2014

2013 Crop AAC Synergy Pilot Malting and Brewing Trials

CMBTC

4/4/2014

2013 Crop AAC Synergy Pilot Malting and Brewing Trials

Summary

CMBTC conducted pilot trials on two AAC Synergy barley samples of 2013 crop. These barley samples were provided to CMBTC by Richardson International. The samples were collected from Carseland, Alberta. The objective of this study was to examine quality and malting and brewing performance of the newly harvested AAC Synergy samples against 2013 crop AC Metcalfe and CDC Copeland as controls.

The trial results generated in this study indicated that there were some significant quality differences between this new barley variety vs. AC Metcalfe and CDC Copeland controls. Some of the important quality differences recorded in this study are summarized in the table below:

AAC Synergy quality compared to control AC Metcalfe and CDC Copeland

2013 crop	Compared to CDC Copeland	Compared to AC Metcalfe
Barley Analysis		
Barley grain protein	Significantly lower	Slightly lower
Germination energy	Slightly higher	Higher
Water sensitivity	Lighter	Lighter
Water-uptake	Faster	Comparable
Chitting	Lower	Higher
Acrospire growth	Slower	Comparable
Malting Performance		
Modification	Comparable	Better
Extract	Slightly higher	Slightly higher
α-amylase	Significantly higher	Slightly lower
Diastatic power	Comparable	Significantly lower
Beta-glucan	Significantly lower	Significantly lower
FAN level	Comparable	Significantly lower
Brewing Performance		
Conversion time	Faster	Faster
Lautering time	Comparable	Comparable
Extraction Efficiency	Comparable	Comparable
Fermentability	Higher	Higher
Green = Better	Red = Poorer	Yellow = Comparable results

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Introduction

CMBTC received two AAC Synergy barley samples of 2013 crop from Richardson International for quality testing. These two AAC Synergy barley samples were collected in Carseland, Alberta. One of the two samples suffered from rain damage during harvest. CMBTC examined barley, malting and brewing quality of these two AAC Synergy barley samples. Barley was tested using CMBTC's standard procedures; malting and brewing trials were conducted with the standard trial conditions designed for quality evaluation of 2013 new crop. In this study, AAC Synergy's barley quality, malting and brewing performance were compared against 2013 crop AC Metcalfe and CDC Copeland barley samples.

1. Barley Analysis

When these barley samples arrived at CMBTC, their quality was examined immediately and the test results are given in Table 1. Please note that except for the germination testing, all the results reported in Table 1 were generated from a single test. Barley testing results indicated that there were significant quality differences between these barley samples.

The two AAC Synergy barley samples (Table 1) both showed acceptable grain moisture contents for safe storage (<13.5%), acceptable protein contents, excellent thousand kernel weight and excellent plumpness. Their germination energy was excellent with negligible water sensitivity. Both Synergy barley samples exhibited quality selectable for malting use. In comparison with the controls, AAC Synergy barley showed on average lower grain moisture, lower protein content, higher germination energy, lighter water sensitivity, higher thousand kernel weight and higher plumpness.

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Table 1. Analysis of 2013 crop barley samples

Sample ID	Harvest time	Moisture, %	Protein, %	Germination, % (4ml, n=2)	Germination, % (8ml, n=2)	1000 Kernel wt, g	Sizing, %			RVA
							>6/64 sieve	>5/64 sieve	Thin	
B-13-053 Sample #1	Prior to rain	11.3	10.8	100	97	53.6	97.23	1.81	0.39	150
B-13-054 Sample #2	Post rain	12.2	11.1	99.5	98	54.0	96.1	1.89	0.52	42
Synergy	Mean	11.8	11.0	99.8	97.5	53.8	96.67	1.85	0.46	96
Control										
CDC Copeland	Mean n=4	12.7	11.5	99.3	93.3	52.2	93.60	4.80	0.83	146
AC Metcalfe	Mean n=4	12.6	11.9	98.5	88.6	47.2	93.1	4.89	1.20	122

The high RVA values for sample #1 indicated this AAC Synergy barley did not experience any pre-harvest sprouting damage during harvest, therefore, good storability can be expected from sample #1. In contrast, sample #2 showed very low RVA values, which indicated that this sample had suffered from pre-harvest sprouting damage. As a result, poor storability is expected for sample #2. On average, AAC Synergy's RVA values were lower than the control AC Metcalfe and CDC Copeland due the extremely low RVA values for the Synergy sample #2.

2. Pilot Malting Trial

Using the pilot malting system at CMBTC, a single pilot malting trial was conducted for each one of the two AAC Synergy samples. The malting trials were carried out under the malting conditions given in Box 1, which were similar to those used for quality evaluation of 2013 new crop barley at CMBTC.

Box 1. Details of pilot-malting conditions employed in this study

STEEPING CYCLES

Total 44 hrs (7 hrs Wet- 14 hrs Dry- 7 hrs Wet- 14 hrs Dry-2 hrs Wet) at 14°

GERMINATION CONDITIONS

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

KILNING CONDITIONS

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

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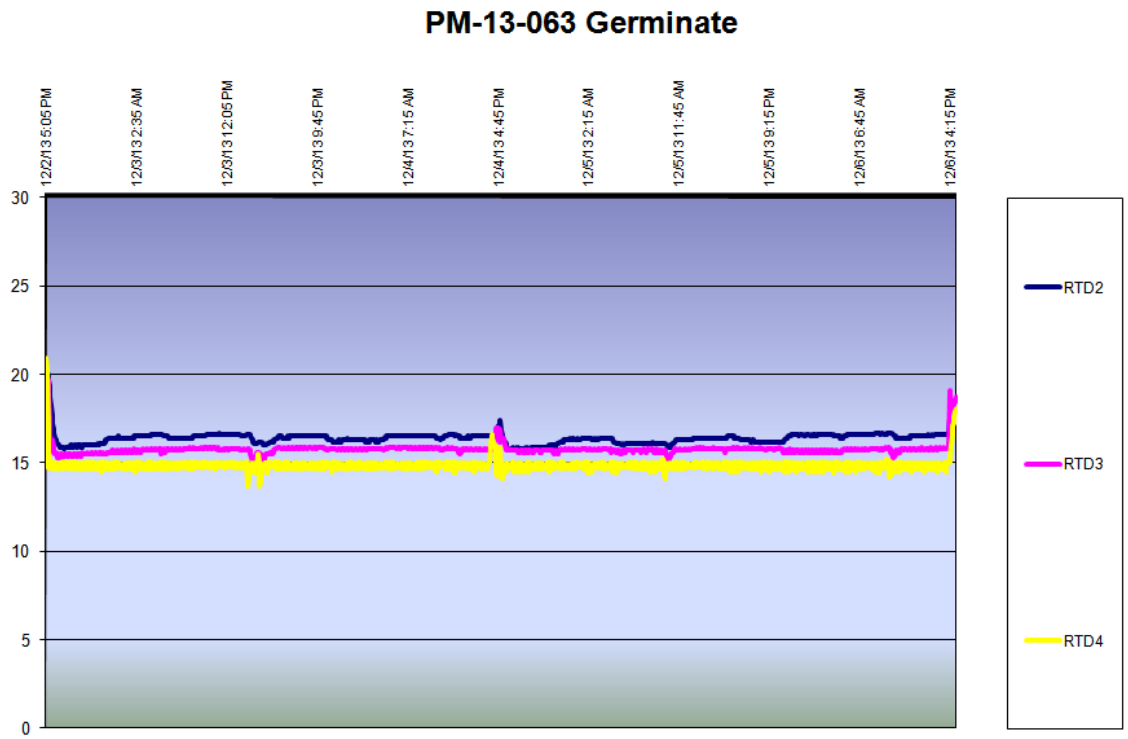
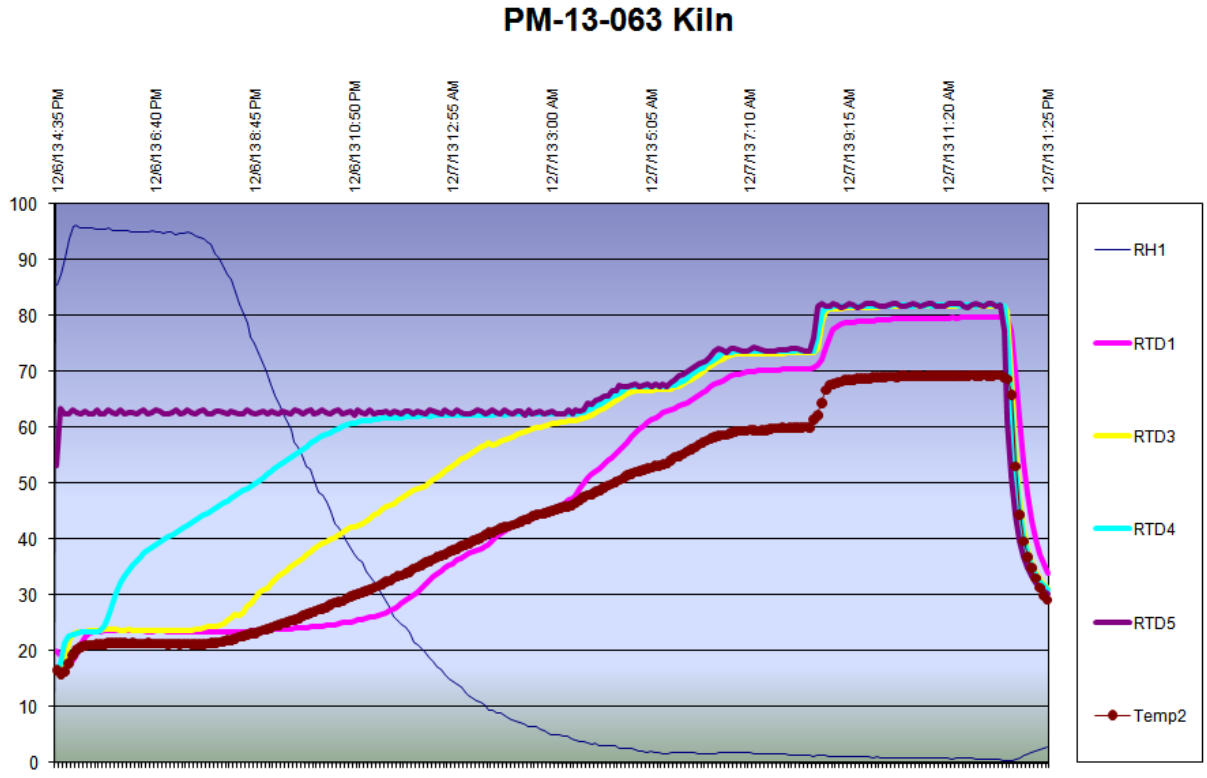
Actual processing conditions recorded in of the pilot trials are given in the two charts below for reference:





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Steep-out moisture, chitting rate and acrospire growth

Under the given malting trial conditions, these two AAC Synergy barley samples did not exhibit any process abnormalities (Table 2). They showed normal water-uptake and normal chitting at steep, and obtained satisfactory steep-out moisture contents and acceptable chitting rates at the end of steep. During germination, these two barley samples showed acceptable growth of acrospires. As expected, some noticeable differences between the two samples in steep-out moisture, chitting rate and growth of acrospires were recorded. Sample #2 (the one that suffered from rain damage) showed faster water-uptake, higher chitting rate and faster acrospire growth than sample #1 (the sound sample with no pre-harvest sprouting damage).

In comparison with the two controls, Synergy barley showed on average faster water-uptake than CDC Copeland but was comparable to AC Metcalfe. Average chitting rate was lower than Copeland but slightly higher than Metcalfe. Its acrospire growth was slower than Copeland and comparable to Metcalfe.

Table 2. Steep-out moisture, chitting rate and acrospire growth profile of 2013 crop barley samples

Variety	Pilot-malting #	Steep-out Moisture	Chitting rate	Acrospire length @96 hrs				
		(%)	(%)	0-¼ (%)	¼-½ (%)	½-¾ (%)	¾-1 (%)	>1 (%)
AAC Synergy								
B-13-053	PM-13-063	42.8	95	0	0	50	50	0
B-13-054	PM-13-065	43.6	100	0	0	20	50	30
	Mean	43.20	97.5	0.0	0.0	35.0	50.0	15.0
Control								
CDC Copeland	N=3	42.5	100	0	0	5	65	30
AC Metcalfe	N=3	43.2	95.0	0.0	3.3	23.3	56.7	16.7

Complete analysis was conducted on the malts generated from the pilot malting trials of 2013 crop AAC Synergy, and the analytical results are given in Tables 3. The table also includes the average malt analysis of 2013 crop AC Metcalfe and CDC Copeland trials carried out at CMBTC for comparison.

Malt analysis/limit dextrinase/RVA test/arabinoxylans analysis/other analyses performed by the Grain Research Laboratory (GRL), Canadian Grain Commission

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Table 3. Analysis of malt generated from the pilot -malting trials

	2013 AAC Synergy			2013 Copeland	2013 Metcalfe
Malting trial ID	**PM-13-063**	**PM-13-065**	**Mean**	**n=3**	**n=3**
Moisture, %	3.5	3.6	3.6	4.0	4.2
Friability, %	91.6	87.7	89.7	91.7	75.8
Fine-extract, %	82.8	81.8	82.3	82.0	81.9
Coarse –Extract, %	82.5	81.4	82.0	81.1	81.3
F/C Difference, %	0.3	0.4	0.4	1.0	0.6
Soluble protein, %	5.10	5.23	5.17	5.04	5.34
Total protein, %	10.1	10.7	10.4	10.9	11.5
Kolbach Index, %	50.3	48.8	49.6	46.3	46.4
Beta-Glucan, ppm	65	43	54	89	163
Viscosity, cps	1.46	1.45	1.46	1.49	1.49
Diastatic power, °L	129	131	130	127	150
a-Amylase, D.U.	66	62.7	64.4	54.8	67.1
Wort colour, ASBC	2.13	2.18	2.16	2.14	2.62
Wort pH	5.88	5.91	5.90	5.88	5.93
FAN, mg/L	201	206	204	200	232

Malting Summary

- ***General modification:*** The values for friability, F/C difference, soluble protein and beta-glucan content all suggested that under the given trial malting conditions the two AAC Synergy barley samples produced malts with very good modification.

- ***Extract yield and enzyme levels:*** AAC Synergy malts exhibited very good extract yield, which was on average significantly higher than the averages of 2013 crop AC Metcalfe and CDC Copeland controls. Synergy malts produced from the 2013 crop developed acceptable levels of enzymes. Its diastatic power was comparable to Copeland but significantly lower than AC Metcalfe. Its α-amylase was significantly higher than CDC Copeland but slightly lower than AC Metcalfe.

- ***Soluble protein, free amino nitrogen (FAN) and malt colour:*** AAC Synergy malts exhibited good protein modification. On average, its soluble protein content was comparable to 2013 crop CDC Copeland and AC Metcalfe, while its KI was significantly higher than Copeland and Metcalfe. Synergy malts developed adequate levels of FAN, which were comparable to CDC Copeland but significantly lower than AC Metcalfe. The malts developed good color, which was comparable to Copeland but lower than Metcalfe.

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3. Pilot Brewing trials

AAC Synergy malt samples from the pilot malting trials were blended (50/50%) and brewed in CMBTCs 300L Pilot Brewery. The following are the brewing and fermentation conditions for the pilot (300L) brewing trials.

PILOT BREWING PARAMETERS (300L):

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

- Pump over to Mash Filter
- Immediate start of runoff
- 125L sparge water at 75°C
- Runoff stopped after 275L of wort collected in Brew Kettle

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 13.5ºC, 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

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PILOT BREWING TRIAL WITH AAC SYNERGY

Figures 1 through 4 detail the brewing trial with AAC Synergy sample.

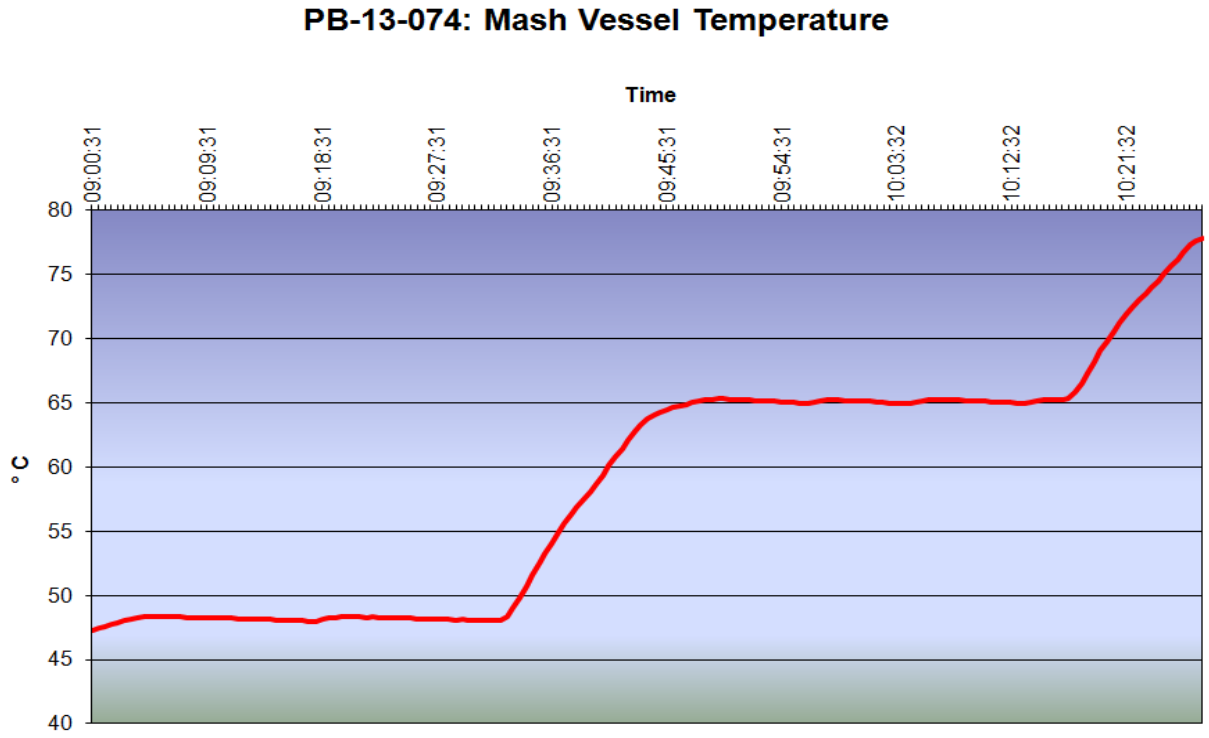

Figure 1: Mash Temperature Profile for AAC Synergy (temperature versus time)

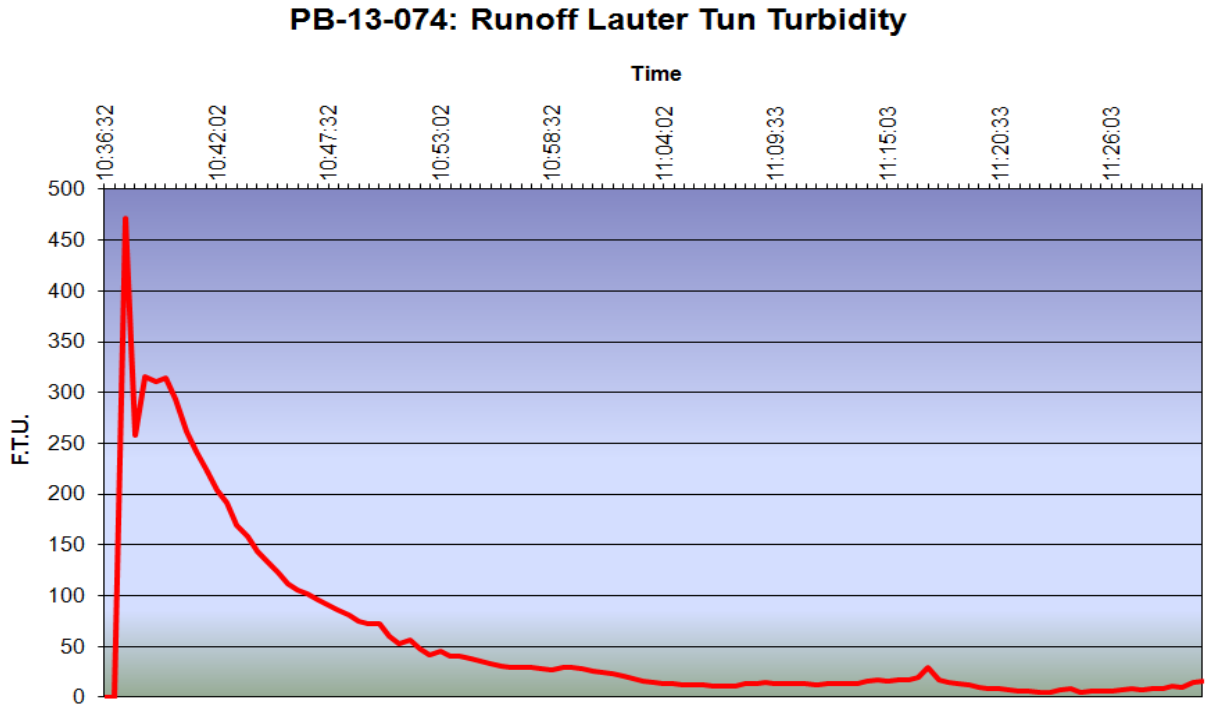

Figure 2: Runoff Turbidity for AAC Synergy (turbidity FTU versus time)

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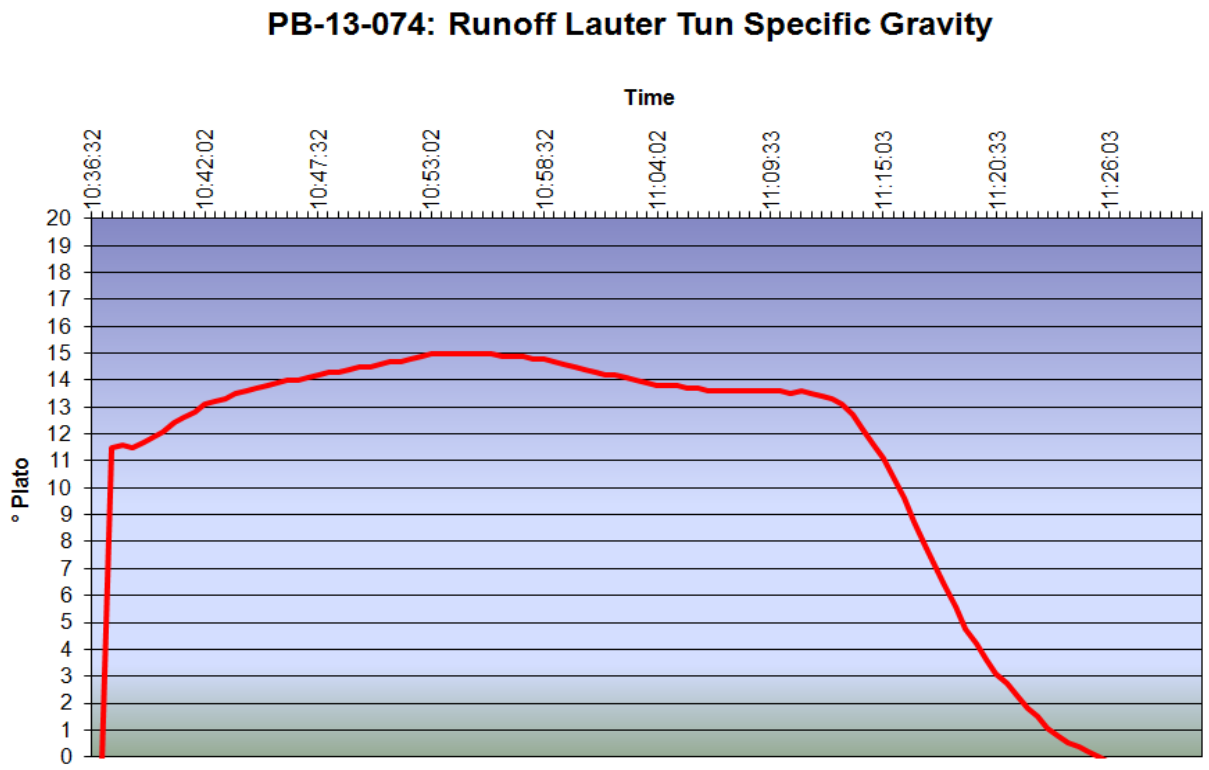

Figure 3: Runoff Specific Gravity for AAC Synergy (°Plato vs time)

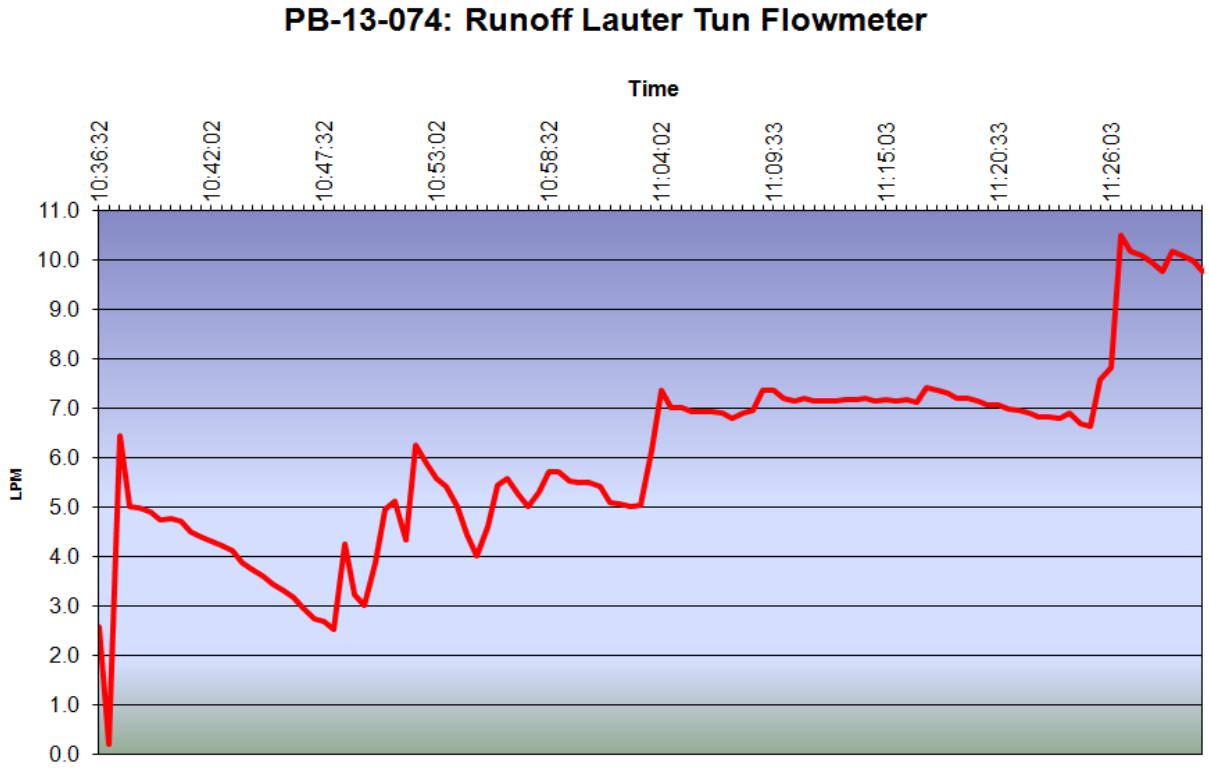

Figure 4: Runoff Flowrate for AAC Synergy (l/minute vs time)

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AAC Synergy brewing results are given in Tables 4, 5, 6, 7 and 8. All the brewing results for AAC Synergy are compared with the averages of new crop AC Metcalfe and CDC Copeland samples malted and brewed at CMBTC.

Table 4. Main Brewhouse observations for AAC Synergy pilot brewing trial

Parameter	2013 AAC Synergy	2013 AC Metcalfe	2013 CDC Copeland
Conversion time (min.)	8	9.5	14
Time to clear (min.)	9	6	5.5
Lautering time (min.)	42	42	42
Brewhouse Yield (%)	73.4	73.5	73.2
Wort pH	5.38	5.28	5.28
Wort Colour (SRM)	6.15	5.32	4.57

In the brewhouse, 2013 crop AAC Synergy sample recorded somewhat shorter conversion time (8 minutes) than both AC Metcalfe and CDC Copeland 2013 crop averages. 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.

The average time for wort to clear to less than 100 FTU in lautering for 2013 crop AAC Synergy samples was 9 minutes. This was slightly longer than both 2013 crop AC Metcalfe and CDC Copeland averages. 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 to obtain wort that is clear (less than 100 FTU) is therefore related to capacity and manpower utilization.

The average lautering time for 2013 crop AAC Synergy malt was comparable to both 2013 crop AC Metcalfe and CDC Copeland 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.

2013 crop AAC Synergy malt had comparable Brewhouse Yield to both the averages of 2013 crop CDC Copeland and AC Metcalfe. Brewhouse 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.

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Wort clarity and break in the wort kettle were acceptable for all the samples. Wort clarity and good protein precipitation is related to improved colloidal stability of the final product.

The wort pH values for all samples were typical for the wort derived from barley malts. 2013 crop AAC Synergy had slightly higher pH value from both 2013 crop AC Metcalfe and CDC Copeland wort averages. 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 and microbiological infection can occur.

2013 crop AAC Synergy recorded slightly higher wort colour than both 2013 crop AC Metcalfe and CDC Copeland averages. 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)

Carbohydrate	2013 AAC Synergy	2013 AC Metcalfe	2013 CDC Copeland
Maltotetrose	**3.90**	**2.42**	**2.34**
Maltotriose	**15.62**	**15.26**	**14.24**
Maltose	**60.04**	**63.50**	**58.75**
Glucose	**12.57**	**15.72**	**12.97**
Fructose	**2.11**	**2.19**	**2.35**

Normal and generally comparable wort sugar spectra were recorded for all the samples (Table 5). 2013 crop AAC Synergy recorded slightly higher levels of unfermentable Maltotetrose and fermentable Maltotriose sugars than the averages of 2013 crop AC Metcalfe and CDC Copeland wort samples.

Table 6. Fermentation observations for AAC Synergy brewing trial

Parameter	2013 AAC Synergy	2013 AC Metcalfe	2013 CDC Copeland
Attenuation Limit (%)	**92.1**	**89.6**	**90.1**

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Fermentabilty of all the wort samples were excellent (Table 6). 2013 crop AAC Synergy had significantly higher fermentability than the averages of both 2013 crop AC Metcalfe and CDC Copeland wort samples. 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.

Table 7. Final beer analysis for AAC Synergy brewing trial

Parameter	2013 AAC Synergy	2013 AC Metcalfe	2013 CDC Copeland
Apparent Ext. (Plato)	1.06	1.41	1.32
Real Ext. (Plato)	3.08	3.33	3.48
Alcohol (v/v %)	5.56	5.28	5.20
Color (ASBC)	2.96	4.68	3.78
pH	4.29	4.20	4.25
Foam (Nibem)	210	164	166
Initial Turbidity (FTU)	26.4	36.2	28.3
Chill Turbidity (FTU) 24 Hr	35.2	37.5	29.3

The 2013 AAC Synergy samples were bottled and they produced beer with good quality. Apparent and real extract were both slightly lower, while final beer alcohol was somewhat higher than the averages of 2013 crop AC Metcalfe and CDC Copeland beers. Final beer colour for 2013 AAC Synergy beer was lower than the averages of 2013 crop AC Metcalfe and CDC Copeland. 2013 AAC Synergy had comparable pH reading to 2013 crop AC Metcalfe and CDC Copeland products. It had better foam stability than 2013 crop AC Metcalfe and CDC Copeland averages. The initial and chill turbidity for 2013 AAC Synergy beer indicated acceptable physical and colloidal stability, which were in general comparable to the 2013 crop AC Metcalfe and CDC Copeland averages.

In terms of sensory, the 2013 AAC Synergy beer received comparable marks to the control 2013 crop AC Metcalfe and CDC Copeland averages, and was rated as normal good beers with no defects and some good characteristics. Beer sensory data is presented in Table 8 and Figure 5 in more details.

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Table 8. Final 2013 AAC Synergy and average AC Metcalfe and CDC Copeland beer organoleptic property

Parameter	2013 AAC Synergy	2013 AC Metcalfe	2013 CDC Copeland
Freshness	3.2	2.3	2.5
Body	1.7	1.8	1.7
Flavour	1.8	1.9	1.9
Smoothness	2.1	2.2	2.3
Hop Aroma	1.0	1.2	1.1
Hop Bitterness	1.1	1.6	1.2
Estery	1.5	1.9	1.7
Cereal	2.0	1.8	1.6
Turbidity	1.0	1.0	1.0
Sour	1.0	1.7	1.6
Sweet	1.0	1.4	1.4
Sulphury	0.7	1.1	1.4
Overall Quality	2.5	2.5	2.4

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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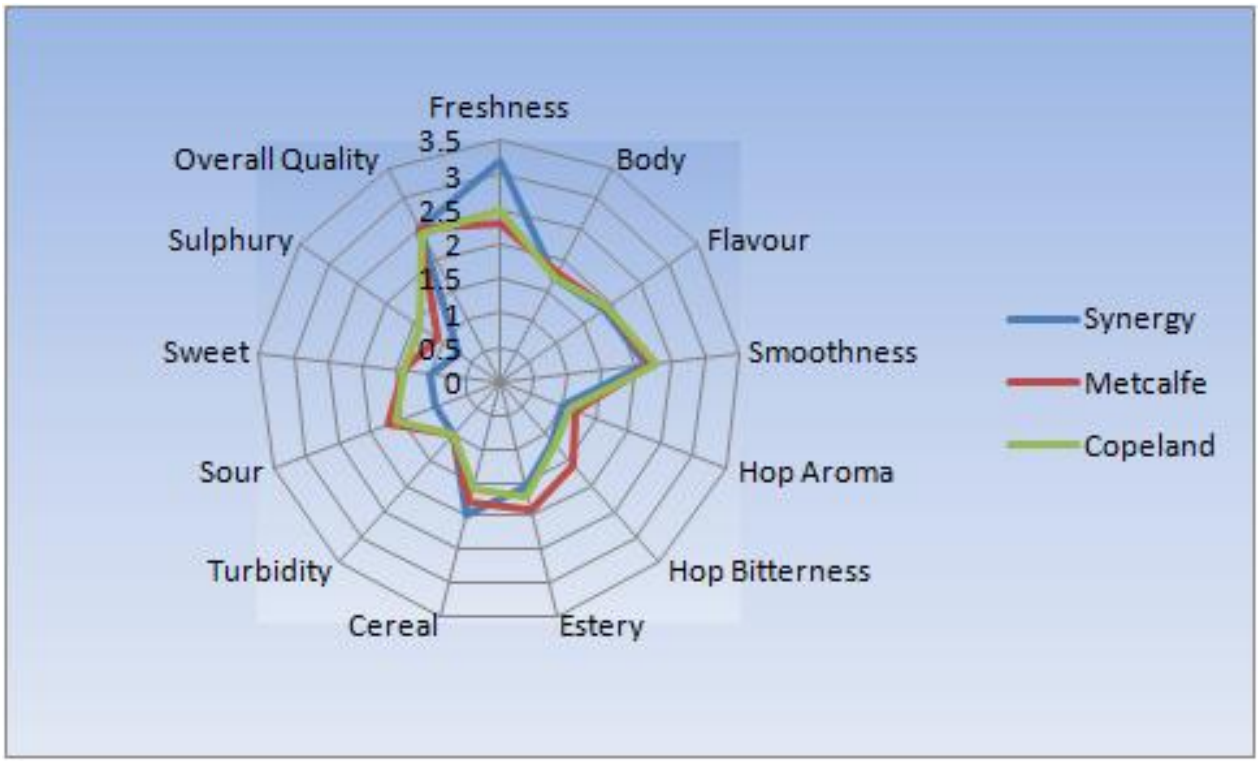

Figure 5. Final 2013 AAC Synergy and average AC Metcalfe and CDC Copeland beer organoleptic property

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