2012

2012 Crop CDC Meredith Malting and Brewing Trials

CMBTC

7/9/2012

Malting and Brewing Trials with CDC Meredith Barley Samples of 2012 Crop

Summary

CMBTC conducted barley analysis, pilot malting and pilot brewing trials on CDC Meredith barley samples of 2012 crop provided to CMBTC by Canada Malting and Richardson International. The objective of this study was to examine the malting and brewing performances of the newly harvested CDC Meredith barley to aid in developing processing guidelines for the users of Canadian malting barley.

These two 2012 crop CDC Meredith barley samples showed normal appearance and no noticeable signs of mould infection and/or serious staining. They both exhibited good moisture contents, desirable protein contents and good germination energy with some water sensitivity, as well as good thousand kernel weight and plumpness. In addition, the barley samples showed good RVA values which suggested that good storability could be expected from these CDC Meredith samples. The barley test results indicated that the CDC Meredith barley samples exhibited selectable quality for malting use.

In the pilot malting trials, the 2012 crop CDC Meredith barley samples showed satisfactory overall malting performance under the given trial malting conditions and did not show any processing difficulties. At steep, they exhibited good water-uptake and obtained good chitting rates; during germination they showed good growth of acrospires. The produced malts showed satisfactory overall quality; the malts showed good values in friability, extract yield, soluble protein, enzymes, FAN levels and malt color, but the malt beta-glucan content was significantly higher than that desired by brewers. Compared with 2012 crop AC Metcalfe, the malts produced from the 2012 crop CDC Meredith barley showed higher friability; higher extract yield, lower soluble protein, comparable KI, lower FAN and lower color, and beta-glucan content. The pilot malting trial results suggested that 2012 crop CDC Meredith barley can be processed under normal processing conditions designed for examining Canadian two-row malting barleys. However, in order to ensure lower malt beta-glucan content, the processing conditions that are known to affect malt beta-glucan content should be closely monitored throughout the malting process.

In the brewhouse, 2012 crop CDC Meredith recorded comparable average conversion time to the 2012 crop AC Metcalfe average. Time for wort to clear to less than 100 FTU in lautering was very good, and was comparable to the averages of 2012 crop AC Metcalfe. Average lautering time for 2012 crop CDC Meredith was slightly longer than 2012 AC Metcalfe averages. Malt Material Yield was very good, and on average slightly higher than the 2012 crop AC Metcalfe averages. Wort clarity and break in the wort kettle were good and comparable to the controls. The wort pH values were typical for the wort samples derived from barley malts, and slightly lower than the averages of

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2012 AC Metcalfe samples. CDC Meredith recorded a somewhat lower average wort colour than the 2012 crop AC Metcalfe. Wort taste was acceptable.

Acceptable wort sugar spectrum was recorded for the average of 2012 crop CDC Meredith. The average fermentability of the worts produced from 2012 CDC Meredith was outstanding and higher than the average for 2012 crop AC Metcalfe.

CDC Meredith malt produced beer with good quality. Apparent and real extracts were good and slightly lower than the 2012 AC Metcalfe controls, while alcohol in final beer was somewhat higher. Average beer colour for 2012 crop CDC Meredith samples was significantly lower than the control averages, while the final pH was slightly lower than 2012 AC Metcalfe controls. 2012 crop CDC Meredith beer had comparable foam stability to the averages of 2012 AC Metcalfe controls. The initial and chill turbidities were good, and lower than the controls, indicating good physical and colloidal stability. CDC Meredith beer had on average comparable body, and was less sweet and sulphury than AC Metcalfe controls.

Summary of Barley Malting and Brewing Characteristics Compared to AC Metcalfe

CDC Meredith	Comparison to 2012 Crop AC Metcalfe
Barley Analysis	
Barley protein	Desirably lower
Germination energy	Slightly higher
Water sensitivity	Lighter
Water-uptake	Faster
Chitting	Higher
Acrospire growth	Comparable
Malting Performance	
Modification	Good
Extract	Significantly higher
α-amylase	Lower
Diastatic power	Lower
Beta-glucan	Similar
FAN level	Lower
Brewing Performance	
Conversion time	Faster
Lautering time	Good
Extraction efficiency	Good
Fermentability	High
Green = better; Red = poorer; Yellow= comparable results	

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1. Barley Quality Analysis

When these 2012 crop CDC Meredith barley samples arrived at CMBTC, their quality was examined prior to the pilot 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.

Table 1. Barley analysis of 2012 crop CDC Meredith samples received at CMBTC

CDC Meredith	*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 CDC Meredith									
B-12-067	**11.8**	**11.6**	**99**	**87**	**43.0**	**92.29**	**6.02**	**0.91**	**134**
B-12-352	**9.1**	**11.2**	**96**	**86**	**39.5**	**90.15**	**8.36**	**1.43**	**116**
Average	**10.5**	**11.4**	**97.5**	**86.5**	**41.3**	**91.22**	**7.19**	**1.17**	**125**
2012 crop AC Metcalfe									
Mean (n=16)	**11.9**	**12.9**	**97.7**	**77.1**	**40.2**	**86.53**	**9.77**	**2.51**	**82**

The CDC Meredith barley samples of 2012 crop showed normal appearance and showed no noticeable signs of mould infection and/or serious staining. The CDC Meredith barley samples exhibited good moisture contents, desirable grain protein contents, and good germination energy with some water sensitivity, as well as acceptable thousand kernel weight and very good plumpness (Table 1). In addition CDC Meredith barley samples showed high RVA values, which suggested that good storability could be expected from 2012 crop CDC Meredith barley. The barley test results indicated that these two CDC Meredith barley samples had selectable quality for malting use.

In comparison with AC Metcalfe barley of 2012 crop, on average, CDC Meredith barley samples showed significantly lower grain moisture and protein content, comparable germination energy and lighter water sensitivity, as well as significantly higher thousand kernel weight and plumpness. In addition, CDC Meredith barley's RVA values were significantly higher than AC Metcalfe; therefore, better storability could be expected for 2012 crop CDC Meredith barley than 2012 crop AC Metcalfe.

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2. Pilot Malting Trials

Pilot malting trials were conducted on these two 2012 crop CDC Meredith barley samples. All of the malting trials were carried out with a batch size of 60kg cleaned barley using CMBTC's pilot malting system. The processing conditions used for these trials are given in Box 1.

Box 1. Malting conditions for CDC Meredith barley trials

STEEPING CYCLES

42 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, Day 3 & Day 4 @ 14°C

KILNING CONDITIONS

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

Water uptake, chitting and acrospires growth:

In the pilot malting trials, under the given processing conditions, these two 2012 crop CDC Meredith barley samples did not show any difficulties in processing. A steep the CDC Meredith barley samples showed good water-uptake and chitted well; both barley samples obtained satisfactory steep-out moisture contents and excellent chitting rates at the end of steep (Table 2). During germination, CDC Meredith barley samples showed good growth of acrospires and good progress in modification. In comparison with 2012 crop AC Metcalfe, CDC Meredith barley samples showed faster water-uptake, higher chitting rate but slower growth of acropires.

Table 2. Average steep-out moisture content, chitting rate and growth of acrospires of 2012 crop CDC Meredith barley

	Steep-out Moisture	Chitting rate	Acrospire length @96 hrs				
	(%)	(%)	0-¼ (%)	¼-½ (%)	½-¾ (%)	¾-1 (%)	>1 (%)
2012 crop CDC Meredith							
Average	45.2	100	0	0	2.5	82.5	15
2012 crop AC Metcalfe							
Mean (n-16)	43.7	97	0	0	9	70	21

The charts below detail the malting process in germination and kilning.

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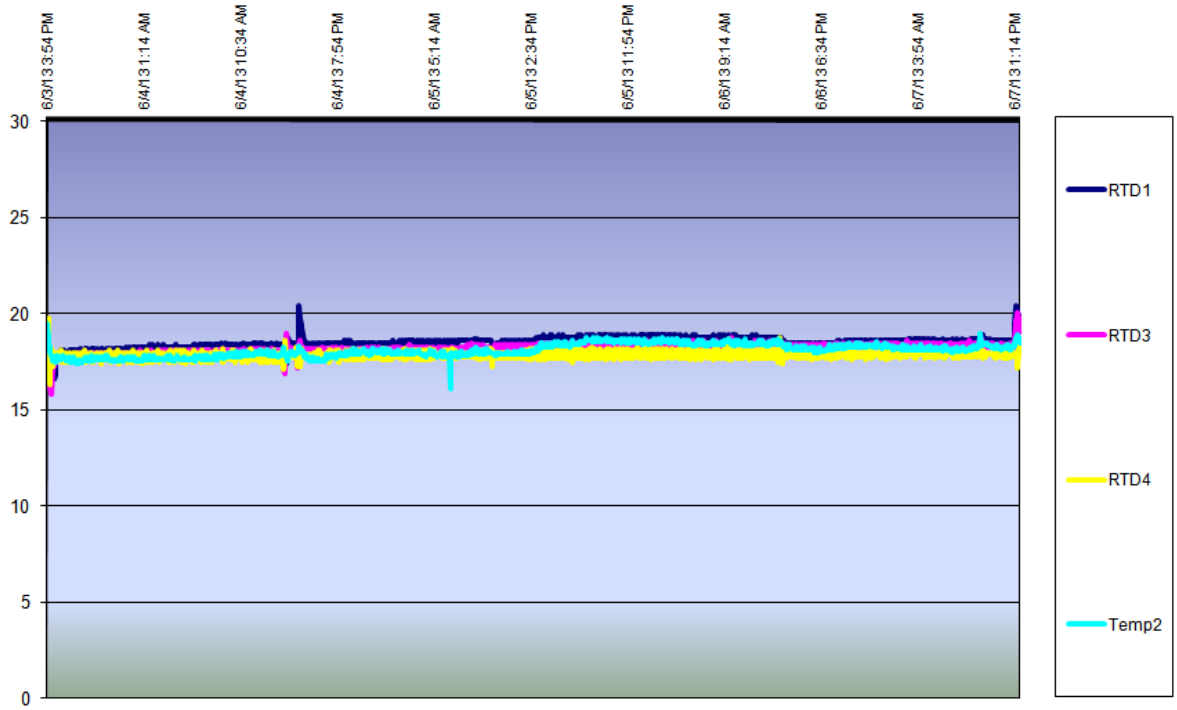
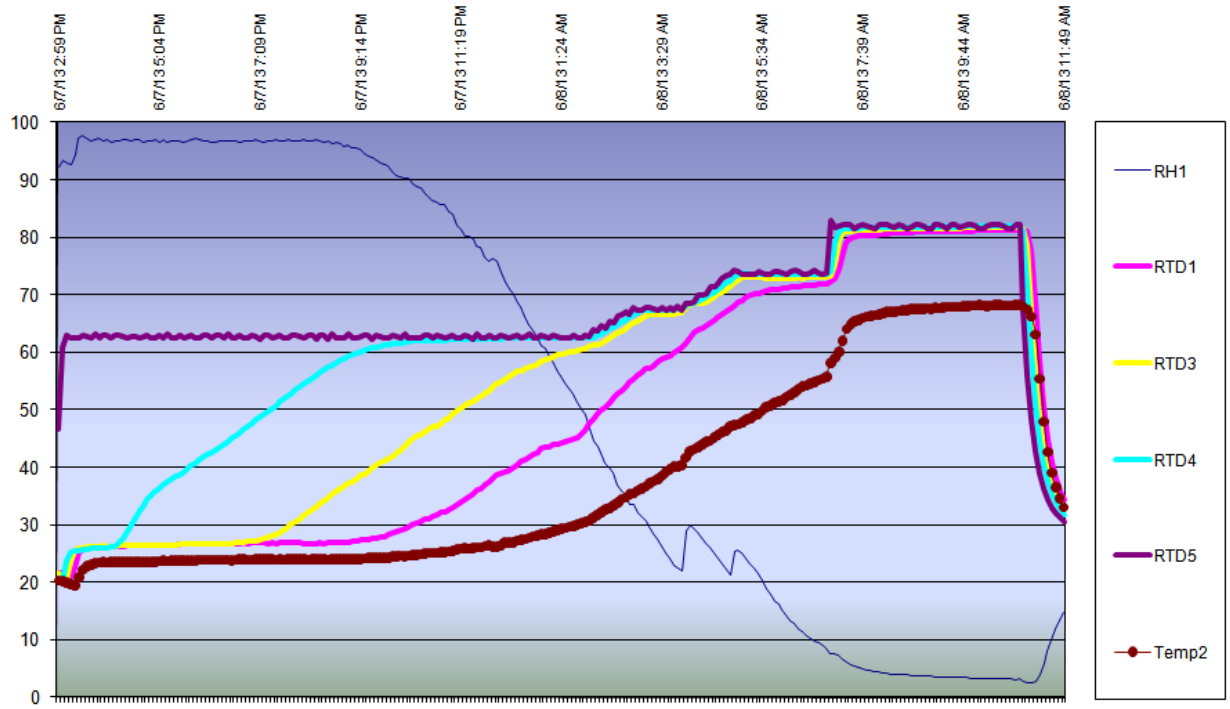
PM-13-017 Germination



PM-13-017 Kilning



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Complete malt analysis was carried out for these pilot malting trials, and the analytical results are given in Table 3. For comparison, the table also includes the average malt analysis for the pilot trials carried out at CMBTC with 2012 crop AC Metcalfe barley samples.

Table 3. Analysis of malts generated from the pilot malting trials with 2012 crop CDC Meredith barley samples

Parameter	2012 crop CDC Meredith			2012 AC Metcalfe
	PM-12-061	PM-13-017	Mean	Mean (n=16)
Malt moist, %	4.4	4.3	4.4	4.3
Friability, %	82.0	82.0	82.0	80.3
Fine-extract, %	81.9	80.6	81.3	80.7
Coarse-extract, %	80.9	79.2	80.1	79.7
F/C Difference, %	1.0	1.4	1.2	1.0
Soluble protein, %	4.93	4.94	4.94	5.40
Total protein, %	11.4	11.3	11.30	12.5
Kolbach Index, %	43.2	43.8	43.8	43.6
Beta-Glucan, ppm	149	176	162	155
Viscosity,cp	1.46	1.46	1.46	1.46
Diastatic power, °L	142	126	134	158
α-Amylase, D.U.	58.4	57.9	58.2	68.3
Limit Dextrinase, *mu/g*	349	342	346	365
Wort colour, ASBC	2.15	2.81	2.48	2.34
Wort pH	5.91	5.89	5.90	5.93
Fan, mg/L	181	188	185	203

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Malting Summary

- ***General modification:*** The values for friability, F/C difference, and soluble protein content all suggested that under the given trial condition these 2012 crop barley samples of CDC Meredith produced malts with good modification. Attention must be paid when processing 2012 crop CDC Meredith barley to ensure proper modification and beta-glucan breakdown.

- ***Extract yield and enzyme levels:*** The malts produced from the 2012 crop CDC Meredith barley samples showed very good extract yield and good levels of enzymes. In comparison with the trial averages of 2012 crop AC Metcalfe, CDC Meredith malts exhibited higher extract yield and lower levels of α-amylase, diastatic power and limit dextrinase than the trial average of 2012 crop AC Metcalfe.

- ***Soluble protein, free amino nitrogen (FAN) and malt colour:*** The malts produced from the 2012 crop CDC Meredith barley samples exhibited good protein solubilisation as indicated by soluble protein, Kolbach Index and FAN, though their soluble protein content and FAN levels were lower than the trial averages of 2012 crop AC Metcalfe. CDC Meredith malts developed good malt color, which was slightly higher than the trial average of 2012 crop AC Metcalfe.

- ***Beta-glucan content and wort viscosity:*** 2012 crop CDC Meredith barley showed slower beta-glucan breakdown during processing, as a result, the produced malts showed elevated beta-glucan contents, which were slightly higher than that required by brewing companies (<150ppm), however, their wort viscosity was within the acceptable ranges. In comparison with the trial averages 2012 crop AC Metcalfe, CDC Meredith malts showed higher beta-glucan content and comparable wort viscosity.

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Comments on the malting process

During the malting process, no difficulties were recorded for the 2012 crop CDC Meredith barley samples. The barley samples were processed under normal processing conditions that were used for quality evaluation of Canadian two-rowed 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 growth of acrospires and protein breakdown. In kilning a lower curing temperature (80-82°C) should be considered to avoid excessive malt color formation.

3. Pilot-brewing Trials

CDC Meredith malt samples from the pilot malting trials were brewed in CMBTCs 300L Pilot Brewery. The following is the brewing and fermentation conditions for the brewing trials with the CDC Meredith malt samples.

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

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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 -2°C, and packaged
- Pasteurized to 15 PU

Figures 1 through 4 detail the first brewing trial with CDC Meredith malt sample.

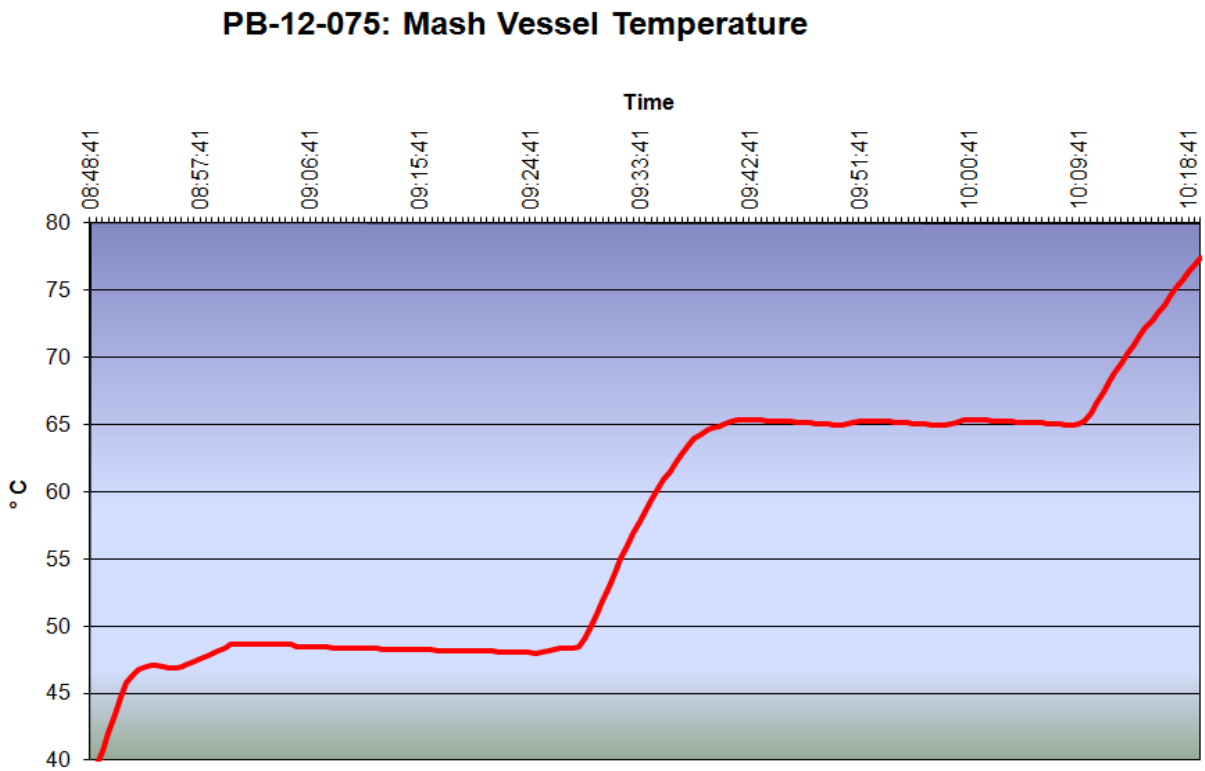

Figure 1: Mash Temperature Profile (temperature versus time)

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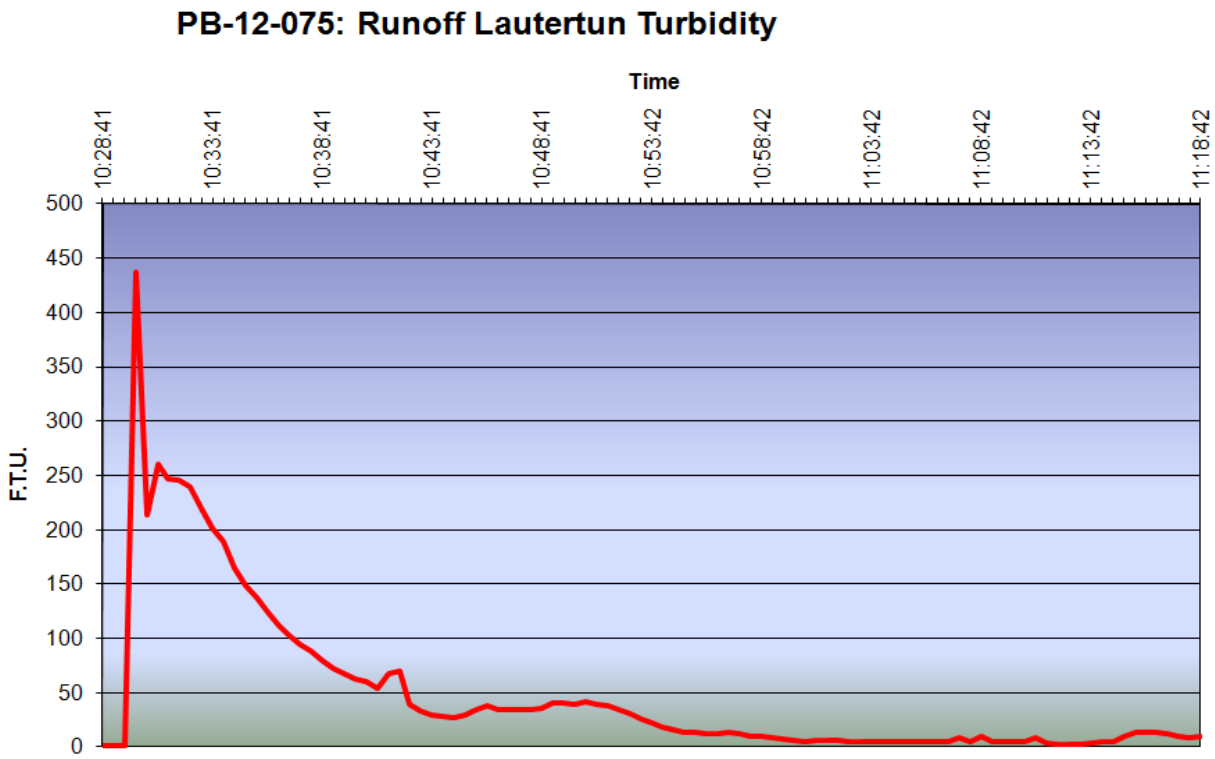

Figure 2: Runoff Turbidity (turbidity FTU versus time)

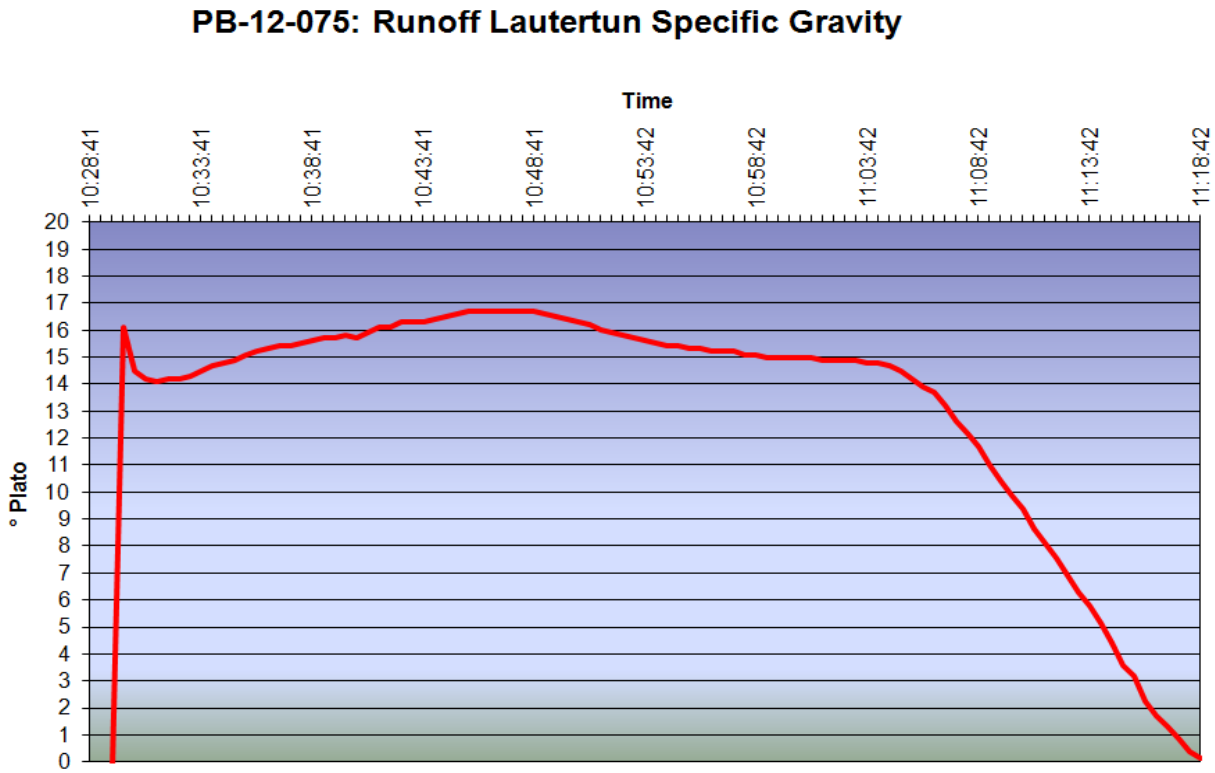

Figure 3: Runoff Specific Gravity (°Plato versus time)

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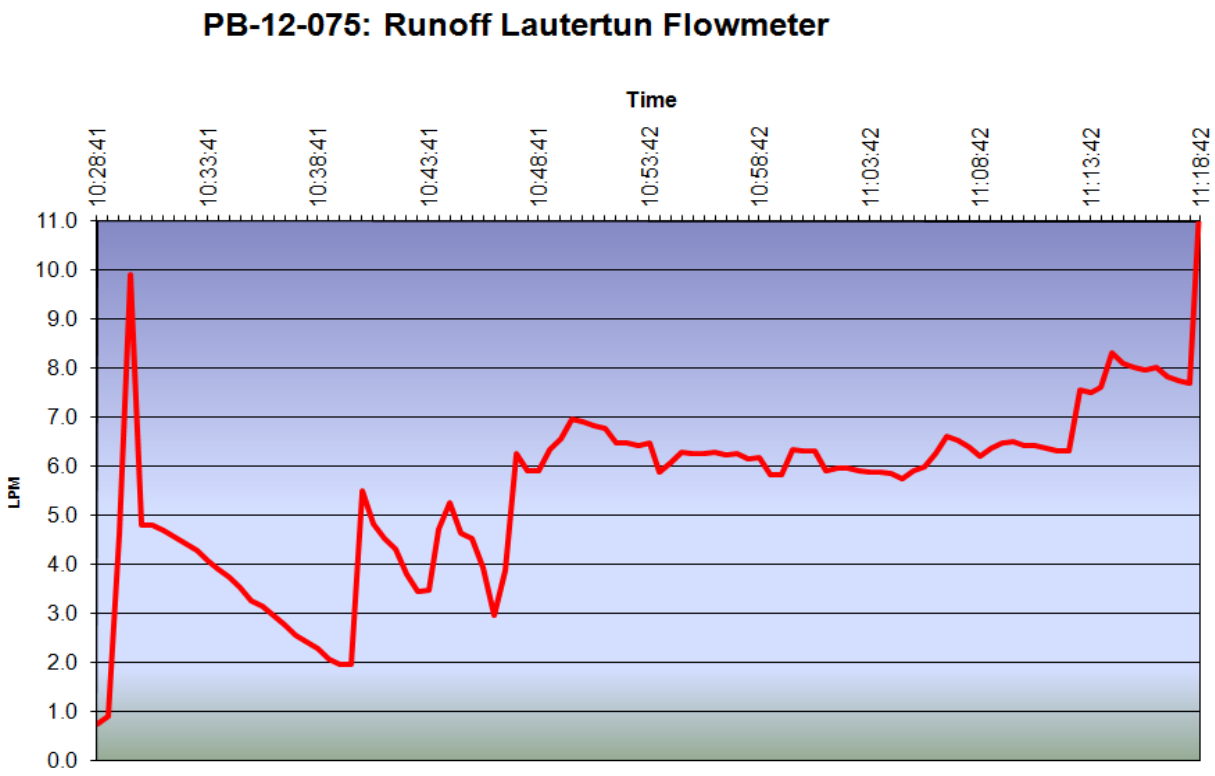

Figure 4: Runoff Flowrate (l/minute versus time)

The brewing results are given in Tables 4 to 8. Tables also contain average values for 2012 crop AC Metcalfe trials for comparison.

Table 4. Main Brewhouse observations for pilot brewing trials

Parameter	CDC Meredith PM-12-061 PB-12-075	CDC Meredith PM-12-089 PB-13-001	CDC Meredith 2012 Mean	AC Metcalfe 2012 Mean
Conversion time (min.)	13	21	17	16.8
Time to clear (min.)	7	7	7	6.6
Lautering time (min.)	43	39	41	39.4
Malt Material Yield (%)	89.6	90.2	89.9	89.0
Wort pH	4.96	5.30	5.13	5.20
Wort Colour (SRM)	2.90	4.11	3.51	4.72

In the brewhouse, 2012 crop CDC Meredith recorded comparable average conversion time to the 2012 crop AC Metcalfe average. Conversion time is a metric that is

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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 in lautering was very good, and was comparable to the averages of 2012 crop AC Metcalfe. 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, which provides better quality beer and also allows for better capacity utilization in fermentation. The time to obtain wort that is clear (less than 100 FTU) is therefore related to capacity and manpower utilization.

Average lautering time for 2012 crop CDC Meredith was slightly longer than 2012 AC Metcalfe averages. 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 Yield was very good, and on average slightly higher than the 2012 crop AC Metcalfe averages. Malt Material Yield shows the 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.

Wort clarity and break in the wort kettle were good and comparable to the controls. Wort clarity and good protein precipitation is related to improved colloidal stability of the final product.

The wort pH values were typical for the wort samples derived from barley malts, and slightly lower than the averages of 2012 AC Metcalfe samples. Wort pH is related to beer flavour stability, the higher the pH the more flavour stable the beer is through time. However, the pH cannot be too high or else the possibility of flavour changes increases and microbiological infection can occur.

CDC Meredith recorded a somewhat lower average wort colour than the 2012 crop AC Metcalfe. Wort colour is positively correlated to the barley protein content, as well as malt colour and malting processing conditions. Most international brewers are looking for a lower pale colour to be derived from the malt, so the lower the better.

Wort taste was acceptable. This is a quick test to look for off-flavours. The wort should be malty, sweet with no off-flavours.

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Table 5. Wort sugar concentration for the brewing trials (mg/L)

Parameter	CDC Meredith PM-12-061 PB-12-075	CDC Meredith PM-12-089 PB-13-001	CDC Meredith 2012 Mean	AC Metcalfe 2012 Mean
Maltotetrose	2.35	2.77	2.56	2.81
Maltotriose	14.42	16.16	15.29	14.63
Maltose	55.15	59.36	57.25	58.09
Glucose	13.11	14.52	13.81	14.96
Fructose	2.29	2.68	2.48	3.15

Acceptable wort sugar spectrum was recorded for the average of 2012 crop CDC Meredith (Table 5). It had generally comparable both unfermentable and fermentable sugars to the averages of 2012 crop AC Metcalfe.

Table 6. Fermentation observations for the brewing trials

Parameter	CDC Meredith PM-12-061 PB-12-075	CDC Meredith PM-12-089 PB-13-001	CDC Meredith 2012 Mean	AC Metcalfe 2012 Mean
Attenuation Limit (%)	89.5	90.8	90.2	86.88

The average fermentability of the worts produced from 2012 crop CDC Meredith (Table 6) was outstanding and higher than the average for 2012 crop AC Metcalfe. 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 fermentability the better.

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Table 7. Final beer analysis for the brewing trials

Parameter	CDC Meredith PM-12-061 PB-12-075	CDC Meredith PM-12-089 PB-13-001	CDC Meredith 2012 Mean	AC Metcalfe 2012 Mean
Apparent Ext. (Plato)	1.29	1.26	1.27	1.56
Real Ext. (Plato)	3.20	3.15	3.17	3.39
Alcohol (v/v %)	5.22	5.18	5.20	5.00
Color (ASBC)	2.73	3.00	2.86	5.27
pH	4.06	4.24	4.15	4.33
Foam (Nibem)	149	130	139.5	140
Initial Turbidity (FTU)	15.1	17.3	16.2	20.0
Chill Turbidity (FTU) 24 Hr	15.9	18.2	17.1	23.3

CDC Meredith malt produced beer with good quality. Apparent and real extracts were acceptable and slightly lower than the 2012 AC Metcalfe controls, while alcohol in final beer was somewhat higher. This was expected owing to the outstanding fermentability. Average beer colour for 2012 crop CDC Meredith samples was significantly lower than the control averages, while the final pH was slightly lower than 2012 AC Metcalfe controls. 2012 crop CDC Meredith beer had comparable foam stability to the averages of 2012 AC Metcalfe controls. The initial and chill turbidities were good, and lower than the controls, indicating good physical and colloidal stability.

Average beer organoleptic data is presented in Table 8 and Figure 5. CDC Meredith beer had on average comparable body, and was less sweet and sulphury than AC Metcalfe controls. Overall quality was better than the control AC Metcalfe.

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Table 8. Final beer organoleptic property data

Parameter	CDC Meredith PM-12-061 PB-12-075	CDC Meredith PM-12-089 PB-13-001	CDC Meredith 2012 Mean	AC Metcalfe 2012 Mean
Freshness	2.61	2.39	2.50	2.63
Body	1.68	2.04	1.86	1.88
Flavour	1.86	1.86	1.86	2.15
Smoothness	2.21	2.11	2.16	2.30
Hop Aroma	1.14	1.43	1.29	1.18
Hop Bitterness	1.57	1.64	1.61	1.70
Estery	1.86	1.64	1.75	1.65
Cereal	1.68	2.04	1.86	1.96
Turbidity	0.75	0.50	0.63	0.97
Sour	1.50	1.50	1.50	1.38
Sweet	0.96	1.07	1.02	1.32
Sulphury	0.75	1.11	0.93	1.06
Overall Quality	2.46	2.36	2.41	2.28

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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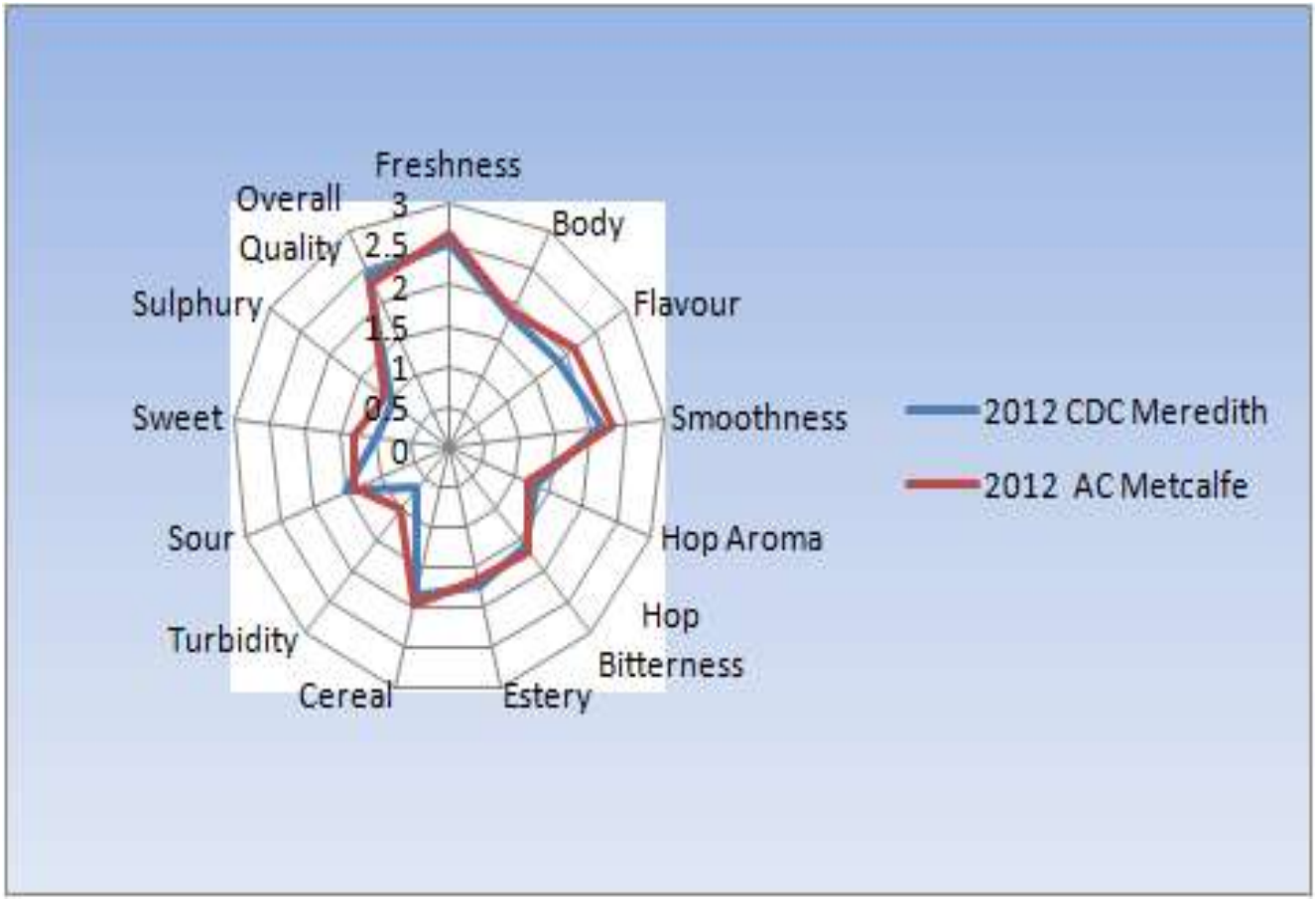

Figure 9. Final beer organoleptic property

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