produced malt with an unbalanced quality profile due to higher beta-glucan content. **In comparison with the 2007 QS CDC Kendall, the malts produced from the 2008 QS CD Kendall showed lower friability, higher extract level, comparable soluble protein, higher FAN, higher diastatic power, slightly lower alpha-amylase and higher beta-glucan. The overall malting performance of 2008 QS CDC Kendall was comparable to the 2007 QS CDC Kendall.**

For 2008 Newdale barley, only one pilot malting trial was conducted. In the malting trial this QS Newdale barley sample performed well. It produced malt with very good quality. **Compared with 2007 QS Newdale, the produced malt showed higher friability, higher extract level, better soluble protein, higher enzymes and lower beta-glucan content. The overall malting performance of 2008 QS Newdale was better than the 2007 QS Newdale.**

For the 2008 Legacy barley, also only one pilot malting trial was conducted. In the malting trial this QS Legacy barley sample performed well at steep and germination, but produced malt with an unbalanced quality profile. **The produced malt showed good values in friability, extract level, soluble protein content and FAN level, while its beta-glucan content was higher than desired.** Since no QS sample for 2007 crop year was collected, no comparison could be made between 2008 QS and 2007 QS Legacy samples.

For the 2008 Tradition barley, also only one pilot malting trial was conducted. In the malting trial this QS Tradition barley sample performed well at steep and germination, but produced malt with an unbalanced quality profile. **The produced malt showed acceptable values for friability, extract yield, soluble protein, FAN, enzymes and malt color, but exhibited undesirably high beta-glucan content.** Since no QS sample for 2007 crop year was collected, no comparison could be made between 2008 QS and 2007 QS Tradition samples.

Under the trial malting conditions the 2008 QS barley samples produced quality malt, although the overall malting performance and resultant malt quality varied from variety to variety and from trial to trial. All the malt produced exhibited good modification with high friability, low F/C difference and lower beta-glucan content. The malt beta-glucan was undesirably high for the 2008 QS Legacy and Tradition samples (this agreed well with the Grain Research Laboratories (GRL) harvest trial results). This suggested that 2008 AC Metcalfe, CDC Copeland, CDC Kendall and Newdale barley can be malted easily, and they do not require special processing conditions. However, for malting Legacy and Tradition barley, maltsters may need to adjust processing conditions to lower malt beta-glucan content. Our previous trial results suggested that steeping the barley at lower temp (14-15 °C) and obtaining adequate steep-out moisture were the key factors

in lowering malt beta-glucan content. Germinating barley at slightly higher temperatures (16-17°C) or at low germination temp for an extended germination period could also reduce malt beta-glucan content. Increasing the green malt moisture content during germination could also be an effective method for reducing malt beta-glucan content. The caution is that increased malting loss will occur.

In the brewing trials, no major problems were encountered. There were no major differences in grist ratio after milling. Even though malt from Copeland recorded increased amounts of fine flour particles, the differences were not large enough to affect brewing performance. The malts for all five barley varieties showed conversion times shorter than in the previous two crop years and comparable to averages from the 2003 to 2005 crop years. Times for wort in lautering to clear to less than 100 FTU were very good and typically shorter than 10 minutes. Lautering times for all the samples were comparable and close to 60 minutes. Malt material yields for all of the samples were very good, ranging from 90% for Kendall to 93.4% for Copeland. Brewhouse yields for the 2008 QS samples were excellent for Copeland and Metcalfe, and very good for other three varieties.

The wort carbohydrate spectra were normal and comparable for all of the 2008 QS samples. The fermentabilities of the worts produced from the 2008 QS samples were very good and superior to the previous two crop years. As recorded in past trials Kendall worts exhibited the highest fermentabilities of the varieties. Wort and beer color were generally low for 2008 QS samples and final beer colloidal and physical stability were excellent.

1. Barley quality analysis

Nine QS samples of six barley varieties were provided to CMBTC by the CWB, which were to represent the overall quality of 2008 crop barley readily available to customers of 2008 crop Canadian malting barley. CMBTC was not involved in the collection and blending of these QS barley samples. When the barley samples arrived at CMBTC, the quality of the barley samples were examined immediately, and the test results are summarized in Table 1. Please note that except for the germination testing all the testing results reported in Table 1 were generated from a single test.

Table 1.1 Quality evaluation of the 2008 quality scoop barley samples

Variety/ Barley ID	Moisture, %	Protein, %	Germination, %		1000 Kernel wt, g	Sizing, %			RVA
			(4ml, n=2)	(8ml, n=2)		>6/64 sieve	>5/64 sieve	Throug h	
AC Metcalf	12.6	12.5	98	92	43.9	95.08	3.67	1.14	102.9
	13.5	12.0	97	96	47.0	94.28	4.05	0.91	101.1
CDC Copeland	13.3	11.2	100	91	48.7	96.99	2.32	0.66	120
	12.6	11.4	99	96	46.2	95.73	3.36	0.84	-
CDC Kendall	13.7	12.9	98	94	45.4	97.57	1.95	0.41	105.3
	13.4	12.1	99	90	47.1	97.11	2.09	0.57	-
Newdale	13.3	12.1	99	88	43.7	94.8	4.18	0.93	120.5
Legacy	12.9	11.8	99	93	40.8	95.8	3.34	0.79	161.5
Tradition	13.2	12.8	100	92	40.9	97.04	2.42	0.49	145.1

General comments on barley quality

The 2008 QS samples of AC Metcalfe, CDC Copeland, CDC Kendall, Newdale Legacy and Tradition all recorded acceptable levels of moisture content and acceptable protein content (Table 1.1). These barley samples recorded very good germination energy and exhibited no significant water sensitivity. All barley samples reported excellent thousand kernel weight and plumpness. The thousand-kernel-weights were comparable to the prairie average for the 2008 new harvest and the plumpness was higher than the prairie average. All of these barley samples showed no signs of mould infection, staining or weathering.

AC Metcalfe, CDC Copeland, CDC Kendall and Newdale barley samples had RVA values lower than 135 but higher than 100. The values were better than those recorded for the 2007 harvest and indicate better storability of 2008 crop Canadian malting barley. Still, this barley should not be stored under high humidity and high temperatures for prolonged periods of time. Legacy and Tradition barley samples had RVA values higher than 135, which suggested that Legacy and Tradition barleys were in a sound condition and were not affected by the pre-germination. These two barleys could be stored safely for an extended period.

In general, the 2008 QS barley samples showed a better overall quality with lower protein content, higher 1000 kernel weight and plumpness, better germination energy and lower water sensitivity than the 2007 QS barley samples.

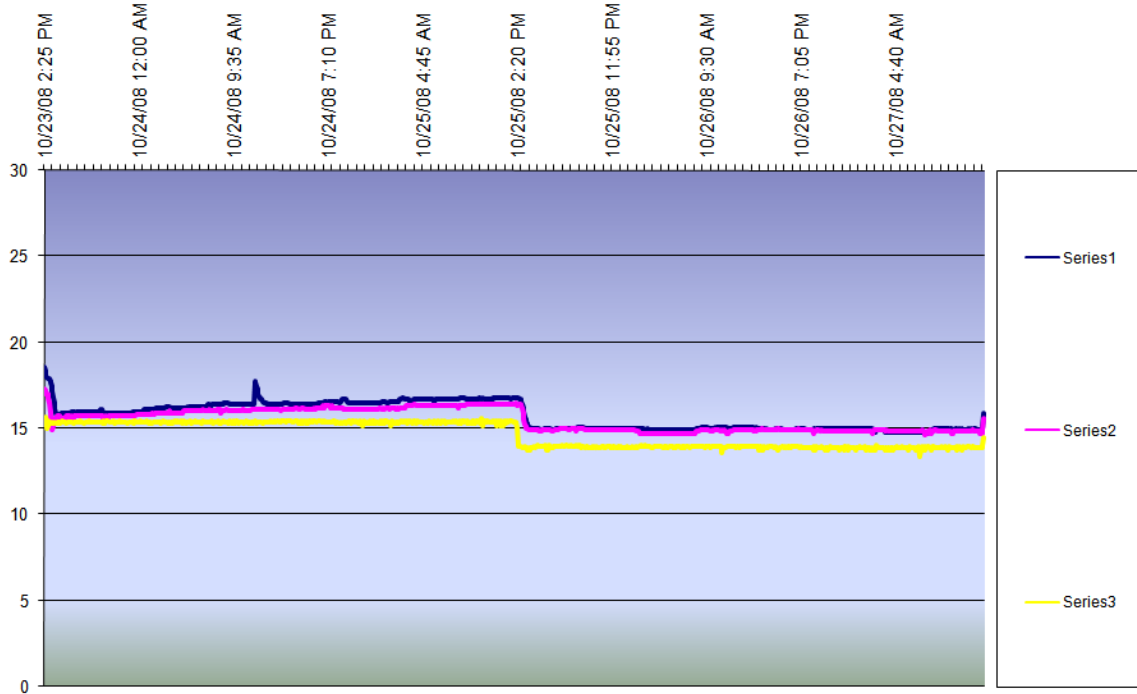
2. Pilot-malting trials

For 2008 QS AC Metcalfe, CDC Copeland and CDC Kendall barley samples two pilot malting trials were conducted for each variety and for CDC Newdale, Legacy and Tradition barley only one pilot malting trial was conducted (due to the limited quantities of those barley samples). The processing conditions used in each of the pilot malting trials are detailed in Table 2.1. Please note that kilning conditions were identical in all the malting trials, but steeping and germination conditions varied slightly from trial to trial. Two example charts showing the temperature profiles for the germination and kilning are also given below for reference.

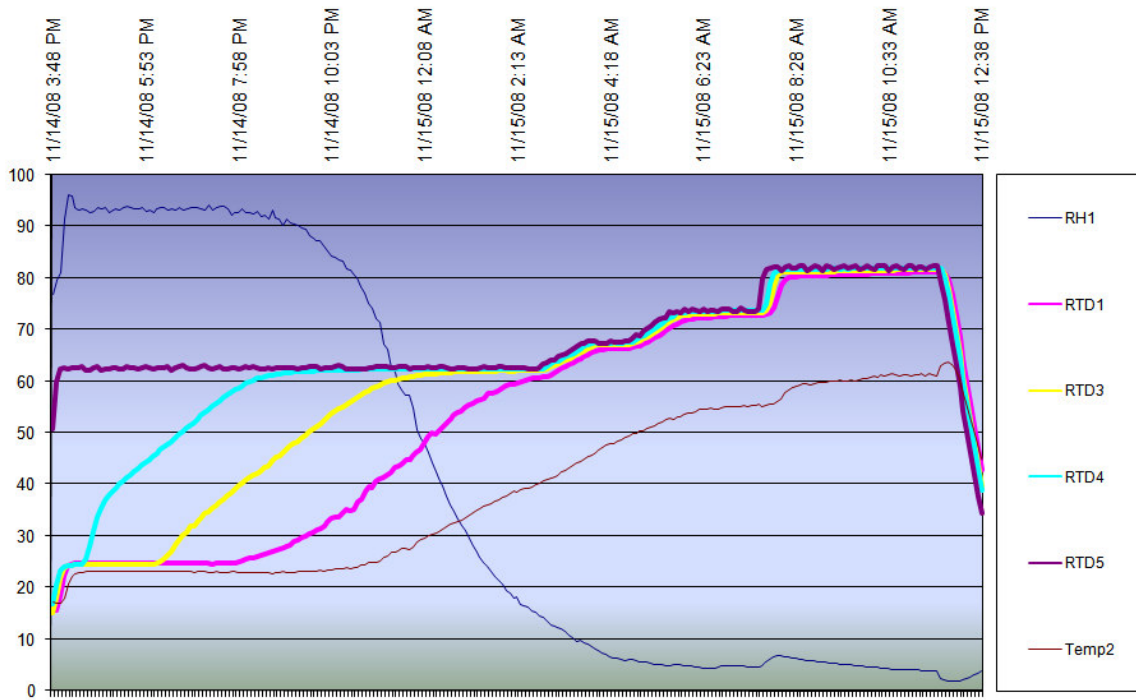
Table 2.1 Processing conditions for the pilot malting trials

# of trials	2		2		1		1	1	1
Variety	AC Metcalfe #1	AC Metcalfe #2	CDC Copeland #1	CDC Copeland #2	CDC Kendall #1	CDC Kendall #2	Newdale	Legacy	Tradition
Protein, %	12.5	12.0	11.2	11.4	12.9	12.1	12.1	11.8	12.8
Steeping Time (hrs)									
1st Wet Period	6	6	7	7	7	7	8	8	9
1st Dry Period	12	12	14	14	13	13	12	12	11
2nd Wet Period	8	8	9	9	9	9	8	7	10
2nd Dry Period	10	10	10	10	12	13	11	12	9
3rd Wet Period	7	4	4	5.3	4	5.3	6	5.5	5
Total steeping Time	43	40	44	45.3	45	47.3	45	44.5	44
Temp (°C)	15	15	15	15	15	15	15	15	16
Germination Conditions									
1st Day Temp (°C)	15	16	16	15	16	15.5	15	15	17
2nd Day Temp (°C)	15	16	16	15	16	15.5	15	15	16
3rd Day Temp (°C)	15	15	15	15	15	15	15	15	15
4th Day Temp (°C)	15	15	15	15	14	15	15	15	15
Total Germ Time (hrs)	96	96	96	96	96	96	96	96	96
Kilning Conditions									
Total Kilning Time (hrs)	21	21	21	21	21	21	21	21	21
Temp(°C) at end of Kilning	82	82	82	82	82	82	82	82	82

Germination



Kilning



3. Malting Performance

AC Metcalfe

During steep the two 2008 QS AC Metcalfe barley samples (#1 & #2) obtained satisfactory steep-out moisture and good chitting rates (Table 3.1). During germination, they showed good acrospire growth and progress of modification.

Table 3.1 2008 QS AC Metcalfe barley's steep-out moisture, chitting rate and acrospire growth

AC Metcalfe #1		Steep-out Moisture (%)			Chitting rate (%)	
		43.3			95	
Acrospire growth						
	0-1/4 (%)	1/4-1/2 (%)	1/2-3/4 (%)	3/4-1 (%)	>1 (%)	
24 hours	0	25	70	5	0	
48 hours	0	0	65	35	0	
72 hours	0	0	35	65	0	
96 hours	0	0	0	95	5	
AC Metcalfe #2		Steep-out Moisture (%)			Chitting rate (%)	
		43.9			100	
Acrospire growth						
	0-1/4 (%)	1/4-1/2 (%)	1/2-3/4 (%)	3/4-1 (%)	>1 (%)	
24 hours	0	45	55	0	0	
48 hours	0	5	70	25	0	
72 hours	0	0	40	60	0	
96 hours	0	0	0	90	10	

The malts produced from these two trials showed good extract level and soluble protein, excellent enzyme levels, good FAN levels and lower beta-glucan content, and lower malt color (Table 3.2). However, on average malt friability for these two samples was lower than for the 2007 QS barley sample, particularly for AC Metcalfe #1.

Table 3.2. Malt analysis and quality evaluation for 2008 QS AC Metcalfe barley

Parameter	2008 QS AC Metcalfe		2007 QS AC Metcalfe
	#1	#2	
Pilot-malting #	PM-08-032	PM-08-037	
Malt moisture, %	4.4	4.0	4.1
Friability, %	71.3	80.8	88.5
Fine-extract, %	79.9	80.5	79.1
Coarse-extract, %	79.4	80.3	78.8
F/C Difference, %	0.5	0.2	0.35
Soluble protein, %	5.10	5.23	5.03
Total protein, %	12.14	11.97	12.1
Kolbach Index, %	42.0	43.7	41.6
Beta-Glucan, ppm	116	86	135
Diastatic power, °L	156	151	138
α-Amylase, D.U.	58.3	61.6	60.2
Wort colour, ASBC	1.86	1.82	2.06
Wort pH	5.90	5.84	5.86
Fan, mg/L	211	228	194

Malting Summary

- **General modification:** The values for friability, F/C difference, beta-glucan content, and soluble protein content all suggested that these two AC Metcalfe barley samples produced well modified malt, although sample #1's friability value was lower than expected. This suggested the malt was under-modified and further modification was required.
- **Extract yield and enzyme levels:** In comparison with the averages of 2006 and 2007 QS samples, the malts produced from these 2008 QS samples exhibited higher extract yield. Their α -Amylase was lower and diastatic power was higher than 2007 QS sample.
- **Soluble protein, free amino nitrogen (FAN) and malt colour:** The malts produced from these two AC Metcalfe barley sample exhibited higher protein modification than that 2007 QS sample as indicated by the Kolbach Index. The malt also developed higher level of FAN than 2007 QS samples. Its malt colour was lower than 2007 QS sample.

Comments on the malting process

During the malting process, no difficulties were recorded for these two AC Metcalfe barley samples.

Please pay attention to processing conditions that influence friability

2008 AC Metcalfe can be processed under normal malting conditions used for Canadian two-row malting barley since it has lower protein content and showed no significant water sensitivity.

In steeping target steep-out moisture of 43-44% and over 85% chitting rate. The steeping cycle should consist of 2 or 3 wet periods at 15-16 °C.

In germination avoid high temperature and excessive watering to control acrospire growth and protein breakdown.

In kilning a lower curing temperature (80-82°C) should be considered to avoid excessive malt color formation.

CDC Copeland

At steep the two 2008 QS CDC Copeland barley samples (#1 & #2) obtained satisfactory steep-out moisture and excellent chitting rate (Table 3.3). During germination, they both showed normal acrospire growth and progress of modification, although CDC Copeland # 1 showed more advanced acrospire growth than CDC Copeland #2.

Table 3.3 2008 QS CDC Copeland barley's steep-out moisture, chitting rate and acrospire growth

CDC Copeland #1		Steep-out moisture (%)		Chitting rate (%)	
		44.0		100	
Acrospire growth					
	0-1/4 (%)	1/4-1/2 (%)	1/2-3/4 (%)	3/4-1 (%)	>1 (%)
24 hours	5	85	10	0	0
48 hours	0	0	75	25	0
72 hours	0	0	10	90	0
96 hours	0	0	0	75	25
CDC Copeland #2		Steep-out moisture (%)		Chitting rate (%)	
		45.3		100	
Acrospire growth					
	0-1/4 (%)	1/4-1/2 (%)	1/2-3/4 (%)	3/4-1 (%)	>1 (%)
24 hours	5	45	45	5	0
48 hours	0	0	45	55	0
72 hours	0	0	40	60	0
96 hours	0	0	5	90	5

In both malting trials, 2008 QS CDC Copeland barley produced malts with an excellent quality profile. The produced malts showed very high friability, low beta-glucan content, good soluble protein, excellent levels of enzyme and FAN, as well as good malt color (Table 3.4). Compared with the 2007 QS samples, the fine extract level and friability value for 2008 CDC Copeland was significantly higher and the beta-glucan content was significantly lower.

Table 3.4. Malt analysis and quality evaluation for 2008 QS CDC Copeland barley

Parameter	2008 QS CDC Copeland		2007 QS CDC Copeland
	#1	#2	
Pilot-malting #	PM-08-035	PM-08-040	
Malt moisture, %	3.9	4.4	3.7
Friability, %	92.0	91.2	90.3
Fine-extract, %	80.9	80.9	78.9
Coarse-extract, %	79.4	78.4	77.8
F/C Difference, %	1.5	1.5	1.2
Soluble protein, %	5.00	5.04	5.05
Total protein, %	11.0	11.5	12.2
Kolbach Index, %	45.6	43.9	41.4
Beta-Glucan, ppm	87	93	207
Viscosity, cps	1.41	1.42	1.46
Diastatic power, °L	144	133	122
α-Amylase, D.U.	62.2	50.2	47.2
Wort colour, ASBC	1.76	1.71	1.80
Wort pH	5.83	5.94	5.87
Fan, mg/L	235	229	188

Malting Summary

- **General modification:** The values for friability, F/C difference, beta-glucan content, and soluble protein all suggested that these two QS CDC Copeland barley samples produced malt with very good modification.
- **Extract yield and enzyme levels:** In comparison with the averages of 2007 QS sample, the malt produced from 2008 QS CDC Copeland samples exhibited significantly higher extract yield than last year's QS sample. Also, both α -amylase and diastatic power were higher than last year's QS sample.
- **Soluble protein, free amino nitrogen (FAN) and malt colour:** The malts produced from these 2008 QS samples exhibited slightly higher protein modification than that in 2007 QS sample as indicated by the Kolbach Index. The malts also developed higher level of FAN and slightly lower malt colour.

Comments on the malting process

During the malting process, no difficulties were recorded for these two QS CDC Copeland barley samples.

2008 CDC Copeland barley could be processed under normal Canadian two-row malting barley malting conditions since it has low protein content and showed no significant water sensitivity.

In steep target a steep-out moisture of 44-45% and over 85% chitting rate. The steeping cycle should consist of 2 or 3 wet periods at 15-16 °C.

In germination avoid high temperature and excessive watering to control acrosspire growth and protein breakdown.

In kilning the curing temperature can be higher than that used for processing AC Metcalfe and CDC Kendall (82-85 °C) since CDC Copeland has a tendency of producing lower malt colors.

CDC Kendall

At steep the two 2008 QS Kendall barley samples obtained satisfactory steep-out moisture and excellent chitting rates (Table 3.5). During germination these two samples showed good acrospire growth and progress of modification.

Table 3.5. 2008 QS CDC Kendall barley's steep-out moisture, chitting rate and acrospire growth

CDC Kendall #1		Steep-out Moisture (%)		Chitting rate (%)	
		43.9		100	
Acrospire growth					
	0-1/4 (%)	1/4-1/2 (%)	1/2-3/4 (%)	3/4-1 (%)	>1 (%)
24 hours	10	50	25	15	0
48 hours	0	15	55	30	0
72 hours	0	0	10	60	30
96 hours	0	0	0	70	30
CDC Kendall #2		Steep-out Moisture (%)		Chitting rate (%)	
		45.2		100	
Acrospire growth					
	0-1/4 (%)	1/4-1/2 (%)	1/2-3/4 (%)	3/4-1 (%)	>1 (%)
24 hours	10	70	20	0	0
48 hours	0	5	65	30	0
72 hours	0	0	30	55	15
96 hours	0	0	0	80	20

Under the trial malting conditions, CDC Kendall #1 produced malt with a well balanced quality profile, and the malt recorded high friability, low F/C difference and very low beta-glucan content. CDC Kendall sample #2 produced malt with an unbalanced quality profile, and the malt had high friability and a low F/C difference, acceptable soluble protein and FAN, but the beta-glucan content was undesirably high. In comparison with the 2007 QS CDC Kendall, 2008 CDC QS Kendall barley showed more advanced acrospire growth, lower friability; higher extract level and comparable soluble protein, higher enzymes (DP) and significantly higher beta-glucan content.

Table 3.6. Malt analysis and quality evaluation for 2008 QS CDC Kendall barley

Parameter	2008 QS CDC Kendall		2007 QS CDC Kendall
	#1	#2	
Pilot-malting #	PM-08-34	PM-08-39	
Malt moisture, %	4.1	5.0	3.9
Friability, %	89.2	84.6	94.2
Fine-extract, %	80.3	80.7	79.4
Coarse-extract, %	79.1	79.5	78.8
F/C Difference, %	1.2	1.2	0.6
Soluble protein, %	5.51	5.05	5.25
Total protein, %	12.6	11.7	12.4
Kolbach Index, %	43.9	43.3	42.5
Beta-Glucan, ppm	88	185	119
Viscosity, cps	1.40	1.45	1.43
Diastatic power, °L	195	129	160
α-Amylase, D.U.	59.3	54.8	62.4
Wort colour, ASBC	1.94	1.87	1.94
Wort pH	6.04	5.82	5.91
Fan, mg/L	237	232	188

Malting Summary

- **General modification:** For CDC Kendall barley sample #1 the values for friability, F/C difference, beta-glucan content, and soluble protein content all suggested that this 2008 QS barley sample produced malt with good modification; while for sample #2 its beta-glucan content suggested that the malt was under-modified, although the values for friability, F/C difference, and soluble protein content were acceptable.
- **Extract yield and enzyme levels:** In comparison with 2007 QS CDC Kendall, the malts produced from these two 2008 QS samples exhibited significant higher extract yield, while their α -amylase level was slightly lower and diastatic power was comparable to the 2007 QS CDC Kendall.
- **Soluble protein, free amino nitrogen (FAN) and malt colour:** The malts produced from these two 2008 QS barley samples exhibited protein modification comparable to 2007 QS barley as indicated by the Kolbach Index. The malts also developed higher levels of FAN and comparable malt color.

Comments on the malting process

During the malting process, no difficulties were recorded for these two CDC Kendall samples

Please pay attention to processing conditions that influence beta-glucan content as there is a tendency to higher malt beta-glucan levels

2008 CDC Kendall can be processed under normal malting conditions used for Canadian two-row malting barley since it has lower protein content and showed no significant water sensitivity.

In steep target a steep-out moisture of 44-45% and over 85% chitting rate. The steeping cycle should consist of 2 or 3 wet periods at 15-16 °C.

In germination avoid high temperature and excessive watering to control acrospire growth and protein breakdown.

In kilning the curing temperature could be set to that similar to used for processing AC Metcalfe (80-82 °C) since CDC Kendall has a tendency of producing high malt colour.

Newdale

At steep the 2008 QS Newdale barley obtained satisfactory steep-out moisture content (lower than expected) and a good chitting rate (Table 3.7). During germination, it showed good acrospire growth and good progress of modification.

Table 3.7 2008 QS Newdale barley's steep-out moisture, chitting rate and acrospire growth

Newdale	Steep-out Moisture (%)		Chitting rate (%)		
	41.8		95		
Acrospire growth					
	0-1/4 (%)	1/4-1/2 (%)	1/2-3/4 (%)	3/4-1 (%)	>1 (%)
24 hours	0	35	65	0	0
48 hours	0	10	25	65	0
72 hours	0	0	50	50	0
96 hours	0	0	25	55	20

The 2008 QS Newdale barley sample produced malt with a balanced quality profile. The malt produced exhibited high friability, low F/C difference, low beta-glucan, good soluble protein and adequate FAN, as well as an acceptable level of enzymes and lower malt color (Table 3.8). Compared with the 2007 QS Newdale, the malt produced from 2008 QS Newdale exhibited better overall quality with higher friability, higher extract level, higher enzymes and lower beta-glucan content.

Table 3.8. Malt analysis and quality evaluation for 2008 QS Newdale barley

Parameter	2008 QS Newdale	2007 QS Newdale
Pilot-malting #	PM-08-041	
Malt moisture, %	4.3	4.6
Friability, %	91.1	88.6
Fine-extract, %	79.6	78.2
Coarse-extract, %	79.1	78.0
F/C Difference, %	0.5	0.2
Soluble protein, %	4.75	4.91
Total protein, %	12.18	13.2
Kolbach Index, %	38.9	37.3
Beta-Glucan, ppm	79	155
Viscosity, cps	1.39	1.43
Diastatic power, °L	141	132
α -Amylase, D.U.	64.0	54.2
Wort colour, ASBC	1.87	1.79
Wort pH	5.85	5.78
Fan, mg/L	189	179

Malting Summary

- **General modification:** The values for friability, F/C difference, beta-Glucan content, and soluble protein content all suggest that the 2008 QS Newdale barley sample produced malt with good modification.
- **Extract yield and enzyme levels:** In comparison with the averages of 2007 QS Newdale sample, the malt produced from this QS sample exhibited significantly high extract yield. Its α -Amylase and diastatic power were both higher than the 2007 QS barley sample.
- **Soluble protein, free amino nitrogen (FAN) and malt colour:** The malt produced from the Newdale barley sample exhibited higher protein modification than that in 2007 crop years as indicated by the Kolbach Index. The malt also developed higher levels of FAN than both the 2007 crop. Its malt colour was slightly higher than the 2007 crops.

Comments on the malting process

During the malting process, no difficulties were recorded for the Newdale QS barley samples.

2008 Newdale barley can be processed under normal Canadian two-row malting conditions since it exhibits moderate protein content and showed only minor water sensitivity.

In steep target a steep-out moisture of 44-45% and over 85% chitting rate. The steeping cycle should consist of 2 or 3 wet periods at 15-16 °C. Please pay attention to the water uptake since in this trial Newdale showed a water uptake rate lower than expected.

In germination avoid high temperature and excessive watering to control acrospire growth and protein breakdown.

In kilning the curing temperature could be set to that used for processing CDC Copeland (82-85 °C) since in the malting trials high malt color formation was not recorded.

Legacy

At steep this 2008 QS Legacy barley obtained good steep-out moisture and a good chitting rate (Table 3.9). During germination, it showed good acrospire growth and good progress of modification.

Table 3.9 2008 QS Legacy barley's steep-out moisture, chitting rate and acrospire growth

Legacy	Steep-out Moisture (%)		Chitting rate (%)		
	43.4		95		
Acrospire growth					
	0-1/4 (%)	1/4-1/2 (%)	1/2-3/4 (%)	3/4-1 (%)	>1 (%)
24 hours	50	25	25	0	0
48 hours	0	40	50	10	0
72 hours	0	10	30	60	0
96 hours	0	0	0	90	10

Under the trial conditions, this 2008 QS Legacy barley produced malt with an unbalanced quality profile. The malt produced exhibited acceptable values for friability, extract yield, soluble protein, FAN, enzymes and malt color, but exhibited undesirably high beta-glucan content (Table 3.10). This suggested the malt was under-modified and needed further modification to lower the beta-glucan content. The trial results agreed well with GRL's harvest malting trials for 2008 crop. In GRL's micro-malting trials, Legacy malt also showed undesirably high malt beta-glucan content. Malts produced at CMBTC with 2006 Legacy barley showed a quality profile comparable to 2008 QS Legacy barley, the malts also showed undesirably high beta-glucan content. This indicates that Legacy barley tends to develop higher beta-glucan content than two-row barleys. Since this was the first time for the CWB to include Legacy barley in the quality scoop trials, no comparison could be made between 2008 QS Legacy and 2007 QS Legacy. However, compared with the trial results of a 2006 Legacy, the 2008 Legacy malt showed better values in extract yield, FAN and enzymes but lower friability and similar beta-glucan content.

Table 3.10 Malt analysis and quality evaluation for 2008 QS Legacy barley

Parameter	2008 QS Legacy	2006 crop Legacy
Pilot-malting #	PM-08-036	Mean
Malt moisture, %	4.4	3.9
Friability, %	83.9	89.8
Fine-extract, %	78.9	78.5
Coarse-extract, %	78.2	78.0
F/C Difference, %	0.7	0.5
Soluble protein, %	5.37	4.78
Total protein, %	11.52	10.4
Kolbach Index, %	46.6	46.3
Beta-Glucan, ppm	278	279
Viscosity, cps	1.45	1.53
Diastatic power, °L	178	129
α-Amylase, D.U.	53.8	40.4
Wort colour, ASBC	2.09	2.36
Wort pH	5.80	5.88
Fan, mg/L	250	200

Malting Summary

- **General modification:** The values for friability, F/C difference, and soluble protein content all suggested that this 2008 QS Legacy barley sample produced malt with good modification, while its beta-glucan content indicated that this malt was under-modified.
- **Extract yield and enzyme levels:** the malt produced from this QS Legacy barley sample exhibited good extract yield and good enzymes.
- **Soluble protein, free amino nitrogen (FAN) and malt colour:** The malt produced from this QS Legacy barley exhibited good protein modification as indicated by the Kolbach Index. The malt also developed good FAN and good malt color.

Comments on the malting process

During the malting process, no difficulties were recorded for this QS Legacy barley sample.

2008 Legacy barley can be processed with under normal Canadian six-row malting conditions since it has moderate protein content and showed very low water sensitivity.

In steep target a steep-out moisture of 44-45% and over 85% chitting rate. The steeping cycle should consist of 2 or 3 wet periods at 15-16 °C.

In germination avoid high temperature and excessive watering to control acrospire growth and protein breakdown.

In kilning the curing temperature could be set to that similar to used for processing AC Metcalfe and CDC Kendall (80-82°C) to avoid high color formation.

Pay attention to processing condition that affect beta-glucan content. Steeping the barley at a lower temperature (14-15 °C) and obtaining adequate steep-out moisture were key factors in lowering malt beta-glucan content. Germinating barley at slightly higher temperatures (16-17°C) or at low germination temp for an extended period could also lower malt beta-glucan content. Increasing the green malt moisture content during germination could also be an effective method for reducing malt beta-glucan content

Tradition

At steep the 2008 QS Tradition barley obtained satisfactory steep-out moisture content (but lower than expected) and a good chitting rate (Table 3.11). During germination, it showed good acrospire growth and good progress of modification.

Table 3.11 2008 QS Tradition barley's steep-out moisture, chitting rate and acrospires growth

Tradition	Steep-out Moisture (%)	42.9	Chitting rate (%)	95	
Acrospire growth					
	0-1/4 (%)	1/4-1/2 (%)	1/2-3/4 (%)	3/4-1 (%)	>1 (%)
24 hours	50	50	0	0	0
48 hours	5	55	40	0	0
72 hours	0	0	75	25	0
96 hours	0	5	30	50	15

Under the trial conditions, this 2008 QS Tradition barley produced malt with an unbalanced quality profile. The produced malt exhibited acceptable values for friability, extract yield, soluble protein, FAN, enzymes and malt color, but exhibited undesirably high beta-glucan content (Table 3.12). This suggested the malt was under-modified and needed further modification to lower the beta-glucan content. The trial results agreed well with GRL's harvest malting trials for 2008 crop. In GRL's micro-malting trials, Tradition malt also showed undesirably high malt beta-glucan content (358 ppm on average). Since this was the first time for the CWB to include Tradition barley in the quality scoop trials, no comparison could be made between 2008 QS and 2007 QS Tradition barley. However, compared with the trial results of a 2007 Tradition, the 2008 Tradition malt showed better values in extract yield, soluble protein, FAN and enzymes but lower friability and significantly higher beta-glucan.

This indicates that the malting condition used in this trial needs to be further tuned to lower malt beta-glucan content.

Table 3.12 Malt analysis and quality evaluation for 2008 QS Tradition barley

Parameter	2008 QS Tradition	2007 crop Tradition
Pilot-malting #	PM-08-045	One trial
Malt moisture, %	4.2	3.9
Friability, %	77.6	89.6
Fine-extract, %	79.2	78.2
Coarse-extract, %	78.0	77.7
F/C Difference, %	1.2	0.5
Soluble protein, %	5.20	4.43
Total protein, %	12.0	11.57
Kolbach Index, %	42.6	38.3
Beta-Glucan, ppm	466	143
Viscosity, cps	1.64	1.49
Diastatic power, °L	194	175
α-Amylase, D.U.	42.6	35.9
Wort colour, ASBC	1.93	1.61
Wort pH	5.98	5.88
Fan, mg/L	213	164

Malting Summary

- **General modification:** The values for F/C difference and soluble protein content all suggested that this 2008 QS Tradition barley sample produced malt with good modification, while its friability and beta-glucan content indicated that this malt was under-modified.
- **Extract yield and enzyme levels:** the malt produced from this QS Tradition barley sample exhibited good extract yield and very good enzymes.
- **Soluble protein, free amino nitrogen (FAN) and malt colour:** The malt produced from this QS Tradition barley exhibited good protein modification as indicated by the Kolbach Index. The malt also developed good FAN content and good malt color.

Comments on the malting process

During the malting process, no difficulties were recorded for this QS Tradition barley sample.

2008 Tradition barley can be processed with the normal Canadian six-row malting conditions since it had moderate protein content and showed very low water sensitivity.

In steep target steep-out moisture of 44-45% and over 85% chitting rate. The steeping cycle should consist of 2 or 3 wet periods at 15-16 °C.

In germination avoid high temperature and excessive watering to control acrospires growth and protein breakdown, but maintaining adequate green malt moisture during germination.

In kilning the curing temperature could be set to that similar to used for processing AC Metcalfe and CDC Kendall (80-82°C) to avoid high color formation.

Pay attention to processing condition that affect beta-glucan content. Steeping the barley at a lower temperature (15-16 °C) and obtaining adequate steep-out moisture were key factors in lowering malt beta-glucan content. Germinating barley at slightly higher temperatures (16-17°C) or at low germination temp for an extended period could also lower malt beta-glucan content. Increasing the green malt moisture content during germination could also be an effective method for reducing malt beta-glucan content

In conclusion, under the trial malting conditions all the barley samples exhibited good water uptake and good chitting rate at steep, and showed good growth during germination. The malts produced all showed satisfactory values in friability, extract level, soluble protein, enzymes, FAN and color; while beta-glucan content was generally lower in all but Legacy and Tradition. Their malts showed undesirably high beta-glucan content, which agreed with GRL's malting results (generated from the 2008 harvest Legacy and Tradition barley samples). Legacy and Tradition barleys may need some special attentions in process to lower beta-glucan content. Compared with the 2007 QS barley, all 2008 QS barley showed better overall malting performance and produced malts with comparable or better quality.

4. Pilot-brewing Trials

Malts produced from the malting trials were pilot brewed in CMBTCs 300L Pilot Brewery. Malts from the two 2008 QS Metcalfe and two 2008 QS Copeland trials were brewed separately. Consequently, the brewing results for these two varieties are presented as the averages of the two brewing trials. The Kendall malt used for brewing was from the 1st Kendall trial and the Legacy and Newdale malts were from single malting trials. There was no brewing done with Tradition because of insufficient quantities of the final malt. The following is the mashing and fermentation conditions for the brewing trials with the 2008 QS sample malts:

Mash Tun

- 100% malt brew – 33 to 41 kg of malt and 150L of water added to mash tun
- Mash in at 48°C, hold for 30 min
- Raise to 65°C, hold for 30 min
- Raise to 76°C
- Pump over to Lauter Tun

Lauter Tun

- Rest for 5 minutes, vorlauf for 10 minutes
- Rakes at 20 cm above bottom, on slow for entire lautering
- 25L underlet
- 125L sparge water at 75°C

Brew Kettle

- First hop (Nugget) boiled for 90 min – 37g
- Second hop (Mt. Hood) boiled for 5 min – 75g

Fermentation, aging, filtering and bottling conditions for the brewing trials

- Cooled to 13.5°C, pitched with lager yeast at 1.25 million cells per mL
- Fermented for 7 days, cooled to 1.5°C and then transferred to storage
- Stored at -0.5 °C for 10 days
- Filtered through a 1 µm pad filter system, carbonated to 2.5 volumes CO₂
- Stored 2 days at -2°C, and packaged
- Pasteurized to 15 PU

The brewing results are given in Tables 4, 5, 6, 7, 8, 9, 10, and 11.

Table 4. Malt grist composition (%) for the brewing trials

Sieve	Metcalfe*	Copeland*	Kendall	Newdale	Legacy
#10	3.47	3.23	3.41	4.77	5.66
#14	9.28	8.19	9.79	10.02	10.38
#20	28.39	33.48	28.9	26.9	27
#30	18.35	13.37	17.61	17.41	17.4
#60	20.83	16.89	19.2	20.19	19.39
#100	13.87	8.52	16.27	13.63	10.08
On pan	5.76	16.32	4.79	7.03	10.06

*Averages of 2 brewing trials

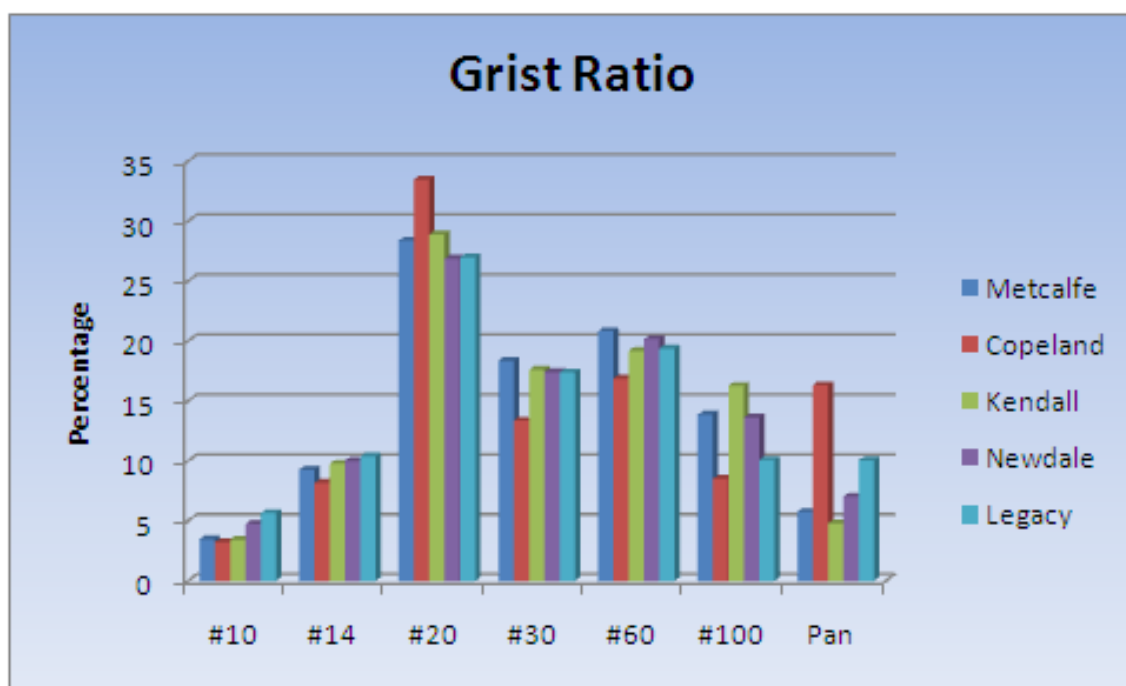


Figure 1: Malt Grist Ratios for the 2008 samples

There were no problems recorded for milling the 2008 quality scoop derived malt, although some variations in malt grist compositions among the barley varieties were observed (Table 4, Figure 1). Milled malt from Copeland recorded increased amounts of fine flour particles; however, the differences were not large enough to affect brewing performance.

Table 5. Brewhouse observations for the brewing trials for 2008.

Parameter	Metcalfe*	Copeland*	Kendall	Newdale	Legacy
Conversion time (min.)	10.5	11	7	10	12
Time to clear (min.)	6.5	7.5	6	11	7
Lautering time (min.)	62	61.5	60	59	61
Malt Material Yield (%)	91.8	93.4	90.0	90.2	91.9
Wort pH	5.16	5.15	5.18	5.15	5.25
Wort Colour (SRM)	3.48	2.79	3.53	3.23	3.57

*Averages of 2 brewing trials

In the brewhouse, the malts for the five barley varieties showed different conversion times, and their conversion times were typically shorter than in the previous two crop years and comparable to averages from 2003 to 2005 crop years (Table 6). Among the tested malts, 2008 QS Kendall showed the shortest conversion time and was significantly shorter than both 2006 QS and 2007 QS. The other four varieties were comparable with conversion times ranging from 10 minutes for Newdale to 12 minutes for Legacy. Time for worts to clear to less than 100 FTU was very good and typically shorter than 10 minutes, except for Newdale. Lautering times for all the samples were comparable and close to 60 minutes. Malt Material Yields for all the samples were very good, ranging from 90% for Kendall to 93.4% for Copeland. Wort colour was the lowest for the Copeland sample. The pH values were typical for of the trial wort samples.

Table 6. Conversion times for 100% malt brews with 2008 crop, versus 2006 and 2007 quality scoop and averages for 2003 to 2005.

	QS 2008	QS 2007	QS 2006	2005	2004	2003
AC Metcalfe	10.5	25	16	8	11	12
CDC Copeland	11	18	16	9	13	15
CDC Kendall	7	19	15	6	8	9
Newdale	10	12*	-	-	-	-
Legacy	12	-	15	-	15	-

*Thinner mash

When Lautering times from the 2008 QS were compared to 2007 QS and 2006 QS and other previous years averages all of the 2008 QS samples were slightly slower or comparable to previous years (Table 7).

Table 7. Lautering times for 100% malt brews with 2008 crop, versus 2006 and 2007 quality scoop and averages for 2003 to 2005.

	QS 2008	QS 2007	QS 2006	2005	2004	2003
AC Metcalfe	62	54	57	57	61	71
CDC Copeland	61.5	57	62	57	60	64
CDC Kendall	60	55	54	56	64	70
Newdale	59	55	-	-	-	-
Legacy	61	-	55	-	58	-

Brewhouse yields for the 2008 QS samples were excellent for Copeland and Metcalfe, and very good for the other three varieties. All the samples showed some improvement or were comparable to previous years (table 8).

Table 8. Brewhouse yields for 2008 crop, versus 2006 and 2007 quality scoop and averages for 2003 to 2005.

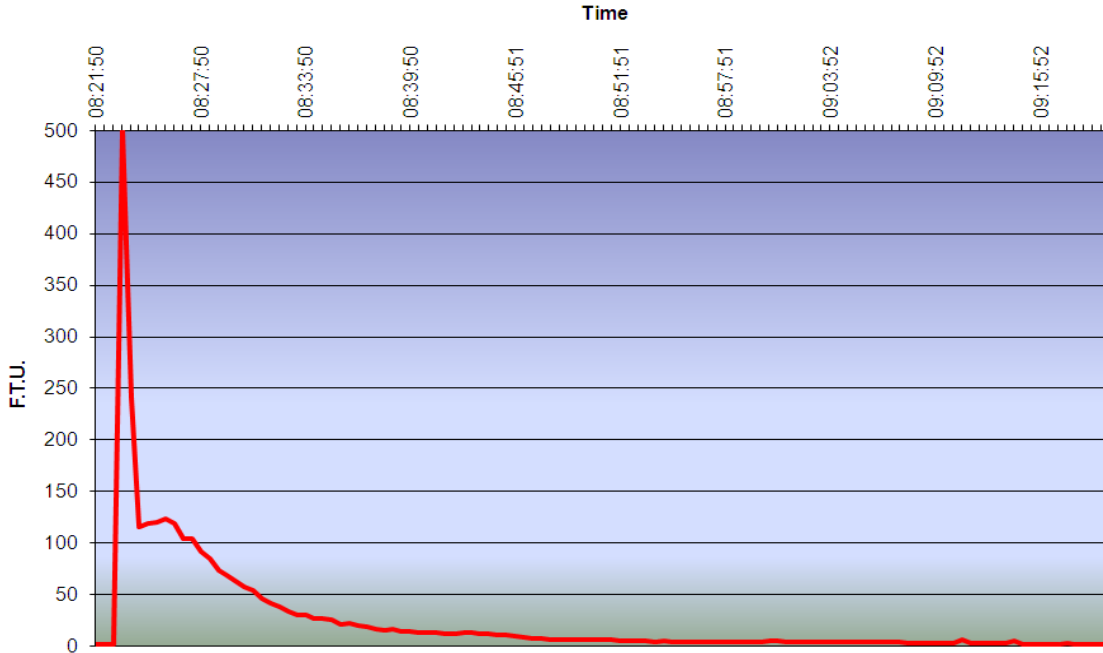
	Quality Scoop 2008	Quality Scoop 2007	Quality Scoop 2006	2005	2004	2003
AC Metcalfe	73.3	74.1	73.3	72.4	71.1	71.4
CDC Copeland	74.2	72.2	72.5	72.4	71.1	71.4
CDC Kendall	71.2	72.6	71.3	71.2	70.6	71
Newdale	71.3	70.9	-	-	-	-
Legacy	71.5	-	72.7	-	70.9	-

Normal sugar spectra were exhibited for all 2008 QS samples (Table 9). The wort carbohydrate spectrum was comparable for all 2008 QS samples wort samples. Newdale recorded slightly higher levels for all the sugars because of the thicker mash, but the ratios were similar to the other varieties.

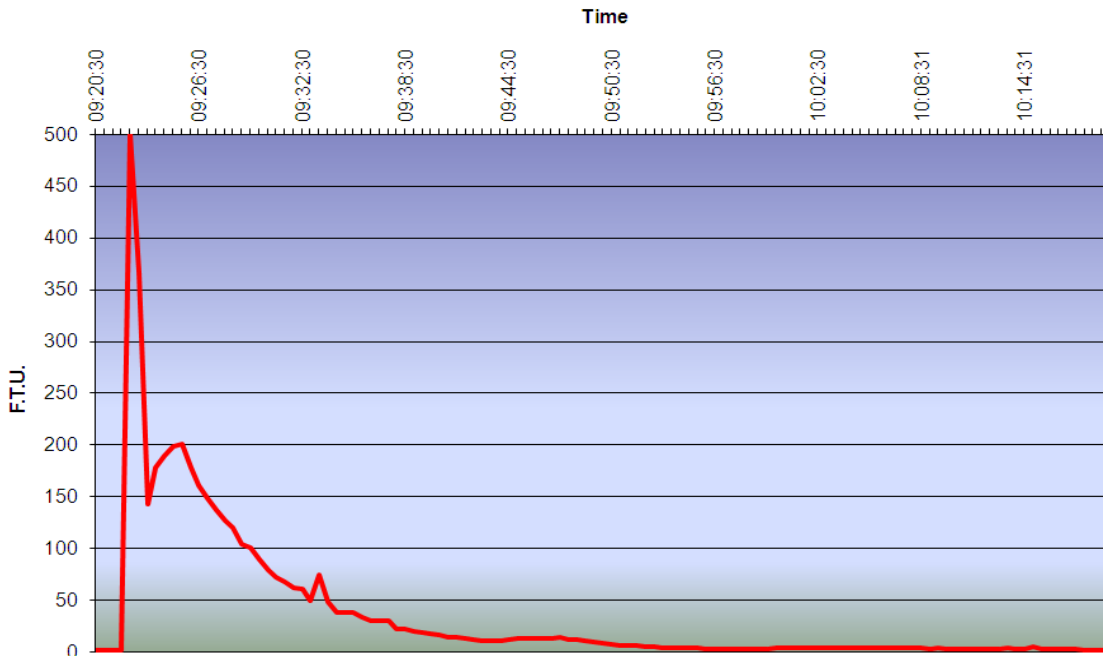
Table 9. Wort sugar concentration for the brewing trials (mg/L)

Carbohydrate	Metcalfe	Copeland	Kendall	Newdale	Legacy
Maltotetrose	2.66	1.94	2.47	2.92	2.76
Maltotriose	12.93	11.85	13.18	13.78	12.64
Maltose	52.54	51.22	52.78	52.01	50.27
Glucose	12.47	11.51	12.03	12.93	11.21
Fructose	3.62	3.15	3.65	3.46	3.36

Metcalfe Runoff Lautertun Turbidity

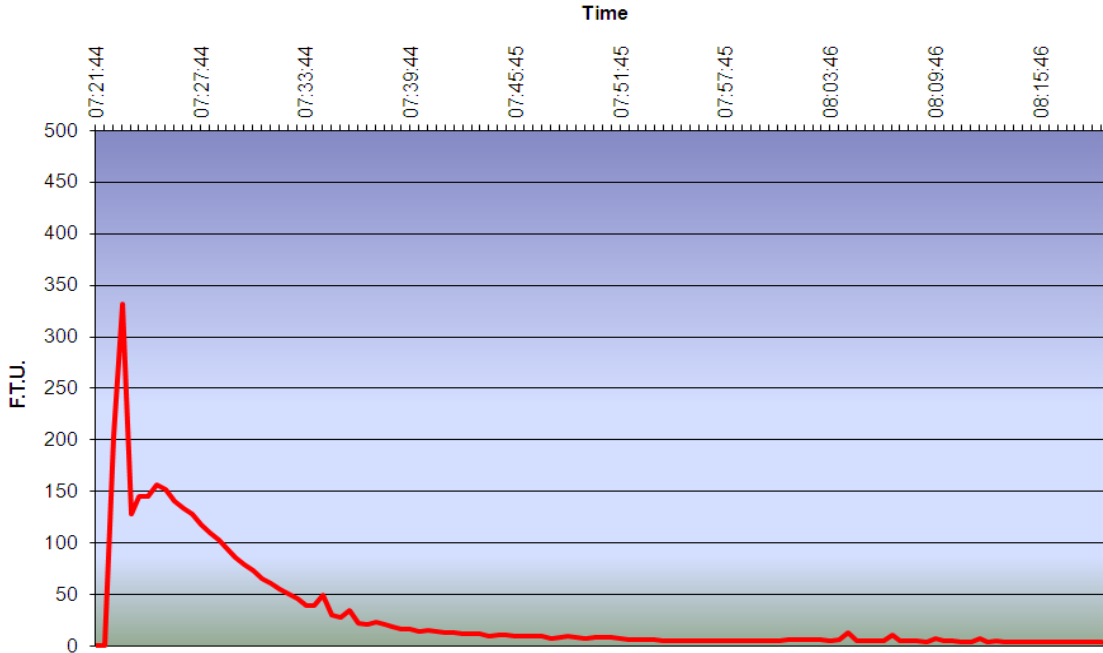


Copeland Runoff Lautertun Turbidity

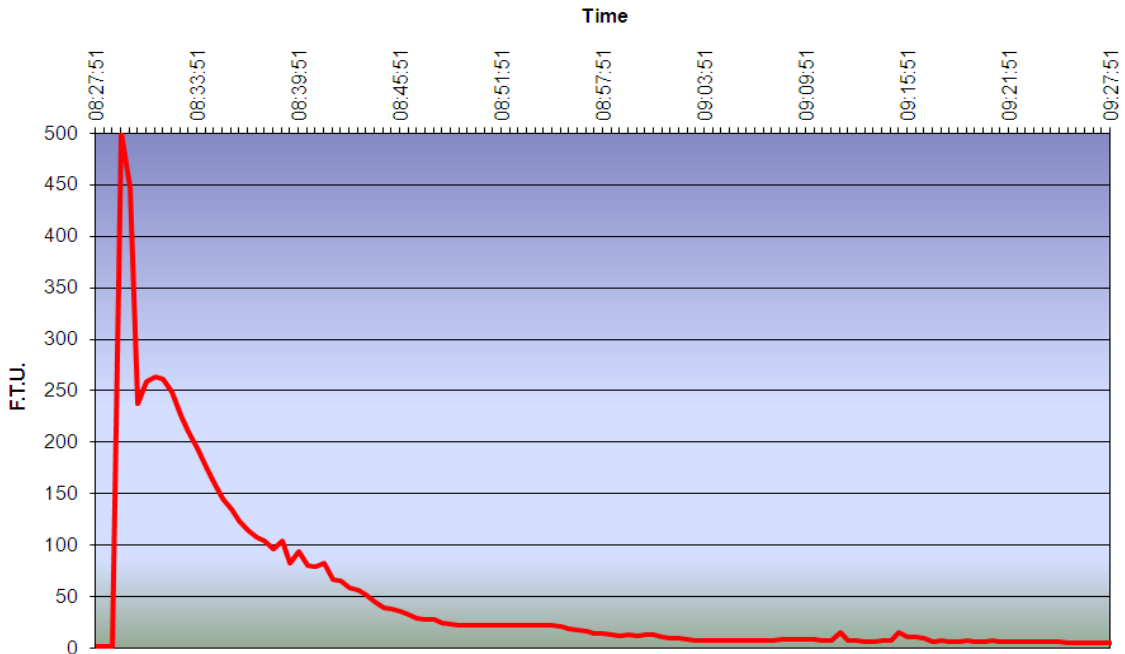


Figures 2 and 3: Runoff turbidity profile for the 2008 test malts.

Kendall Runoff Lautertun Turbidity



Newdale Runoff Lautertun Turbidity



Figures 4 and 5: Runoff turbidity profile for the 2008 test malts.

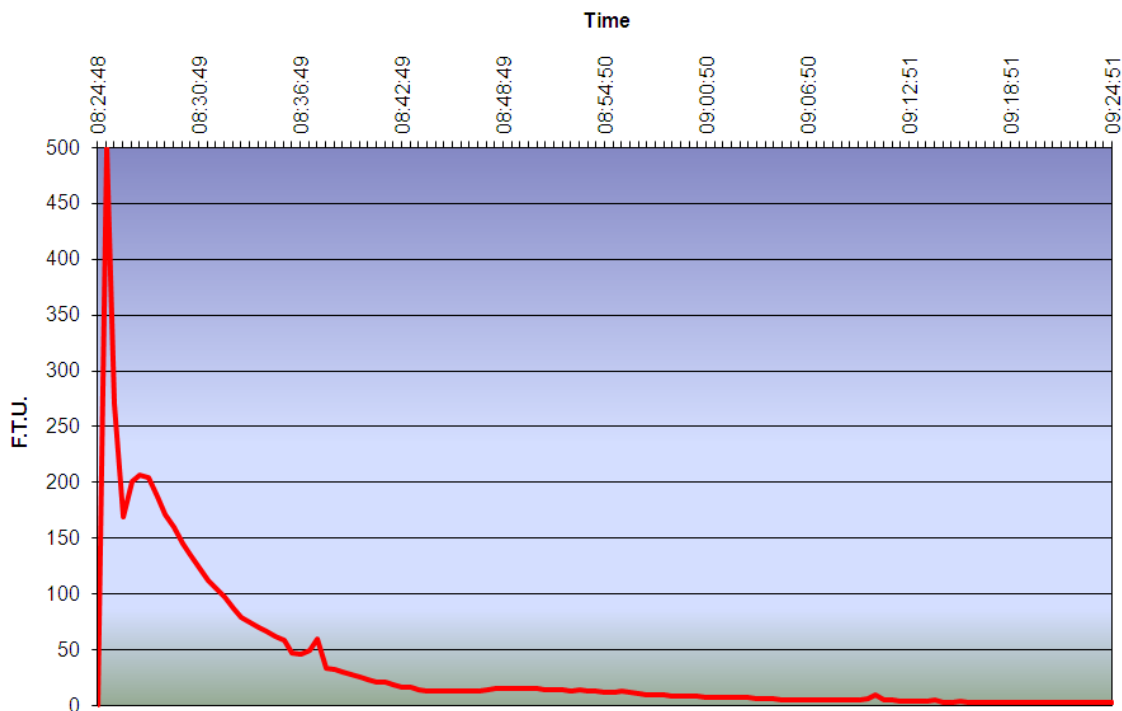
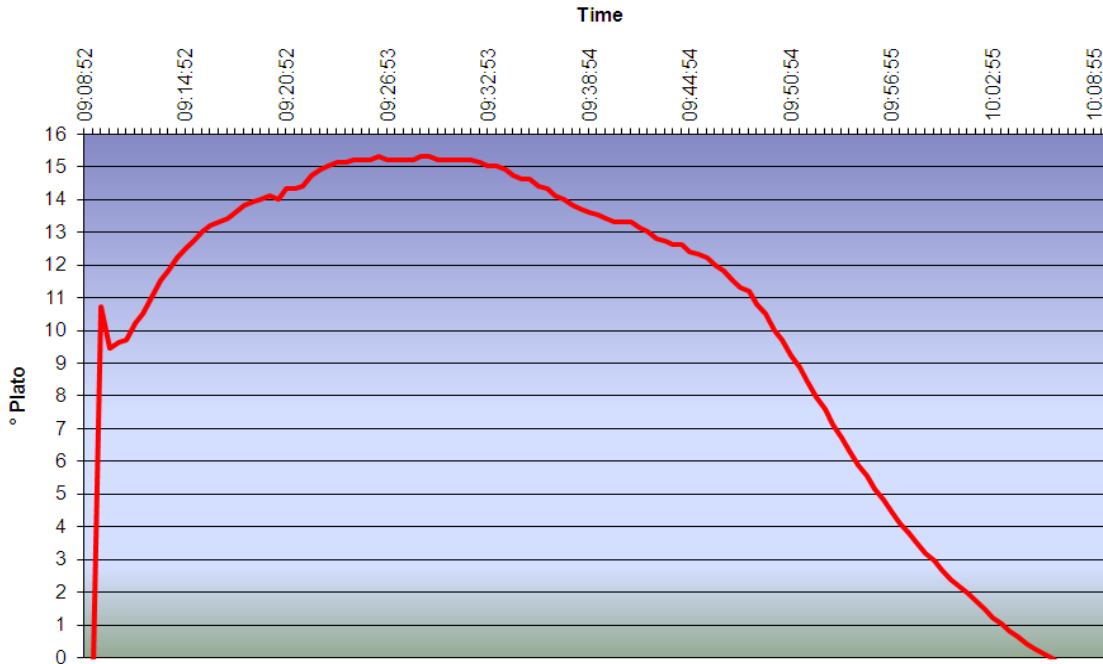
Legacy Runoff Lautertun Turbidity


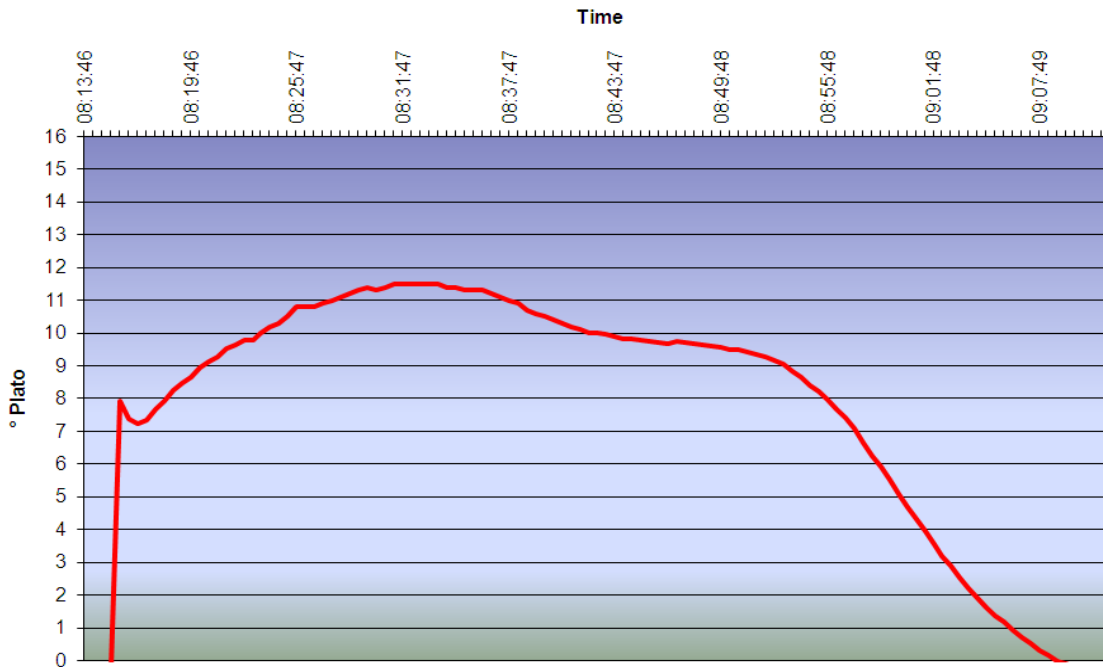
Figure 6: Runoff turbidity profile for the 2008 test malt.

Runoff turbidities for the test malts were within the normal range for the 2008 QS produced malts (Figures 2 – 6). Clarity below 100 FTU was obtained in a normal time ranging from 6 minutes for Kendall to 11 minutes for Newdale. Wort clarity curve recorded for all test varieties was normal, with Kendall showing the lowest initial turbidity.

Metcalfe Runoff Lautertun Specific Gravity

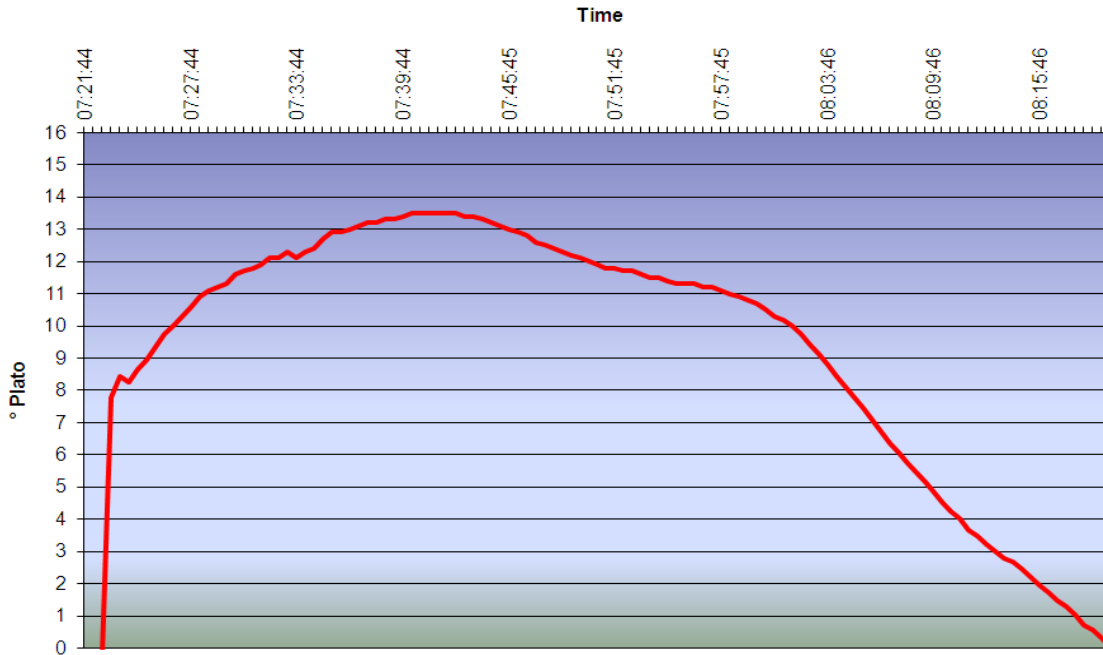


Copeland Runoff Lautertun Specific Gravity

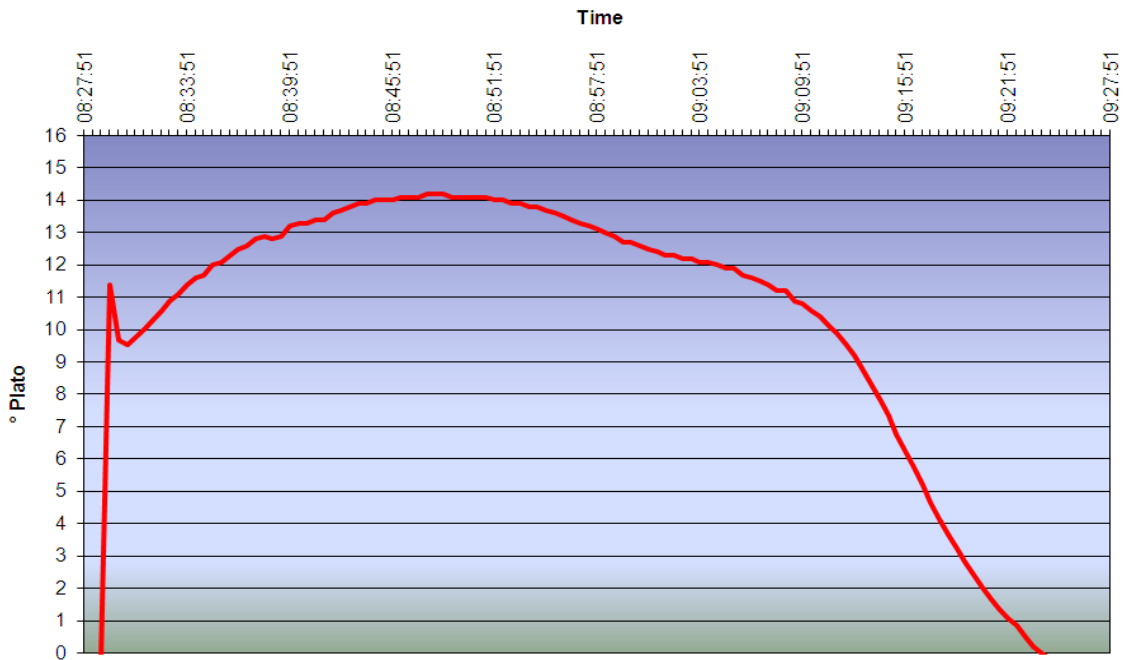


Figures 7 and 8: Runoff specific gravity profile for the 2008 test malts.

Kendall Runoff Lautertun Specific Gravity



Newdale Runoff Lautertun Specific Gravity



Figures 9 and 10: Runoff specific gravity profile for the 2008 test malts.

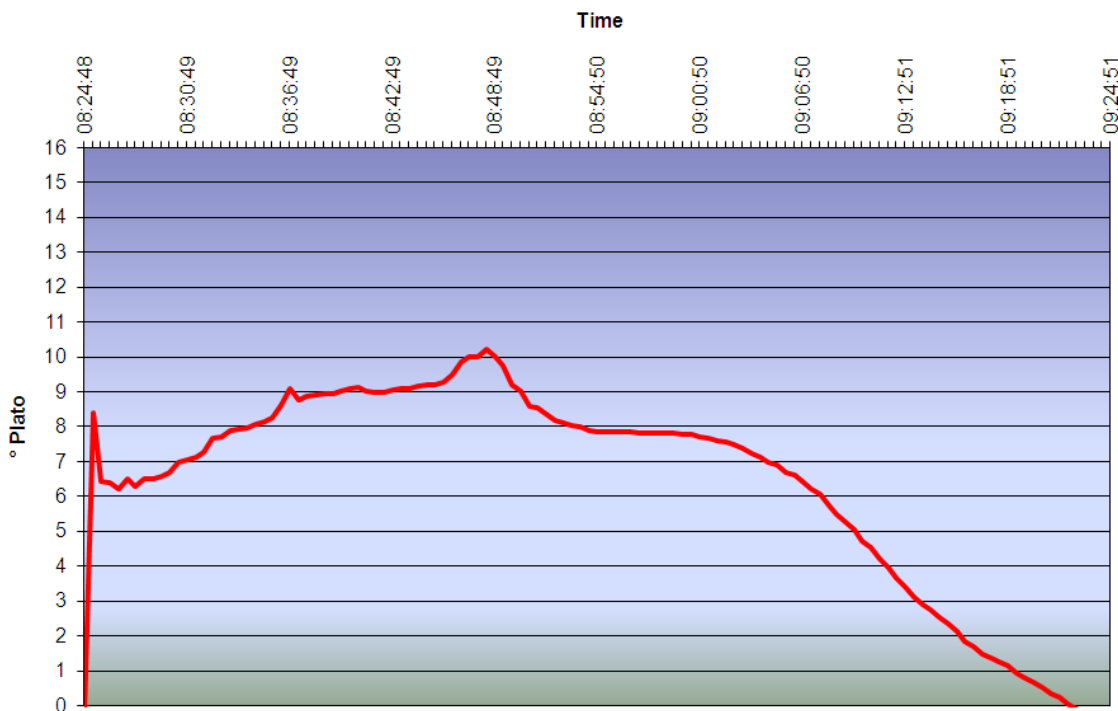
Legacy Runoff Lautertun Specific Gravity


Figure 11: Runoff specific gravity profile for the 2008 test malt.

Runoff specific gravity profiles for the test malts were within the normal range for the 2008 QS samples (Figures 7 – 11).

Table 10: Fermentation observations for the brewing trials

Brews	Metcalfe	Copeland	Kendall	Newdale	Legacy
Attenuation Limit (%)	85.0	85.6	86.0	85.8	85.2

The fermentabilities of the wort produced from the 2008 samples (Table 10) were very good. As recorded in past trials Kendall worts exhibited the highest fermentability of the varieties.

Table 11. Final beer analysis

Parameter	Metcalfe	Copeland	Kendall	Newdale	Legacy
Apparent Extract (Plato)	1.49	1.37	1.49	1.57	1.53
Real Extract (Plato)	2.99	3.00	3.21	3.44	3.08
Alcohol, %	4.19	4.56	4.81	5.26	4.36
Color, (ASBC)	2.71	2.30	2.76	2.56	3.32
pH	4.15	4.00	4.10	4.03	4.15
Foam (sec)	116	94	152	169	64
Initial Turbidity (FTU)	9.8	10.7	14.2	26.0	28.3
Chill Turbidity (FTU) 24 Hr	10.9	12.5	16.2	58.6	32.1
IBU	10.38	11.25	12.44	11.83	12.4

All malts produced beer with acceptable quality. All the beers produced from 2008 crop QS showed generally low colours. Copeland showed slight beer colour decrease, while Metcalfe, Kendall and Newdale had slightly higher colour than the last year's crop. Beers produced from Newdale offered the highest foam value. The initial and chill turbidity for all 2008 QS samples were exceptionally good, indicating good physical and colloidal stability.



TECHNICAL REPORT

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