

2013

2012 crop CDC Landis Malting and Brewing Trials



CMBTC

6/19/2013

Report of the Malting and Brewing Trials with 2012 Crop CDC Landis Barley Sample

Summary

Pilot malting and pilot brewing trials were conducted at CMBTC with CDC Landis barley provided to CMBTC by the Fedoruk Seeds, Kamsack, Saskatchewan. This barley sample was collected from 2012 harvest. The objective of this study was to examine the malting and brewing performances of this CDC Landis barley sample under the trial processing conditions that are currently used at CMBTC for evaluating new crop barley samples.

This 2012 crop CDC Landis sample showed normal appearance and no noticeable signs of mould infection and/or serious staining. Unfortunately, it showed undesirably high moisture content and protein content. Its moisture content was higher than the levels required for safe storage (<13.5%), and its protein content was higher than that required for malting use (\leq 13.5%). However, this CDC Landis sample exhibited very good germination energy but recorded strong water sensitivity. Its thousand kernel weight was excellent, and its plumpness was very low. The RVA test result suggested that this CDC Landis barley sample did not suffer from significant pre-harvest sprouting; therefore, good storability could be expected from this barley. In comparison with 2011 crop CDC Landis, this CDC Landis showed poorer overall quality. ***Because of growing site conditions excess moisture resulted in abnormally high barley protein. This site was the only one to grow CDC Landis in 2012 and the decision was made to go ahead and malt this sample, despite the higher protein.***

In the pilot malting trials, CDC Landis barley did not show abnormalities in processing. It did produce malts with unsatisfactory quality; the malts developed good soluble protein, good FAN and adequate enzymes but the friability, KI, extract yield and beta-glucan content were less than desirable. The unbalanced malt quality was mainly due to the higher barley protein content, too high for regular malting use. Despite the malt being unbalanced in quality, pilot brewing was still done.

In the brewhouse, 2012 crop CDC Landis recorded somewhat shorter average conversion time than the 2012 crop AC Metcalfe average. Time for wort to clear to less than 100 FTU in lautering was excellent, and was significantly shorter than the averages of 2012 crop AC Metcalfe. Average lautering time for 2012 crop CDC Landis was slightly shorter than 2012 AC Metcalfe averages. Malt Material Yield was very good, and on average comparable to 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 higher than the averages of 2012 AC Metcalfe samples. CDC Landis recorded a slightly 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 Landis. It had slightly lower unfermentable and fermentable sugars than the averages of 2012 crop AC Metcalfe, although this was expected given higher barley protein (more protein = less extract). The average fermentability of the worts produced from 2012 crop CDC Landis was good and comparable to the average for 2012 crop AC Metcalfe. **Considering that the barley protein was high, and that the malt produced was unbalanced, the brewing results were surprisingly positive.**

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

Overall Summary of Barley, Malting and Brewing Characteristics Of 2012 CDC Landis versus 2012 AC Metcalfe

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

1. Barley Quality Analysis

When the CDC Landis barley sample arrived at CMBTC, its quality was examined immediately. The test results are given in Table 1. Please note that except for the germination testing all the results given in Table 1 were generated from a single test only.

Table 1. Barley analysis of 2012 crop CDC Landis barley

Variety	Moisture, %	Protein, %	Germination, % (4ml)	Germination, % (8ml)	1000 Kernel, wt. g	Over 6/64 sieve, %	Over 5/64 sieve, %	RVA
2012 crop								
CDC Landis B-12-202	14.1	15.1	99	59	46.3	80.75	16.03	153
2011 crop								
CDC Landis	13.7	12.8	100	97	53.5	99.75	0.16	
2012 crop AC Metcalfe								
Mean (n=16)	11.9	12.9	97.7	77.1	40.2	86.53	9.77	82

This 2012 crop CDC Landis sample showed undesirably high moisture content and grain protein contents (Table 1). Its moisture content was higher than the levels that required for safe storage (<13.5%); and its grain protein content was higher than that required for malting use ($\leq 13.5\%$). However, This 2012 CDC Landis barley sample exhibited very good germination energy but exhibited strong water sensitivity. Its thousand kernel weight was excellent and its plumpness was average. It showed very high RVA value, which suggested that this CDC Landis barley sample did not suffer from any pre-harvest sprouting damages; as a result, good storability could be expected from this barley. Despite the higher protein content we decided to continue pilot trials since we did not have any other samples of 2012 crop CDC Landis.

In comparison with 2011 crop CDC Landis barley sample, this 2012 crop CDC Landis barley sample exhibited significantly higher moisture content and grain protein content; its germination energy was comparable and its water sensitivity was significantly stronger; its thousand kernel weight and plumpness were significantly lower than 2011 crop CDC Landis barley. When compared to 2012 crop AC Metcalfe the 2012 CDC

Landis showed better germination, higher 1000 kernel weight and more positive RVA values.

2. Pilot Malting Trial

Three pilot-malting trials of 55 kg cleaned barley each were conducted on this 2012 crop CDC Landis with CMBTC's 80 kg pilot malting system using the trial malting conditions are detailed in Box 1. Conditions were changed in order to account for the higher barley protein content.

Box 1. Processing conditions for the pilot malting trials

STEERING CYCLE

41 hours (8 Wet-13 Dry- 8Wet-11Dry- 1Wet) at 15 °C

GERMINATION CONDITIONS

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

KILNING CONDITIONS

A 24 hour cycle with a 4-hour curing phase at 82°C

Water uptake, chitting and acrospire growth:

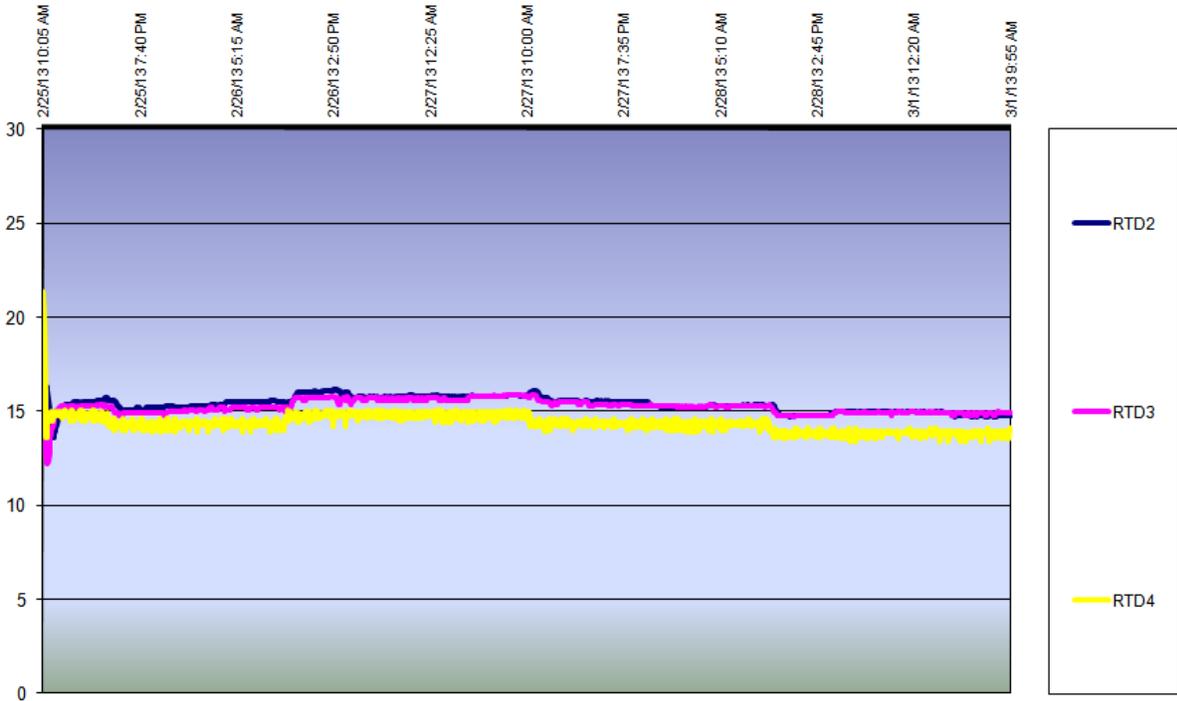
Under the given malting conditions, this 2012 crop CDC Landis barley did not exhibit any processing abnormalities in the malting trials. At steep it showed good water-uptake and good chitting; at the end of steep it obtained satisfactory steep-out moisture contents and good chitting rates (Table 2). Those rates were comparable to 2012 crop AC Metcalfe. During germination it showed normal growth of acrospires, again similar to that of AC Metcalfe.

Table 2. Steep-out moisture content, chitting rate and growth of acrospires for 2012 crop CDC Landis barley

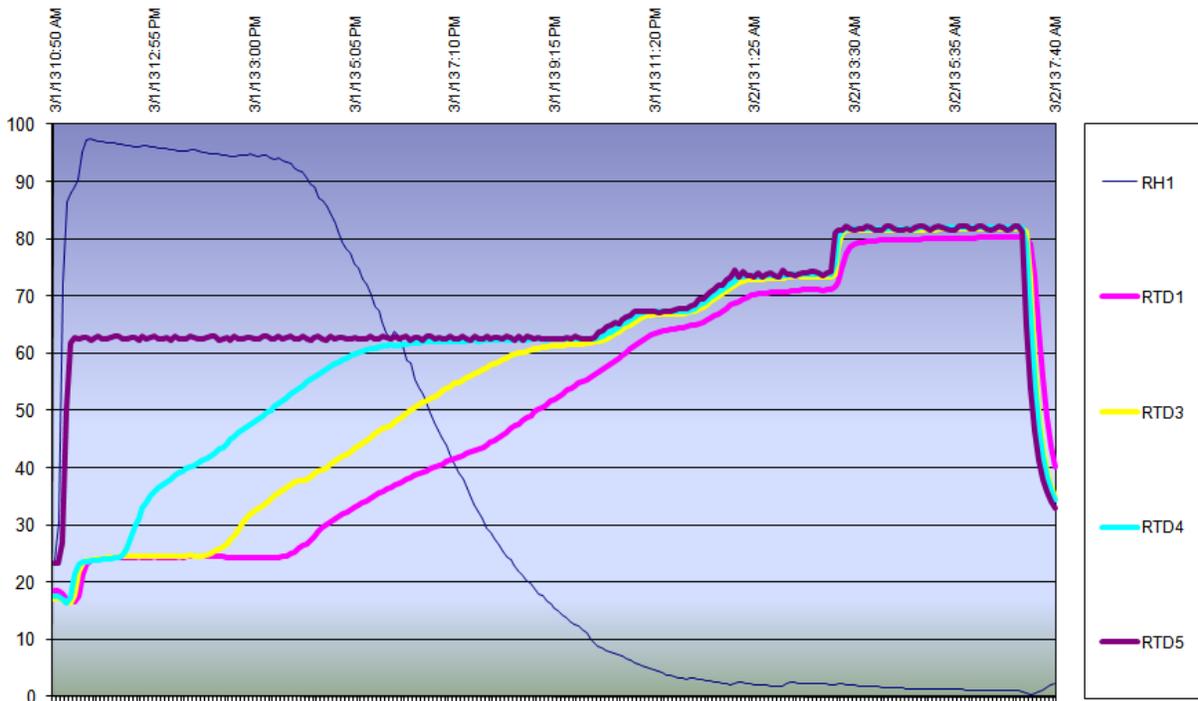
	Steep-out Moisture (%)	Chitting rate (%)	Acrospire growth length @96 hrs				
			0-1/4 (%)	1/4-1/2 (%)	1/2-3/4 (%)	3/4-1 (%)	>1 (%)
2012 crop CDC Landis							
PM-12-085	46.2	96.7	0	0	15	75	10
PM-12-074			0	0	0	95	5
PM-12-093			0	0	30	70	0
Mean	43.5	95.5	0.0	0.0	15.0	80.0	5.0
2012 crop AC Metcalfe							
Mean	43.7	97.0	0	0	9.0	70.0	21

The following two figures detail a typical germination cycle and kilning cycle for the trials detailing the temperature profile as well as relative humidity.

PM-12-085 Germination



PM-12-085 Kilning



Complete malt analysis was carried out for the malts produced from these pilot malting trials, and the test results are given in Table 3. For comparison, the table also includes the malt analysis for 2011 crop CDC Landis malting trial and averaged malt analysis of 2012 crop AC Metcalfe.

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

Parameter	2012 crop CDC Landis				2011 Crop CDC Landis	2012 crop AC Metcalfe
	PM-12-074	PM-12-085	Mean (n=16)	Mean	PM-12-008	Mean (n=16)
Malt moist, %	4.2	4.1	4.4	4.2	4.5	4.3
Friability, %	53.9	62.5	57.7	58.0	75.1	80.3
Fine-extract, %	76.1	77.1	76.5	76.6	81.5	80.7
Coarse-extract, %	74.9	75.8	75.3	75.3	80.4	79.7
F/C Difference, %	1.2	1.3	1.2	1.2	1.09	1.0
Soluble protein, %	4.72	5.39	4.69	4.93	5.32	5.40
Total protein, %	15.3	15.38	15.44	15.4	12.8	12.5
Kolbach Index, %	30.8	35.1	30.4	32.1	41.6	43.6
Beta-Glucan, ppm	188	112	180	160	191	155
Viscosity, cps	1.44	1.43	1.44	1.44	1.46	1.46
Diastatic power, °L	135	153	132	140	143	158
α -Amylase, D.U.	56.0	60.6	56.9	57.8	57.3	68.3
Limit Dextrinase (mu/g)				286		414.2
Wort color, ASBC	2.59	2.72	2.46	2.59	2.45	2.34
Wort pH	5.87	5.90	5.91	5.89	5.90	5.93
Fan, mg/L	176	203	166	182	203	203

Malting Summary

- **Overall modification:** In the three malting trials the 2012 crop CDC Landis barley samples produced malts with unbalanced modification. The malts showed low friability, low KI and elevated beta-glucan content; in contrast, the values for F/C difference, soluble protein content and enzymes suggested the malts had acceptable modification. Again this was expected because of the higher barley protein content.
- **Extract yield and enzyme levels:** The malts produced from this 2012 CDC Landis barley exhibited very low extract yield but good enzymes; its extract yield was significantly lower than 2011 CDC Landis and 2012 AC Metcalfe; and its α -amylase and diastatic power levels were comparable to 2011 crop CDC Landis but lower than 2012 crop AC Metcalfe.
- **Soluble protein, free amino nitrogen (FAN) and malt color:** The malts produced from this 2012 CDC Landis barley sample exhibited acceptable soluble protein content but its overall protein solubilisation was not acceptable as indicated by the very low KI value. Please note that the low KI value was mainly due to the high total malt protein content. Its soluble protein content and KI were significantly lower than 2011 crop CDC Landis and 2012 crop AC Metcalfe. The malts developed good levels of FAN and malt colour. The FAN levels for 2012 crop CDC Landis were lower than 2011 crop CDC Landis and 2012 crop AC Metcalfe, and the malt color was slightly higher than 2011 crop CDC Landis and lower than 2012 crop AC Metcalfe.

1. Pilot-brewing Trials

CDC Landis 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 Landis malt samples. Only the first Landis sample (PB-12-079) was filtered and bottled. The second (PB-13-003) and third (PB-13-009) samples were brewed and only the overnight fermentation samples were collected and analyzed.

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 13.5°C, pitched with lager yeast at 1.25 million cells per mL
- Fermented for 7 days (3 days at 13.5°C and 4 days at 15°C)
- Cooled and stored at -0.5 °C for 7 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

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

PB-12-079: Mash Vessel Temperature

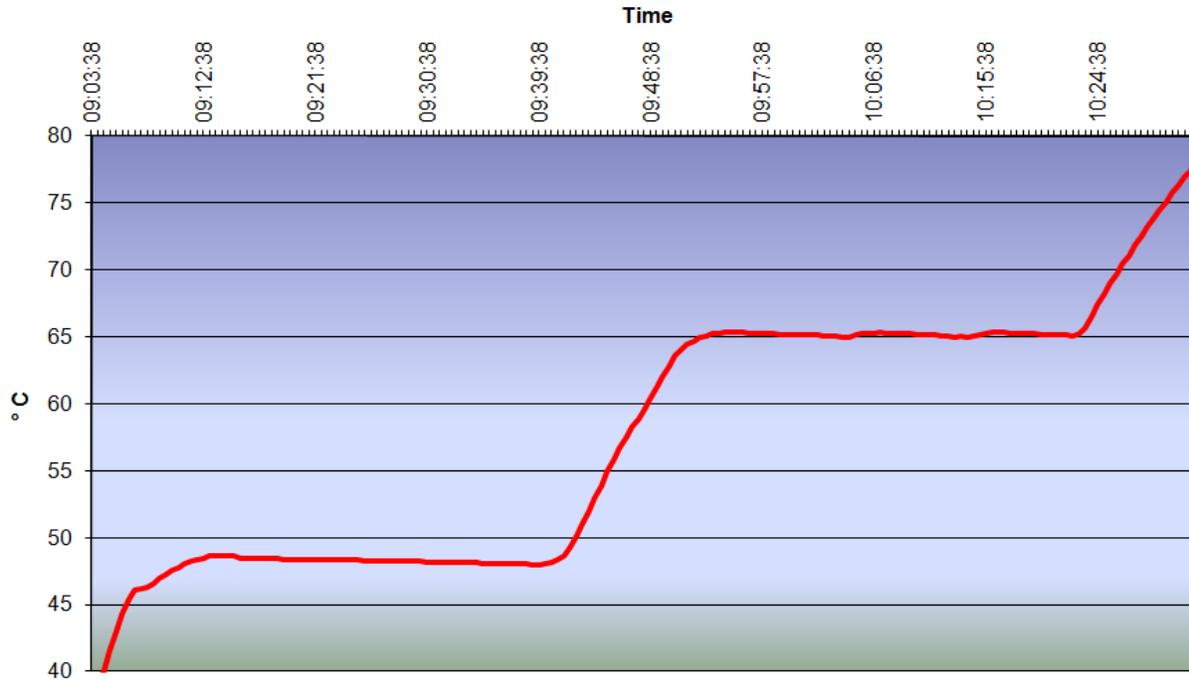


Figure 1: Mash Temperature Profile (temperature versus time)

PB-12-079: Runoff Lautertun Turbidity

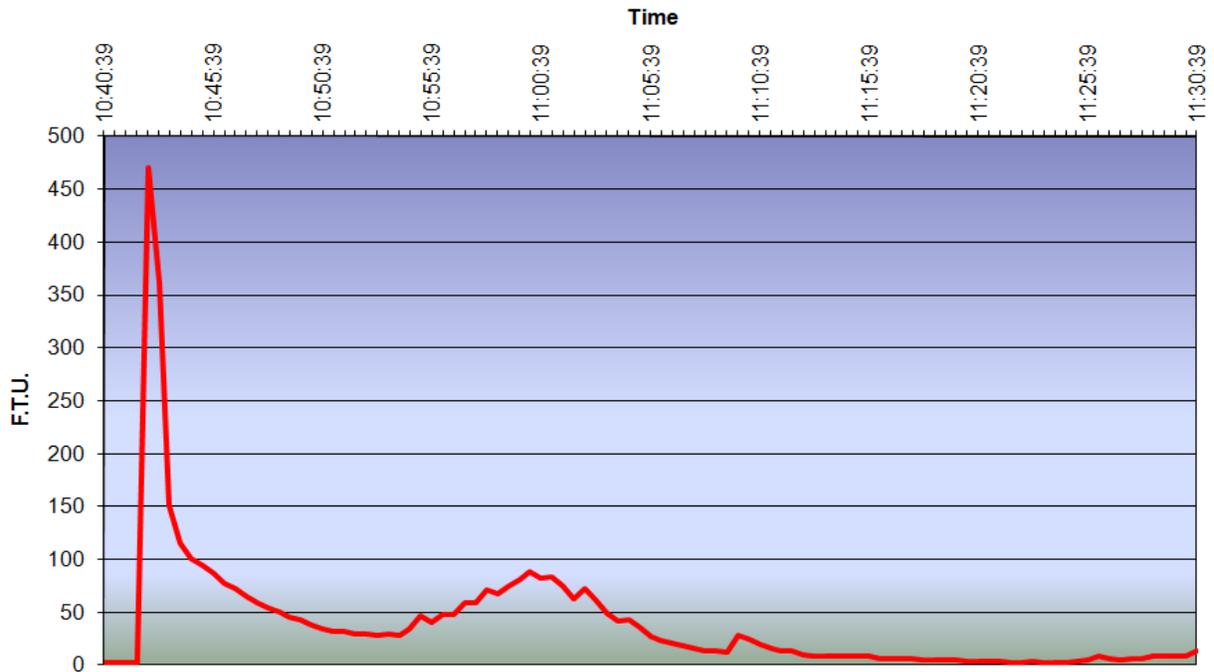


Figure 2: Runoff Turbidity (turbidity FTU versus time)

PB-12-079: Runoff Lautertun Turbidity

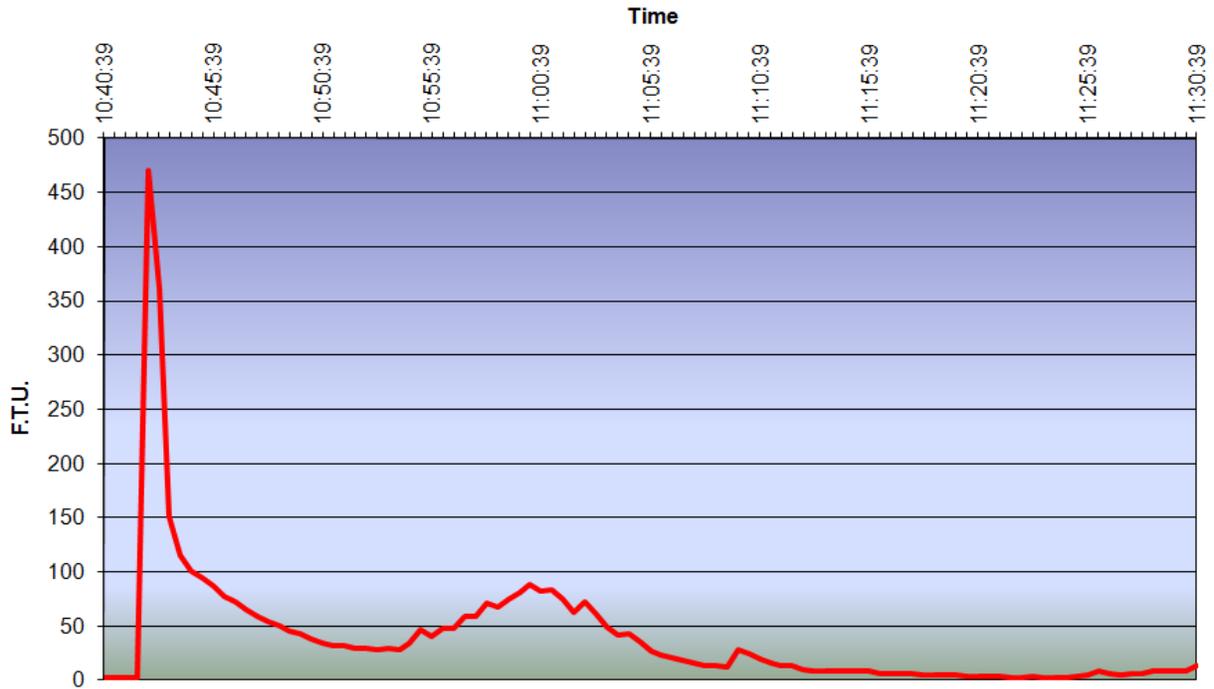


Figure 3: Runoff Specific Gravity (°Plato versus time)

PB-12-079: Runoff Lautertun Flowmeter

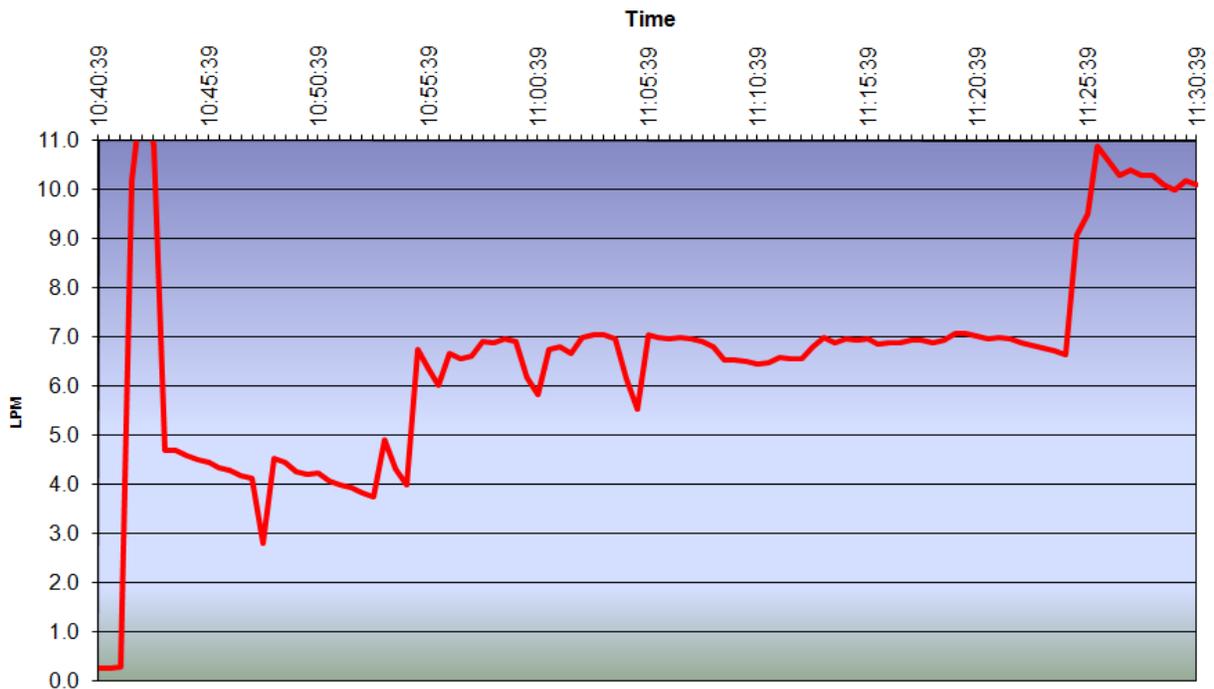


Figure 4: Runoff Flowrate (l/minute versus time)

The brewing malting 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 Landis PM-12-074 PB-12-079	CDC Landis PM-12-085 PB-13-003	CDC Landis PM-12-093 PB-13-009	CDC Landis 2012 Mean	AC Metcalfe 2012 Mean
Conversion time (min.)	13	12	16	13.7	16.8
Time to clear (min.)	2	1	1	1.3	6.6
Lautering time (min.)	39	38	39	38.7	39.4
Malt Material Yield (%)	87.5	91.1	88.9	89.2	89.0
Wort pH	5.17	5.35	5.40	5.31	5.20
Wort Colour (SRM)	4.26	4.02	3.99	4.09	4.72

In the brewhouse, 2012 crop CDC Landis recorded somewhat shorter average conversion time than the 2012 crop AC Metcalfe average. 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 in lautering was excellent, and was significantly shorter than 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 Landis was slightly shorter 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 comparable to 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 higher 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 Landis recorded a slightly 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.

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

Parameter	CDC Landis PM-12-074 PB-12-079	CDC Landis PM-12-085 PB-13-003	CDC Landis PM-12-093 PB-13-009	CDC Landis 2012 Mean	AC Metcalfe 2012 Mean
Maltotetrose	2.41	2.16	2.36	2.31	2.81
Maltotriose	12.48	13.36	12.42	12.75	14.63
Maltose	48.58	51.89	48.80	49.76	58.09
Glucose	11.84	14.19	11.66	12.56	14.96
Fructose	3.48	3.01	2.66	3.05	3.15

Acceptable wort sugar spectrum was recorded for the average of 2012 crop CDC Landis (Table 5). It had lower unfermentable and fermentable sugars than the averages of 2012 crop AC Metcalfe, again expected because of the inverse relationship between barley protein content and extract content.

Table 6. Fermentation observations for the brewing trials

Parameter	CDC Landis PM-12-074 PB-12-079	CDC Landis PM-12-085 PB-13-003	CDC Landis PM-12-093 PB-13-009	CDC Landis 2012 Mean	AC Metcalfe 2012 Mean
Attenuation Limit (%)	86.16	86.66	85.85	86.22	86.88

The average fermentability of the worts produced from 2012 crop CDC Landis (Table 6) was good and comparable to 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.

Overall in terms of brewhouse performance the CDC Landis malt performed similar to AC Metcalfe despite having unacceptably high barley protein. In fact there were several positives for CDC Landis including faster conversion time, quicker wort clearing and faster lautering time.

Table 7. Final beer analysis for the brewing trials

Parameter	CDC Landis PM-12-074 PB-12-079	AC Metcalfe 2012 Mean
Apparent Ext. (Plato)	1.74	1.56
Real Ext. (Plato)	3.44	3.39
Alcohol (v/v %)	4.66	5.00
Color (ASBC)	3.34	5.27
pH	4.31	4.33
Foam (Nibem)	152	140
Initial Turbidity (FTU)	21.8	20.0
Chill Turbidity (FTU) 24 Hr	23.9	23.3

CDC Landis malt produced beer with good quality. Apparent and real extracts were good and slightly higher than the 2012 AC Metcalfe controls, while alcohol in final beer was somewhat lower. Again this was expected due to the higher barley protein and lower extract. Average beer colour for 2012 crop CDC Landis samples was significantly lower than the control averages, while the final pH was generally comparable to 2012 AC Metcalfe controls. 2012 crop CDC Landis beer had slightly higher foam stability compared to the averages of 2012 AC Metcalfe controls. The initial and chill turbidities were good, and comparable to the controls, indicating good physical and colloidal stability.

Average beer organoleptic data is presented in Table 8 and Figure 5. CDC Landis beer had on average slightly lower body, and was less sweet, estery, grainy and sulphury than AC Metcalfe controls.

Table 8. Final beer organoleptic property data

Parameter	CDC Landis PM-12-074 PB-12-079	AC Metcalf 2012 Mean
Freshness	2.39	2.63
Body	1.50	1.88
Flavour	1.50	2.15
Smoothness	2.39	2.30
Hop Aroma	0.79	1.18
Hop Bitterness	0.93	1.70
Estery	1.43	1.65
Cereal	1.29	1.96
Turbidity	0.89	0.97
Sour	1.00	1.38
Sweet	0.89	1.32
Sulphury	0.43	1.06
Overall Quality	2.43	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

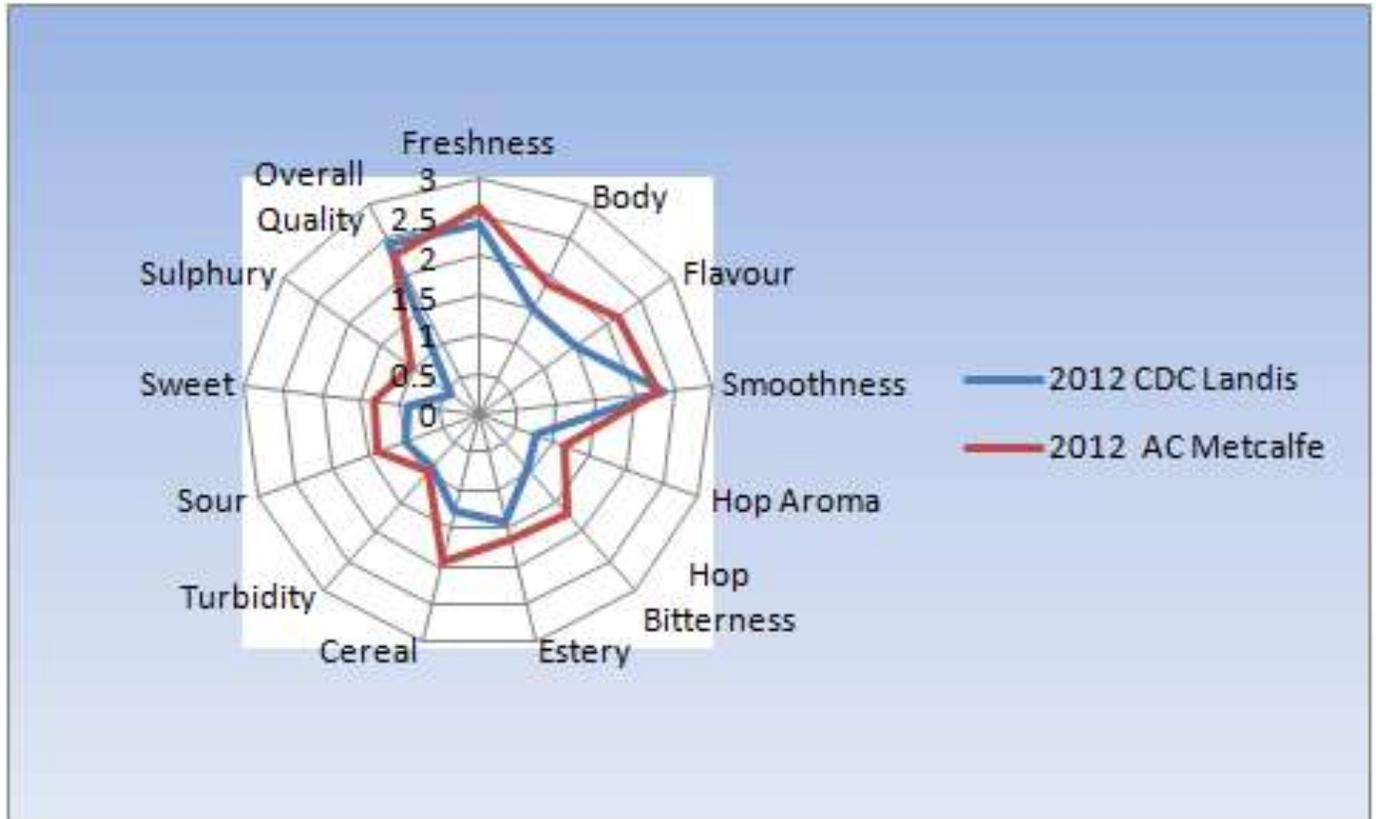


Figure 9. Final beer organoleptic property

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