CMBTC™
CANADIAN MALTING BARLEY TECHNICAL CENTRE

2012

Crop 2012 Quality Scoop

December 17 2012

Report of the Malting and Brewing Trials with the 2012 Quality Scoop Barley Samples

Summary

AC Metcalfe and CDC Copeland 2012 crop Quality Scoop (QS) barley samples (blend of barley from all selection areas in Western Canada) were provided to CMBTC by Viterra Inc., Rahr Malting and MaltEurop. CMBTC conducted routine barley analysis, pilot malting and pilot brewing tests with these QS barley samples. The objective of this study was to examine the malting and brewing performances of the newly harvested AC Metcalfe and CDC Copeland barley samples to aid in developing processing guidelines for the 2012 crop malting barley for customers of Canadian malting barley.

AC Metcalfe and CDC Copeland 2012 crop QS barley samples showed an overall quality slightly inferior to last year's crop. The barley samples showed acceptable grain moisture content and good protein content, but significantly lower thousand kernel weight and plumpness than last year crop. On average their germination energy was slightly lower than 2011 crop and showed stronger water sensitivity. In addition, RVA values for all of these QS barley samples were very low, except for one CDC Copeland barley sample, which indicated that these barley samples have suffered from pre-harvest sprouting damage. Therefore, some germination decline in long term-storage would be expected from 2012 crop AC Metcalfe and CDC Copeland barley.

In the pilot malting trials, under the given trial malting conditions, AC Metcalfe and CDC Copeland 2012 crop QS barley samples performed well and did not show any processing difficulties. They exhibited good water uptake and good chitting at steep, and showed good growth during germination. The malts produced from these 2012 QS barley samples all showed satisfactory values in friability, extract level, soluble protein, enzymes, FAN levels and color, as well as low beta-glucan content in all of the finished malts. Compared with 2011 QS barley, all 2012 QS samples showed satisfactory overall malting performance and produced malts with quality comparable to the 2011 QS barley samples. However, the overall malting performance and quality of the resulting malt varied from variety to variety and from trial to trial.

Malting trial results suggested that 2012 crop AC Metcalfe and CDC Copeland can be processed under normal processing conditions for Canadian two-row malting barleys. However, processing conditions that are known to effect malt soluble protein and malt color should be closely monitored throughout the malting process.

There were no problems recorded during milling of 2012 quality scoop derived malt, although some variations in malt grist compositions among the barley varieties were observed. In the brewhouse, the malts for the two QS barley varieties showed different

conversion times, which were on average shorter than last crop year but longer than in the previous three crop years. The AC Metcalfe samples took between 14 and 17 minutes for starch conversion, while the two CDC Copeland samples took 11 and 13 minutes to convert respectively. Time for wort to clear to less than 100 FTU was very good for both AC Metcalfe and CDC Copeland. Average lautering times for both AC Metcalfe and CDC Copeland samples were 38 and 39 minutes respectively. Malt Material Yields for both samples were good, ranging from 88.0% for CDC Copeland to 89.0% for AC Metcalfe. Wort colour for both AC Metcalfe and CDC Copeland were generally acceptable, with AC Metcalfe recording slightly lower values. The pH values were typical for the trial wort samples.

Average brewhouse yields for both 2012 QS samples were good. AC Metcalfe showed slightly higher value than the last crop year but lower than in the previous three crop years, while CDC Copeland showed somewhat lower values than in the previous four crop years. Normal sugar spectra were recorded for both 2012 QS varieties. The 2012 QS average wort carbohydrate spectrum for AC Metcalfe and CDC Copeland were in general very comparable.

The fermentability of the worts produced from the 2012 samples was very good. AC Metcalfe and CDC Copeland had comparable attenuation limits. Runoff turbidities for the test malts were within the normal range for the 2012 QS produced malts. Clarity below 100 FTU was typically obtained in less than 7 minutes for all the samples.

All malts produced beer with acceptable quality. Beers from both varieties had very comparable apparent and real extract, alcohol, pH and bitterness (IBU) values. All the beers produced from 2012 crop QS showed generally higher colours. CDC Copeland showed slightly higher beer colour and offered somewhat higher foam value than AC Metcalfe samples. The initial and chill turbidity for all 2012 QS samples were good, indicating good physical and colloidal stability, with AC Metcalfe showing slightly lower turbidity readings.

The produced beers were analyzed by the CMBTC Expert Taste Panel. All trial beers were rated as reasonably fresh, normal good beer with no obvious defects. AC Metcalfe samples were clean, slightly harsher with some grainy and sulphury notes. CDC Copeland beer samples were also clean, smother, with good body and some estery notes and more hop character.

1. Barley Quality Analysis

CMBTC received AC Metcalfe and CDC Copeland barley samples collected by grain and malting companies from the 2012 harvest. These were to represent the selection quality of the two largest varieties of 2012 crop selected for customers of Canadian malting barley. CMBTC was not involved in the collecting these QS barley samples.

When these barley samples arrived at CMBTC, their quality was examined prior to the malting trials, and the test results are summarized in Table 1. Please note that all the testing results reported in Table 1 were generated from a single test except for the germination test.

QS AC Metcalfe barley samples from 2012 harvest showed normal appearance and no noticeable signs of mould infection and/or serious staining. AC Metcalfe samples recorded desirable moisture content, and good protein content (Table 1). Compared with 2011 crop QS barley samples, 2012 crop AC Metcalfe's moisture content was lower and protein content was higher. 2012 crop AC Metcalfe barley samples showed very good germination energy with strong water sensitivity. Their germination energy was comparable to 2011 crop QS samples and their water sensitivity was stronger than 2011 crop QS samples. Although 2012 crop QS AC Metcalfe samples showed good thousand kernel weight and acceptable plumpness, these attributes were significantly lower than 2011 crop QS samples.

As observed with QS samples of 2012 AC Metcalfe, CDC Copeland QS samples from 2012 harvest also showed normal appearance and no noticeable signs of mould infection and/or severe staining. CDC Copeland barley samples showed acceptable moisture contents and desirable protein contents (Table 1). Their grain moisture contents were lower than 2011 crop QS samples, and their protein contents were higher than 2011 crop QS samples. 2012 crop CDC Copeland barley samples exhibited good germination energy but all with some water sensitivity. In comparison with 2011 crop QS samples, their germination energy was slightly lower, and their water sensitivity was stronger. 2012 CDC Copeland barley samples showed good thousand kernel weight and acceptable plumpness, but these values were significantly lower than 2011 QS samples.

Except for one CDC Copeland sample, QS barley samples of AC Metcalfe and CDC Copeland from 2012 harvest reported low RVA values (<135). This indicated that these samples had suffered pre-harvest sprouting damage. Therefore, some decrease in germination during long-term storage could be expected from 2012 crop AC Metcalfe and CDC Copeland barley samples.

Table 1. Analysis of 2012 crop barley samples received at CMBTC

Variety	Moisture, %	Protein, %	Germination, % (4ml, n=2)	Germination, % (8ml, n=2)	1000 Kernel wt, g	Sizing, %			RVA
						>6/64 sieve	>5/64 sieve	Through	
2012 Crop QS samples									
AC Metcalfe B-12-019(Malteurop)	12.8	13.2	98	77	38.6	83.2	12.87	1.88	63
AC Metcalfe B-12-025(Viterra)	10.2	12.6	99	87	44.3	87.6	9.36	0.99	29
AC Metcalfe B-12-026(Rahr)	12.2	13.1	99	89	46.4	86.9	9.85	1.30	42
AC Metcalfe B-12-028 (Viterra)	9.3	11.6	99	79	39.9	86.9	7.11	0.62	100
Average	11.1	12.6	98.8	83.0	42.30	86.1	9.80	1.20	58.50
σ	1.65	0.73	0.50	5.89	3.66	2.0	2.37	0.53	31.01
CDC Copeland B-12-020 (Malteurop)	12.7	12.5	97	80	40.0	78.3	16.64	3.57	151
CDC Copeland B-12-024(Viterra)	10.1	11.6	100	80	45.5	86.0	10.23	1.47	79
Average	11.4	12.05	98.5	80	42.8	82.2	13.44	2.52	115
σ	1.84	0.64	2.12	0.00	3.89	5.5	4.53	1.48	50.9
Average of 2011 QS									
AC Metcalfe	12.0	12.0	98.8	94.8	47.0	92.6	4.67	1.61	144
CDC Copeland	12.7	11.4	99.3	92.2	48.9	92.3	5.04	1.43	161

In general, the 2012 crop barley samples received at CMBTC showed an acceptable overall quality. In comparison with 2011 QS barley samples, 2012 new crop barley samples had slightly higher protein content, slightly lower germination energy and stronger water sensitivity, as well as lower thousand kernel weight and plumpness.

2. Pilot malting trials

Pilot malting trials were conducted on 2012 QS AC Metcalfe and CDC Copeland barley samples. In total five pilot malting trails were conducted, three on AC Metcalfe and two on CDC Copeland samples. All of the malting trials were carried out with a batch size of 50-60kg cleaned barley using CMBTC's pilot malting system. The processing conditions used for the trials are given in Box 1.

Box 1. Malting conditions for processing of AC Metcalfe and CDC Copeland 2012 QS barley samples

AC Metcalfe

STEEPING CYCLES

44hours (8 hrs Wet- 12 hrs Dry- 9 hrs Wet -14 hrs Dry -1 hr Wet) at 14°C

GERMINATION CONDITIONS

Day 1, Day 2, Day 3 & Day 4 @ 14°C

KILNING CONDITIONS

A 21 hour cycle with a 4-hour curing phase at 82°C

CDC Copeland

STEEPING CYCLES

44 hours (8 hrs Wet- 12 hrs Dry- 9 hrs Wet -14 hrs Dry -1 hr Wet) at 15°C

GERMINATION CONDITIONS

Day 1 & Day 2 @ 15°C; Day 3 & Day 4 @ 14°C

KILNING CONDITIONS

A 21 hour cycle with a 4-hour curing phase at 82°

AC Metcalfe

In the pilot malting trials, 2012 crop AC Metcalfe barley samples did not show any difficulties in processing. At the end of steep, the barley samples obtained satisfactory steep-out moisture contents and achieved very good chitting rates (Table 2). During germination, AC Metcalfe barley samples showed good acrospire growth and good modification progress.

In comparison with 2011 QS AC Metcalfe barley samples, 2012 samples showed slightly faster water up-take and obtained slightly higher chitting rates at the end of steep. During germination 2012 QS AC Metcalfe samples showed a growth profile more advanced than 2011 QS AC Metcalfe.

Table 2. Averaged steep-out moisture content, chitting rate and growth of acrospires for 2012 QS AC Metcalfe

2012 QS AC Metcalfe (Mean n=3)					
2012 AC Metcalfe		Steep-out Moisture (%)		Chitting rate (%)	
		45.97		98.75	
Acrospire growth					
	0-¼ (%)	¼-½ (%)	½-¾ (%)	¾-1 (%)	>1 (%)
24 hours	1.3	38.8	58.8	1.3	0
48 hours	0	11.3	28.8	60	0
72 hours	0	0	18.8	75	6.3
96 hours	0	0	8.8	60	31.2
2011 QS AC Metcalfe (Mean n=2)					
2011 AC Metcalfe		Steep-out moisture (%)		Chitting rate(%)	
		45.6		97.5	
Acrospire growth					
	0-¼ (%)	¼-½ (%)	½-¾ (%)	¾-1 (%)	>1 (%)
24 hours	2.5	45	52.5	0	0
48 hours	0	50	40	10	0
72 hours	0	0	25	70	5
96 hours	0	0	5	77.5	17.5

Complete malt analysis was carried out for the pilot malting trials, and the analytical results for the trials are given in Table 3. For comparison, the table also includes the average malt analysis of AC Metcalfe for the malting trials carried out at CMBTC with 2011 and 2010 crop AC Metcalfe barley samples.

Table 3. Analysis of malts generated from the pilot malting trials with 2012 crop QS AC Metcalfe barley samples.

Parameter	2012 QS				2011 QS	2010 QS
	PM-12-045	PM-12-052	PM-12-053	Mean	Mean	Mean
Malt moist, %	4.3	4.0	4.1	**4.1**	**4.1**	**4.0**
Friability, %	89.4	82.5	82.3	**84.7**	**84.0**	**76.4**
Fine-extract, %	80.4	80.2	79.8	**80.1**	**81.0**	**80.2**
Coarse-extract, %	79.9	79.3	79.0	**79.4**	**80.4**	**79.6**
F/C Difference, %	0.5	0.9	0.8	**0.7**	**0.7**	**0.65**
Soluble protein, %	6.28	5.83	5.83	**5.98**	**5.35**	**5.12**
Total protein, %	13.2	12.4	12.8	**12.8**	**11.5**	**11.6**
Kolbach Index, %	47.4	46.9	45.4	**46.6**	**46.4**	**44.5**
Beta-Glucan, ppm	32	78	59	**56**	**74**	**179**
Diastatic power, °L	168	171	180	**173**	**144**	**174**
α-Amylase, D.U.	78.1	68.7	66.7	**71.2**	**60.5**	**67.2**
Wort colour, ASBC	2.93	2.65	2.49	**2.69**	**2.22**	**2.09**
Wort pH	5.83	5.9	5.92	**5.88**	**5.99**	**5.93**
Fan, mg/L	244	200	217	**220**	**193**	**210**

Malting Summary

- ***General modification:*** The values for friability, F/C difference, soluble protein content and beta-glucan content all suggested that the three 2012 QS barley samples of AC Metcalfe produced malts with a very good modification.

- ***Extract yield and enzyme levels:*** In comparison with the trial averages of 2011 and 2010 QS barley samples of AC Metcalfe, the malts produced from 2012 QS AC Metcalfe samples exhibited significantly lower extract yield than 2011 crop, but were similar to 2010 crop. The malts developed adequate levels of enzymes. Their α-amylase was higher than in QS samples of 2011 and 2010 crops, while their diastatic power was higher than the QS samples of 2011, and comparable to the QS samples of 2010 crops.

- ***Soluble protein, free amino nitrogen (FAN) and malt colour:*** The malts produced from the barley samples of 2012 QS AC Metcalfe exhibited good protein solubilisation, which was slightly higher than 2011 and 2010 crop QS samples as indicated by higher soluble protein content, although their Kolbach Index was similar to 2011 crop and higher than 2010 crop. The malts also developed adequate levels of FAN, which were higher than 2011 and 2010 QS samples. Malt colour for 2012 QS AC Metcalfe barley samples was good but was significantly higher than 2011 and 2010 QS samples.

Comments on the malting process

During the malting process, no difficulties were recorded for the 2012 crop QS AC Metcalfe barley samples. The barley samples were processed under normal processing conditions for quality evaluation of Canadian two-row malting barley.

At steeping target a steep-out moisture content of 43-44% and an over 85% chitting rate. The steeping cycle should consist of 2 or 3 wet periods at 14-16°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

In the malting trials, 2012 crop QS CDC Copeland barley samples did not show any processing difficulties. At the end of steep, the CDC Copeland barley samples obtained satisfactory steep-out moisture content and excellent chitting rates (Table 4). During germination, these barley samples showed good growth of acrospires.

In comparison with 2011 QS CDC Copeland samples, 2012 QS CDC Copeland barley samples showed slightly slower water up-take and slightly lower chitting rate at the end of steep. During germination, 2012 QS CDC Copeland barley samples showed slightly slower growth of acrospires than the 2011 QS CDC Copeland.

Table 4. Averaged steep-out moisture content, chitting rate and growth profile acrospires of 2012 QS CDC Copeland barley

2012 QS CDC Copeland (Mean n=2)					
2012 CDC Copeland		Steep-out moisture (%)		Chitting rate(%)	
		43.04		97.5	
Acrospire growth					
	0-¼ (%)	¼-½ (%)	½-¾ (%)	¾-1 (%)	>1 (%)
24 hours	10	45	45	0	0
48 hours	0	42.5	22.5	35	0
72 hours	0	27.5	22.5	50	0
96 hours	0	0	15	77.5	7.5
2011 QS Copeland (Mean n=2)					
2011 CDC Copeland		Steep-out moisture (%)		Chitting rate (%)	
		44.7		100	
Acrospire growth					
	0-¼ (%)	¼-½ (%)	½-¾ (%)	¾-1 (%)	>1 (%)
24 hours	0	30	60	10	0
48 hours	0	2.5	67.5	30	0
72 hours	0	0	30	60	10
96 hours	0	0	10	80	10

Complete malt analysis was carried out for the two pilot malting trials, and the analytical results for the trials are given in Table 5. For comparison, the table also includes the average malt analysis of CDC Copeland malting trials carried out at CMBTC with 2011 and 2010 crop QS CDC Copeland barley samples.

Table 5. Malt analysis for 2011 QS CDC Copeland barley samples

Parameter	2012 QS			2011 QS	2010 QS
	PM-12-046	PM-12-049	Mean	Mean	Mean
Malt moist, %	3.9	4.3	**4.1**	**4.1**	**3.8**
Friability, %	89.4	89.4	**89.4**	**89.7**	**86.7**
Fine-extract, %	81.3	80.0	**80.7**	**81.0**	**80.4**
Coarse-extract, %	80.0	79.6	**79.8**	**80.3**	**79.4**
F/C Difference, %	1.3	0.4	**0.9**	**0.7**	**1.0**
Soluble protein, %	6.78	5.51	**6.15**	**5.27**	**5.20**
Total protein, %	12.4	11.9	**12.2**	**11.1**	**11.4**
Kolbach Index, %	54.6	46.5	**50.6**	**47.8**	**45.8**
Beta-Glucan, ppm	68	77	**73**	**79**	**133**
Diastatic power, °L	128	133	**131**	**122**	**131**
α-Amylase, D.U.	66.2	48.8	**57.5**	**46.1**	**48.1**
Wort colour, ASBC	4.03	2.36	**3.20**	**2.23**	**2.34**
Wort pH	5.83	5.88	**5.86**	**5.96**	**5.91**
Fan, mg/L	255	208	**232**	**189**	**226**

Malting Summary

- ***General modification:*** The values for friability, F/C difference, soluble protein content and beta-glucan content all suggested that these two 2012 QS CDC Copeland barley samples produced malts with very good modification.

- ***Extract yield and enzyme levels:*** The malts produced from 2012 QS CDC Copeland samples exhibited extract yield slightly lower than 2011 crop QS samples and higher than 2010 QS samples. The malts from 2012 QS Copeland developed good levels of enzymes. Their α-amylase was higher than 2011 and 2010 QS Copeland samples, while their diastatic power was higher than 2011 QS samples and similar to 2010 QS samples.

- ***Soluble protein, free amino nitrogen (FAN) and malt colour:*** The malts produced from the 2012 crop QS Copeland samples exhibited significantly higher protein modification than QS samples of 2011 and 2010 crops as indicated by soluble protein and Kolbach Index. The malts also developed adequate levels of FAN, which were higher than in 2011 and 2010 QS samples. Malt colour for 2012 QS Copeland barley was good. It was higher than 2011 and 2010 QS samples.

Comments on the malting process

During the malting process, no difficulties were recorded for the 2012 QS CDC Copeland barley samples. 2012 CDC Copeland barley can be processed under the normal processing conditions for Canadian two-row malting barley. However, please pay attention to processing conditions that affect soluble protein and malt color.

At steep, target steep-out moisture of 43-44% and over 85% chitting rate. The steeping cycle should consist of 2 or 3 wet periods at 14-15 °C. In germination avoid high temperature and excessive watering to control the growth of acrospires and protein breakdown. In kilning the curing temperature can be similar to that used for processing AC Metcalfe (80-82°C). 2012 QS CDC Copeland did not show the tendency of producing lower malt color.

3. Pilot-brewing Trials

Malts produced from the malting trials were pilot brewed in CMBTCs 300L Pilot Brewery. Malts from the three 2012 QS Metcalfe and two 2012 QS Copeland trials were brewed separately. The following is the mashing and fermentation conditions for the brewing trials with the 2012 QS sample malts:

Mash Tun

- 100% malt brew – 40 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 10 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 – 45g
- Second hop (Mt. Hood) boiled for 5 min – 90g

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

- Cooled to 13.5ºC, pitched with lager yeast at 1.25 million cells per mL
- Fermented for 7 days (3 days at 13.5ºC and 4 days at 15ºC)
- Cooled and stored at -0.5 ºC for 7 days
- Filtered through a 1 µm pad filter system, carbonated to 2.5 volumes CO_2
- Stored 2 days at -2ºC, and packaged
- Pasteurized to 15 PU

The brewing results are given in Tables 6 to 14.

Table 6. Malt grist composition (%) for the 2012 QS brewing trials

Sieve	AC Metcalfe average (n=3)	CDC Copeland average (n=2)
#10	13.48	10.49
#14	23.55	17.93
#20	30.84	28.13
#30	10.76	13.02
#60	11.10	14.75
#100	4.27	5.55
On pan	5.96	10.10

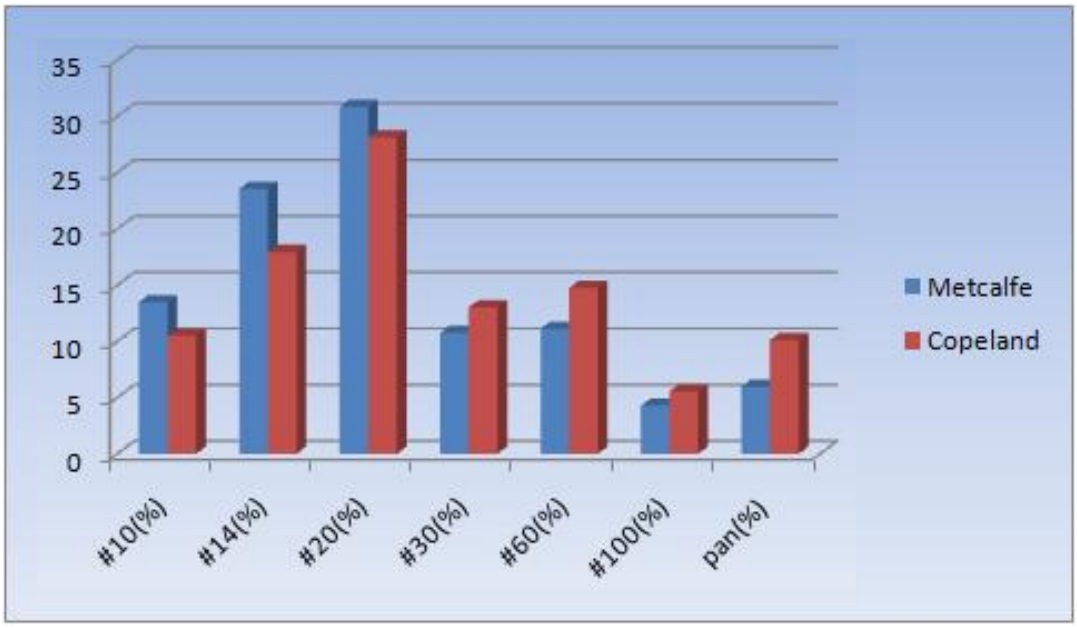

Figure 1: Malt Grist Ratios for the 2012 samples

There were no problems recorded during milling of 2012 quality scoop derived malt, although some variations in malt grist compositions among the barley varieties were observed (Table 6, Figure 1). After milling malt from AC Metcalfe showed higher portion of coarse particles while CDC Copeland recorded slightly increased amounts of fine flour particles. However, the differences were not large enough to affect brewing performance. Average malt grist particle size distribution of AC Metcalfe and CDC Copeland samples correlates well with malt friability results, where AC Metcalfe showed lower average readings than CDC Copeland.

Table 7. Brewhouse observations for the brewing trials for 2012.

Parameter	AC Metcalfe average (n=3)	CDC Copeland average (n=2)
Conversion time (min.)	15	12
Time to clear (min.)	5	7
Lautering time (min.)	38	39
Malt Material Yield (%)	89.0	88.0
Wort pH	5.10	5.10
Wort Colour (SRM)	7.63	9.77

In the brewhouse, the malts for the two QS barley varieties showed different conversion times (Table 7), which were on average shorter than last crop year but longer than in the previous three crop years (Table 8). The AC Metcalfe samples took between 14 and 17 minutes for starch conversion, while the two CDC Copeland samples took 11 and 13 minutes to convert respectively. Conversion time is a metric that is important for the brewer in regards to the economics of his brewhouse. Longer conversion times could translate into higher operating costs in more energy requirement, higher labour costs or decreased capacity. Conversion time is related to the enzyme content of the malt, and can be manipulated by changing malt: water ratio and temperature. Time for wort to clear to less than 100 FTU was very good for both AC Metcalfe (5 minutes) and CDC Copeland (7 minutes). Time required for the wort to clear is a metric that is important for the brewer in regards to the economics of his brewhouse as well as the quality of the finished beer. Most brewers want clear wort, it provides better quality beer and also allows for better capacity utilization in fermentation. The time therefore to obtain wort that is clear (less than 100 FTU) is therefore related to capacity and manpower utilization. Average lautering times for both AC Metcalfe and CDC Copeland samples were 38 and 39 minutes respectively, and were faster than the averages of the last four crop years (Table 9). Time to complete the runoff is a metric that is important for the brewer in regards to the economics of his brewhouse. Longer times could translate into higher operating costs in more energy requirement, higher labour costs or decreased capacity. Runoff time is related to the beta-glucan content of the malt as well as the friability and milling of the malt. Malt Material Yields for both samples were good, ranging from 88.0% for CDC Copeland to 89.0% for AC Metcalfe. Wort colour for both AC Metcalfe and CDC Copeland were generally acceptable, with AC Metcalfe recording slightly lower values.

Table 8. Conversion times for 100% malt brews with 2012 crop, versus 2011, 2010, 2009 and 2008 quality scoop.

Variety	QS 2012	QS 2011	QS 2010	QS 2009	QS 2008
AC Metcalfe	15	17	11	8.5	10.5
CDC Copeland	12	19	11.5	10	11

Table 9. Lautering times for 100% malt brews with 2012 crop, versus 2011, 2010, 2009 and 2008 quality scoop.

Variety	QS 2012	QS 2011	QS 2010	QS 2009	QS 2008
AC Metcalfe	38	59	59	58.5	62
CDC Copeland	39	59	59	58	61.5

Average brewhouse yields for both 2012 QS samples were good. AC Metcalfe showed slightly higher value than the last crop year but lower than in the previous three crop years, while CDC Copeland showed somewhat lower values than in the previous four crop years (Table 10). Brewhouse Yield shows what percentage of the extract that was recovered into the cast wort. It is a measure of how easily the extract is recovered from the malt. Brewhouse material efficiency also is a metric to determine the ease of obtaining the extract from the mash. The pH values were typical for the trial wort samples.

Table 10. Brewhouse yields for 2012 crop, versus 2011, 2010, 2009 and 2008 quality scoop.

Variety	QS 2012	QS 2011	QS 2010	QS 2009	QS 2008
AC Metcalfe	70.7	70.1	71.7	71.1	73.3
CDC Copeland	70.2	71.8	70.9	70.8	74.2

Normal sugar spectra were recorded for both 2012 QS varieties (Table 11). The 2012 QS average wort carbohydrate spectrum for AC Metcalfe and CDC Copeland were in general very comparable.

Table 11. Wort sugar concentration for the brewing trials (mg/L)

Carbohydrate	AC Metcalfe	CDC Copeland
Maltotetrose	2.63	2.67
Maltotriose	14.71	15.23
Maltose	57.62	56.57
Glucose	15.32	14.29
Fructose	3.54	4.43

The fermentability of the worts produced from the 2012 samples (Table 12) was very good. AC Metcalfe and CDC Copeland had comparable attenuation limits. Fermentability is important in that it is a measure of the amount of beer that can be produced from the original malt. The higher the better.

Table 12: Fermentation observations for the brewing trials

Parameter	AC Metcalfe	CDC Copeland
Attenuation Limit (%)	**88.8**	**88.9**

Runoff turbidities for the test malts were within the normal range for the 2012 QS produced malts (Figures 2 – 6). Clarity below 100 FTU was typically obtained in less than 7 minutes for all the samples. Wort clarity curve recorded for both varieties tested was normal and comparable, with CDC Copeland showing slightly longer time for initial turbidity reduction.

Runoff specific gravity profiles for the test malts were within the normal range for the 2012 QS samples (Figures 7 – 11).

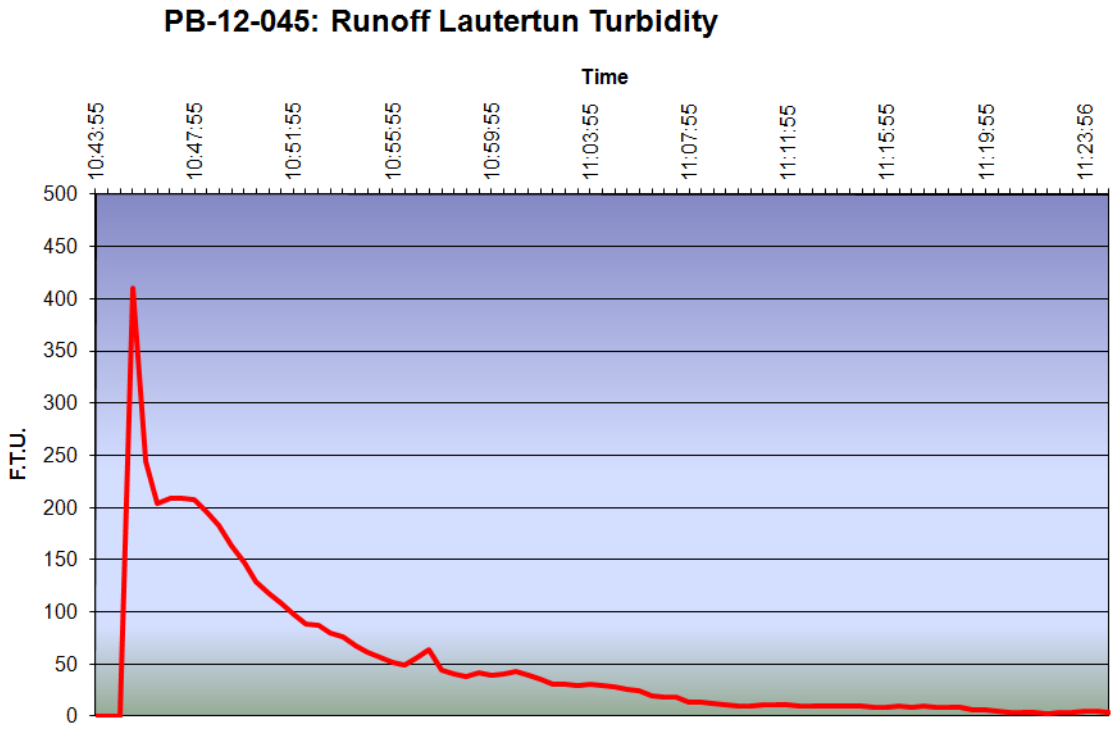

Figure 2: AC Metcalfe runoff turbidity profiles for the 2012 QS test malts

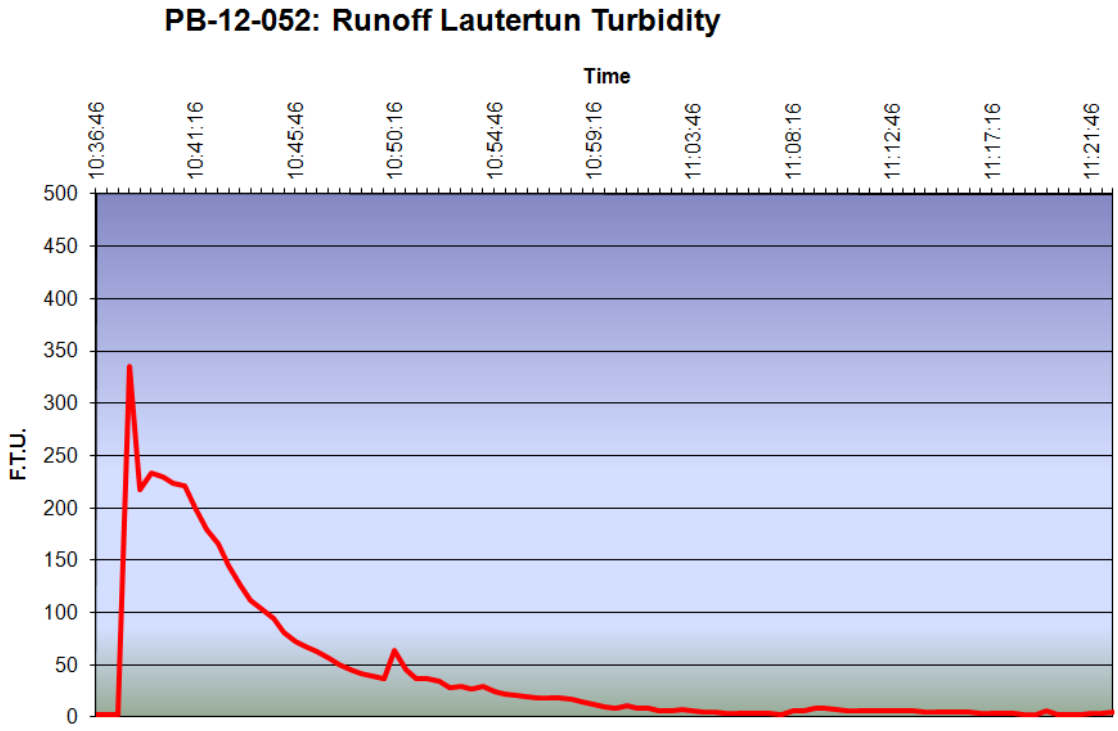

Figure 3: AC Metcalfe runoff turbidity profiles for the 2012 QS test malts

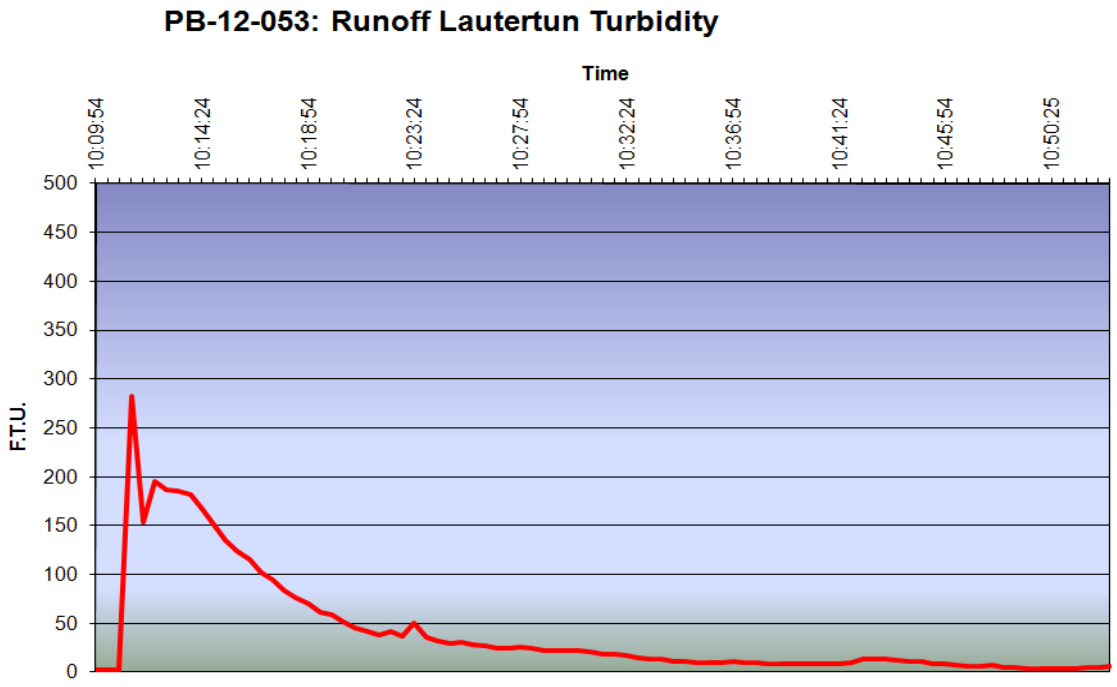

Figure 4: AC Metcalfe runoff turbidity profiles for the 2012 QS test malts

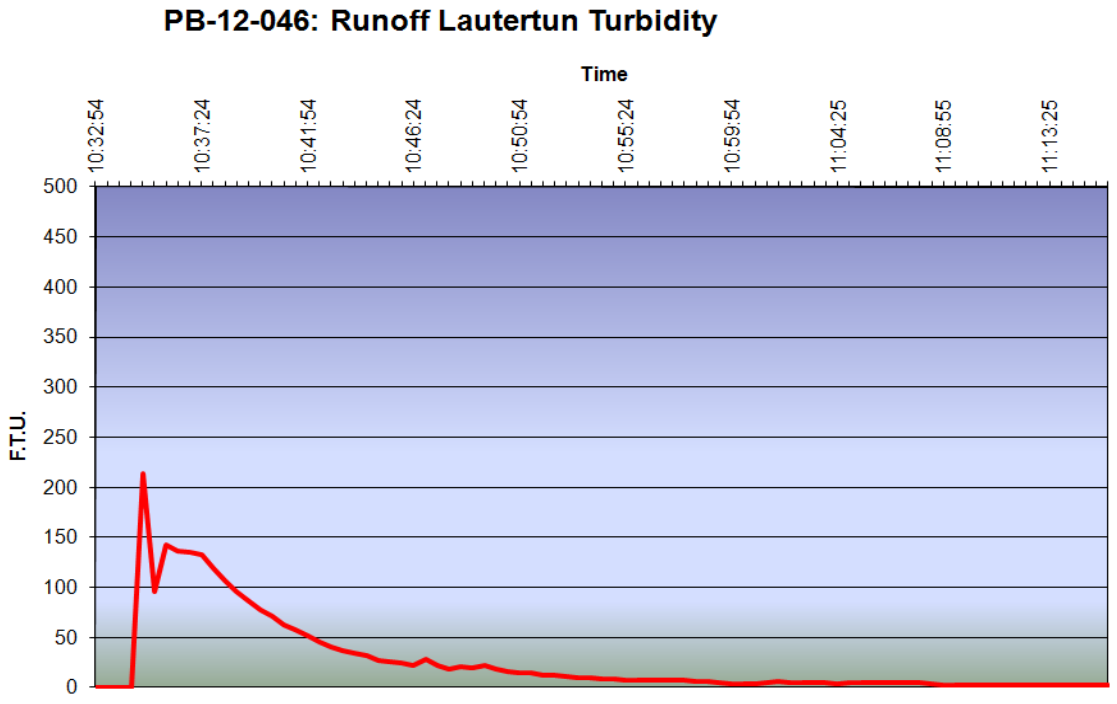

Figure 5: CDC Copeland runoff turbidity profiles for the 2012 QS test malts

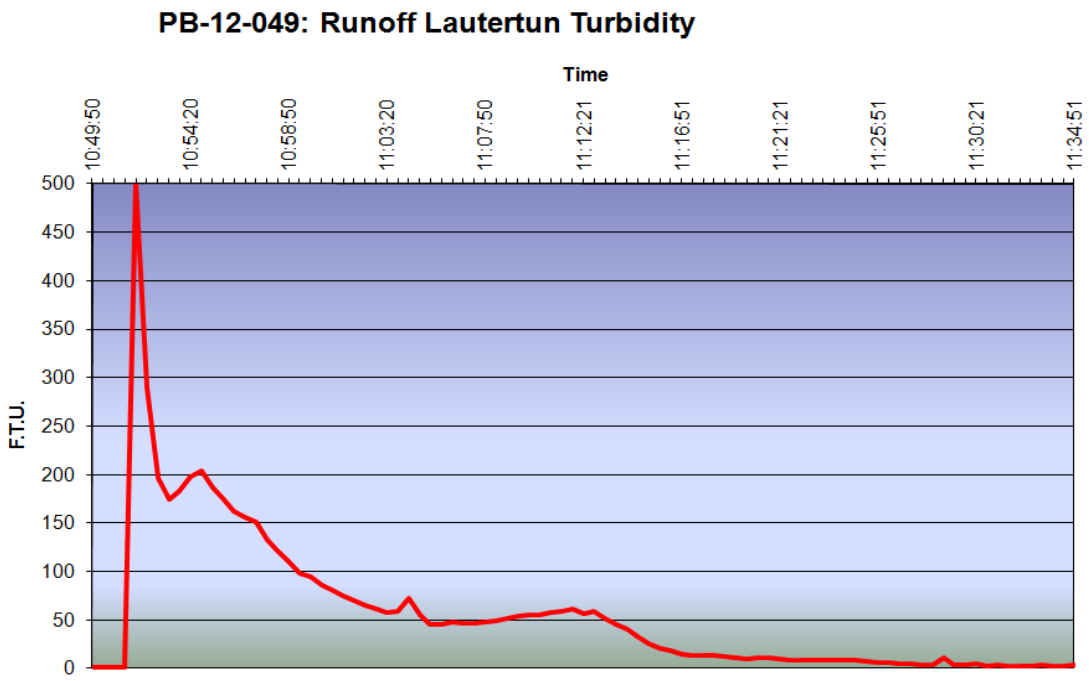

Figure 6: CDC Copeland runoff turbidity profiles for the 2012 QS test malts

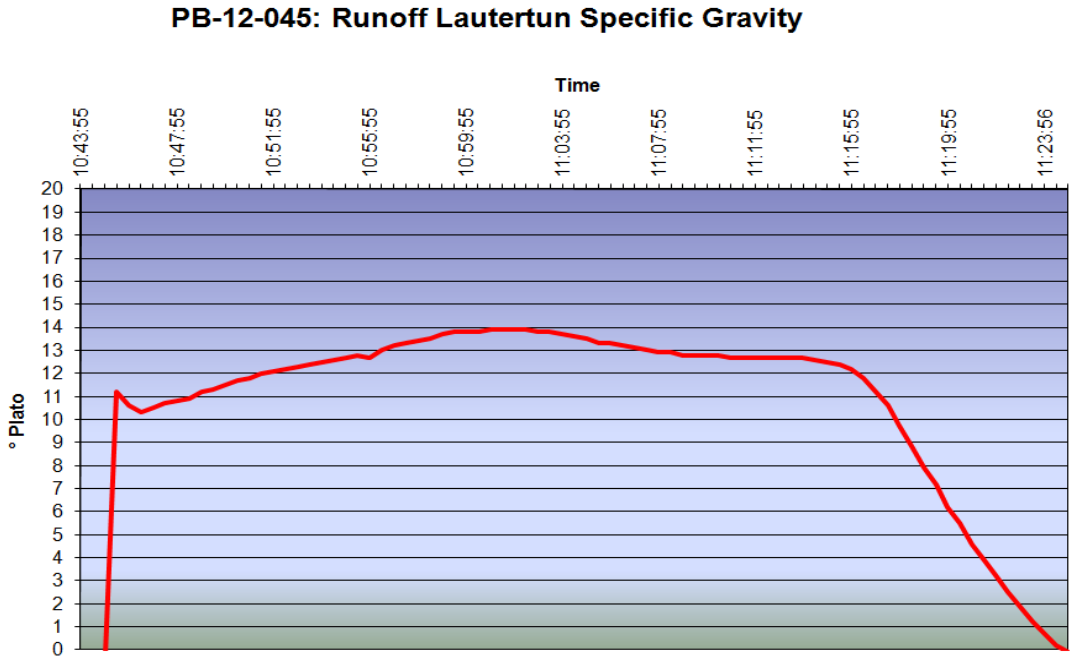

Figure 7: AC Metcalfe runoff runoff specific gravity profiles for the 2012 QS test malts.

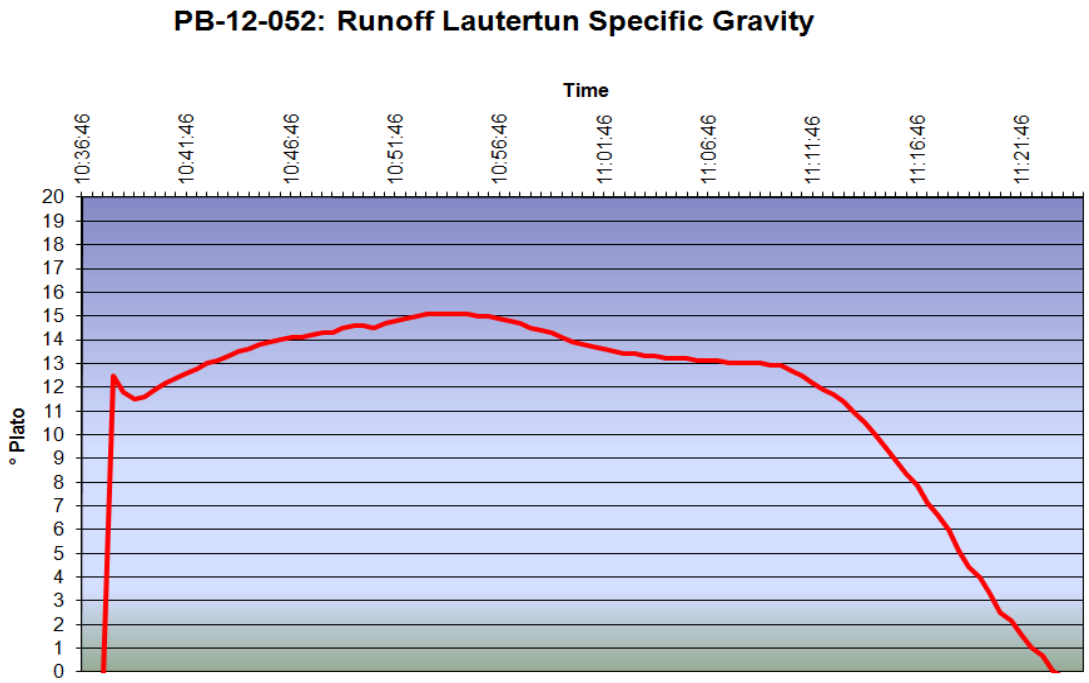

Figure 8: AC Metcalfe runoff runoff specific gravity profiles for the 2012 QS test malts.

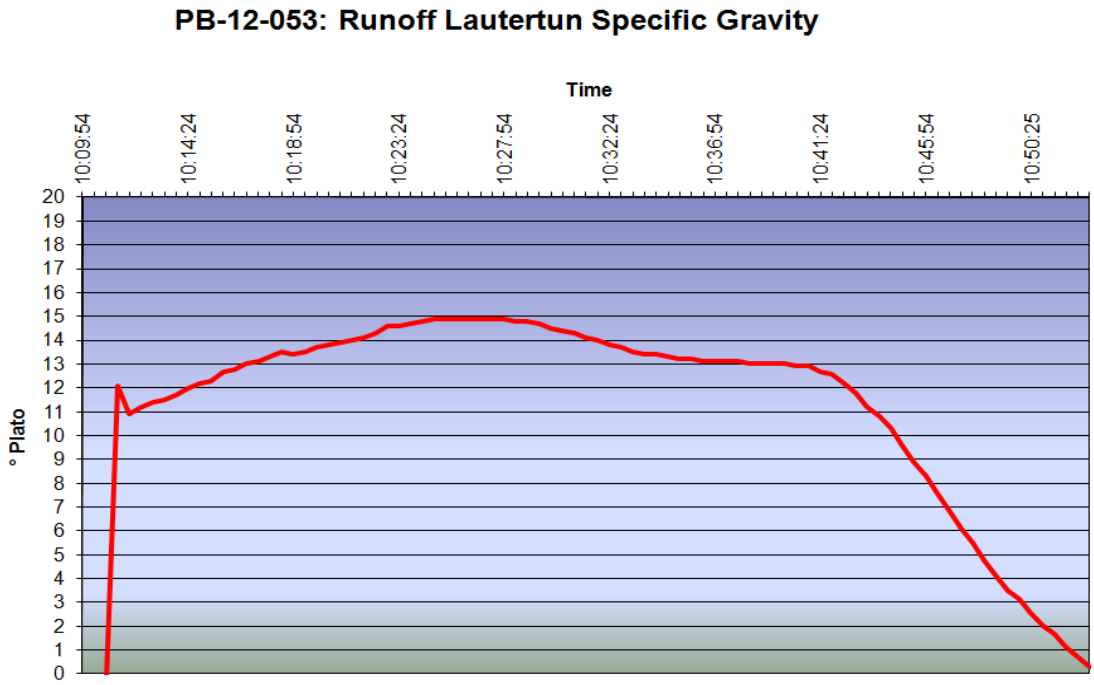

Figure 9: AC Metcalfe runoff runoff specific gravity profiles for the 2012 QS test malts.

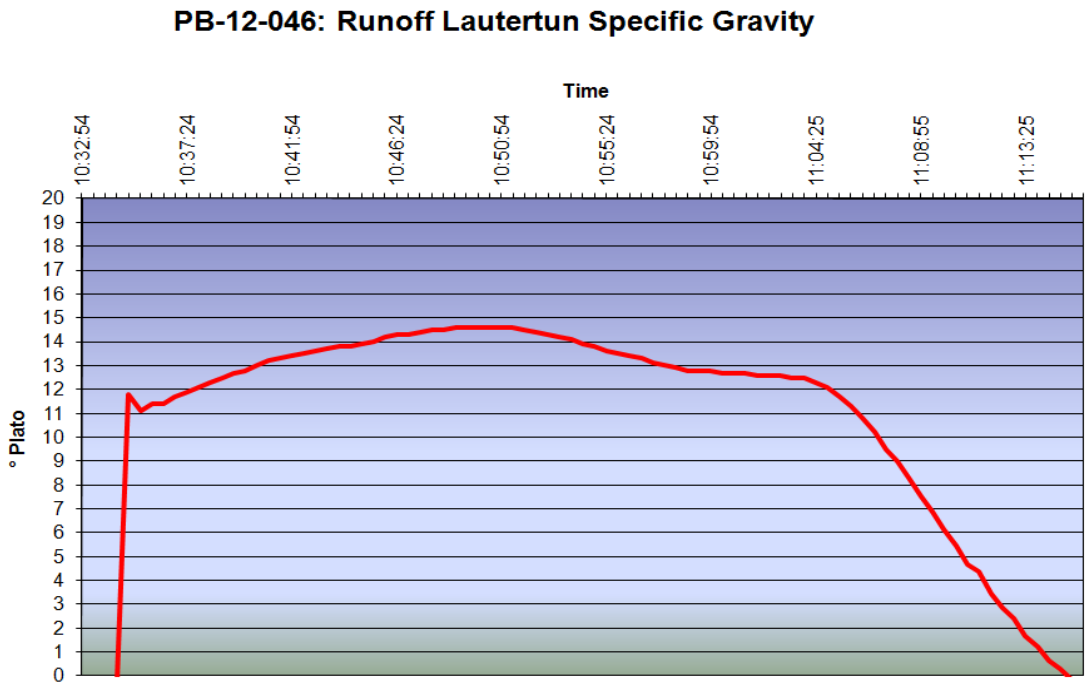

Figure 10: CDC Copeland runoff specific gravity profile for the 2012 QS test malts.

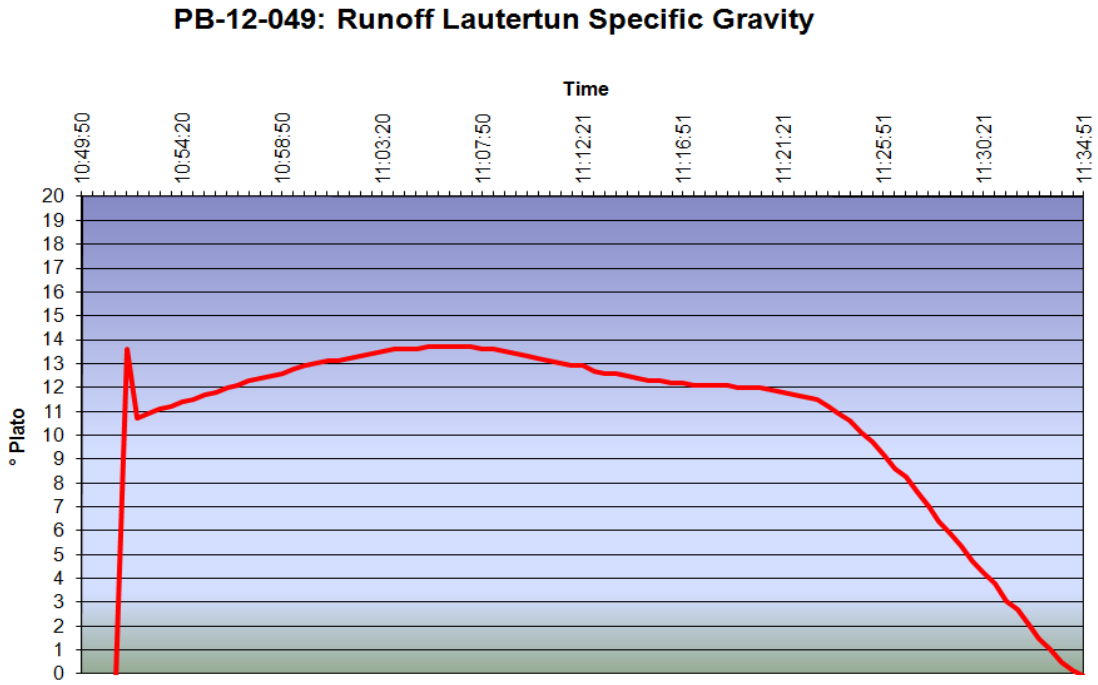

Figure 11: CDC Copeland runoff specific gravity profile for the 2012 QS test malts.

All malts produced beer with acceptable quality (Table 13). Beers from both varieties had very comparable apparent and real extract, alcohol, pH and bitterness (IBU) values. All the beers produced from 2012 crop QS showed generally higher colours. CDC

Copeland showed slightly higher beer colour and offered somewhat higher foam value than AC Metcalfe samples. The initial and chill turbidity for all 2012 QS samples were good, indicating good physical and colloidal stability, with AC Metcalfe showing slightly lower turbidity readings.

Table 13. Final beer analysis

Parameter	AC Metcalfe	CDC Copeland
Apparent Extract (Plato)	**1.48**	**1.47**
Real Extract (Plato)	**3.36**	**3.35**
Alcohol, %	**5.17**	**5.17**
Color, (ASBC)	**6.51**	**7.21**
pH	**4.28**	**4.27**
Foam (sec)	**141**	**152**
Initial Turbidity (FTU)	**20.7**	**21.5**
Chill Turbidity (FTU) 24 Hr	**24.3**	**25.9**
Forcing Turbidity (FTU)	**328**	**458**
IBU	**13.8**	**14.4**

The produced beers were analyzed by the CMBTC Expert Taste Panel. Beer sensory data is presented in Figure 12 and Table 14 in more details. All trial beers were rated as reasonably fresh, normal good beer with no obvious defects. AC Metcalfe samples were clean, slightly harsher with some grainy and sulphury notes. CDC Copeland beer samples were also clean, smother, with good body and some estery notes and more hop character.

Figure 12. Final CDC Copeland and AC Metcalfe beer organoleptic properties

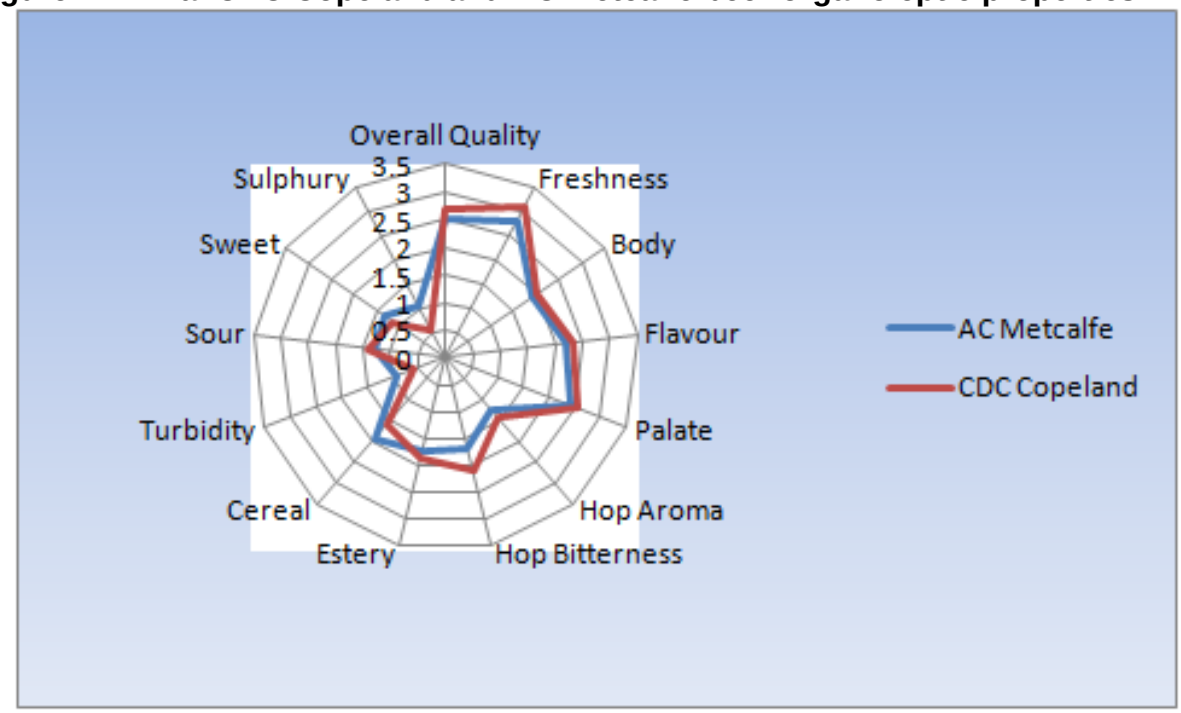

Table 14. AC Metcalfe and CDC Copeland beer organoleptic property data

Parameter	AC Metcalfe	CDC Copeland
Freshness	**2.8**	**3.1**
Body	**1.9**	**2.0**
Flavour	**2.2**	**2.3**
Smoothness	**2.4**	**2.6**
Hop Aroma	**1.2**	**1.4**
Hop Bitterness	**1.7**	**2.1**
Estery	**1.7**	**1.9**
Cereal	**1.9**	**1.6**
Turbidity	**0.9**	**0.6**
Sour	**1.3**	**1.4**
Sweet	**1.3**	**1.2**
Sulphury	**1.1**	**0.6**
Overall Quality	**2.5**	**2.7**

Quality scale
0 – Undrinkable
1 – Defects at high level (consumer would notice)
2 – Slight defects (expert would object, typical slightly aged market beer)
3 – Normal good beer (nothing really good or bad, reasonably fresh)
4 – Excellent (no real defects and many good characters)

Additional Terms Rating Scale
0 – Non existent
1 – Light, faint
2 – Mild
3 – Very noticeable
4 – Very strong

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