Campden BRI Group:
Campden BRI (registered no. 510618)
Campden BRI (Chipping Campden) Limited (registered no. 3836922)
Campden BRI (Nutfield) (registered no. 2690377)

Registered Office:
Station Road ◆ Chipping Campden ◆ Gloucestershire ◆ GL55 6LD ◆ UK

Report for:

QuadraChem Laboratories Ltd
Riverside
Forest Row Business Park
Forest Row
East Sussex
RH18 5DW

Assessment of the CDR BeerLab Touch Analyser

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Campden BRI Group contracting company:

Campden BRI (Nutfield)
www.campdenbri.co.uk

Report issued and authorised by:

Catharine O'Shaughnessy ◆ Assessment Programme Manager

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Assessment of the CDR BeerLab Touch Analyser

Executive Summary

We have trialled the CDR BeerLab Touch Analyser to establish whether it could meet the requirements for analysing a number of important beer and wort quality parameters.

In our work with the BeerLab Touch Analyser we found that:

- The instrument was easy to use
- The user interface was logical and user friendly
- No calibration is required
- Compared to traditional alcohol and bitterness methods, the BeerLab Touch methods were much quicker
- The system has a low environmental impact due to minimal waste production and the very low sample and reagent volumes required
- A downside to the current software, is that if a mistake is made during the absorbance reading stage, the whole test has to be repeated rather than just reinserting the cuvette and re-reading the absorbance. The manufacturer however is aware of the issue and is looking into software updates.

Our assessment of the ability of the BeerLab Touch to analyse for pH, bitterness, colour and alcohol in beers and worts showed that based on the data obtained in this study, the test instrument gave comparable results to the reference methods. Statistical analysis suggested that in the majority of cases and based on current data there is no statistically significant evidence for a difference in bitterness and alcohol measurements for beer when using the BeerLab Touch versus the reference methods. Accuracy of the BeerLab Touch with regards to agreement with the declared values of ABV was very good for all sample types. Analysis of ten replicates of the same brand of beer showed that the BeerLab Touch had greatest precision in the measurement of pH and least for bitterness.

Background

CDR has developed a fast, simple and reliable analyser that determines important quality parameters for beer and wort including colour, pH, alcohol and bitterness. The quick and accurate analysis requires no sample preparation except for prior degassing in the case of carbonated samples. It is specifically designed to monitor the brewing process, increase the consistency of the product and ensure quality control in breweries and microbreweries. In this evaluation the BeerLab Touch has been tested against traditional beer and wort analysis methods. The results were then compared for precision and repeatability.

Evaluation

The BeerLab Touch Analyser is a self-contained unit and only requires a power supply. Set-up is very straightforward. The machine is turned on, warms up to the correct operating temperature and then is ready to use. One benefit of the machine is that calibration is not required and the only sample preparation necessary is the prior degassing of carbonated samples. The instrument is controlled through a simple on-screen menu and the included software has the capacity to store many test methods.

Detailed step by step instructions for each method are provided through the touch screen menu and the training at installation was sufficient for analysts experienced in the use of pipettes and spectrophotometers. During any test the user can easily refer back to the instruction steps by clicking on the question mark in the top right of the screen. Although no calibration is required QC samples were included as controls. The four reading cells of the BeerLab Touch each read absorbance at a different wavelength. An extremely useful tool is that when it comes to reading the absorbance the appropriate cell will flash blue.

A recurring but key step in a number of the BeerLab Touch tests undertaken in this study is the careful blotting of the outside of the pipette tip before immersing it in the reaction cuvette (in order to prevent excess carryover of sample/reagent which in turn would alter absorbancy readings). The user undertaking the study was experienced in the use of pipettes. If this is not the case it is recommended that the user practises a few times until they are confident in their results.

Another procedure which could introduce false readings is the manual extraction step in the bitterness method. The user has to manually invert the reactions tubes for one minute. In this study, initial bitterness readings were much lower than the readings from the reference method and this was put down to insufficient extraction due to too gentle inversion. If done too vigorously however, then the results were not consistent. A method of shaking which gave much better results was determined by the user in this study and therefore it is recommended that any new users experiment with their own shaking technique on known bitterness content samples before moving on to unknown samples. As this shaking step is very user dependent, each user of the machine should undergo this initial training.

The cuvettes, reaction vials, pipette tips, reagents etc. required to perform the tests are all provided in sealed bags by the manufacturer. For this study, the ten test packs were used but larger (and therefore cheaper) packs are available. Only the ABV test pack needs to be stored in a fridge, the others can be stored at room temperature.

A mini sonication bath and mini-centrifuge were provided by the client for the purpose of this study. These do not come as standard with the BeerLab Touch so would need be purchased separately and are relatively low cost items.

Minimal waste is produced, which along with the small sample and very low reagent volumes required, provides analysis with a very low environmental impact. The methodology used for the bitterness test still employs the use of a solvent but the volumes required are significantly less than that required in more traditional bitterness methods (including the reference method used in this study), thus reducing health and safety concerns and environmental impact.

Another benefit of the BeerLab Touch is the ability to run two different tests (with the longer method being run in the background).

Results are printed off automatically but are also stored within the machine and can be accessed by a USB port for export into Excel and Ethernet for LIMS connection although this is subject to compatibility.

A potential improvement to the BeerLab Touch is to improve the flexibility of navigating through a method. Currently, if a mistake is made during a test – i.e. reading the wrong cuvette or pressing next sample before actually reading the result you are unable to go back and repeat that last step but instead have to repeat the whole test from the beginning. When doing colour this is not an issue but for all the other tests where reagents are added etc. this means that test is wasted and this will cost the customer both time and money. The manufacturer is aware of the recommendation and is looking into software updates.

The only maintenance action required was the daily automated start up procedure which only took a few minutes to perform. All the tests are performed in disposable vials and cuvettes and are hence non-invasive and therefore no build-up of sample components was apparent during the evaluation.

Sample analysis

To establish robustness over a range of alcohol and colour values, seven small pack beer samples and three worts were analysed in triplicate using the BeerLab Touch and the reference methods for:

- pH
- Colour
- Bitterness
- Alcohol

The worts (Table 1) were stored frozen prior to analysis to ensure product stability. They were gently defrosted in a water bath and then centrifuged to remove any cold trub that had formed upon freezing. Seven small pack beers with alcohol contents ranging from 3% to 9% (Table 2), and covering a range of colour values were analysed in triplicate. All the beers were degassed by leaving them overnight on the bench in a conical flask. In the case of alcohol analysis a fresh can of sample was opened just prior to analysis and degassed by cold filtration in the case of the reference method or placed in a sonication bath for a couple of minutes to degas in the case of the BeerLab Touch method.

Table 1 Worts used in study

Code	Type	Brew No.
1	Ale	Brew 08/14
2	Ale	Brew 01/16
3	Lager	Brew 07/15

Table 2 Beers used in study

Code	Type	Declared ABV (%)
CB49 (QC)	Lager	4
G44 (QC)	Lager	5
A	Ale	3.2
B	Ale	4.5
C	Lager	5
D	Ale	5.4
E	Ale	6
F	Lager	8.8
G	Ale	6.3

Tables 3-8 summarise the mean and precision data for the duplicate analyses of the wort and beer samples using the BeerLab Touch and reference methods, together with any assigned values for the samples used in the tests.

pH Analysis

Samples were analysed for pH using the BeerLab Touch and the reference UKAS accredited method (Campden BRI Method AM/029 based on Analytica EBC, 9.35, 2004 and 8.17, 1999)

Table 3 Summary of pH analysis results for three different wort samples

		BeerLab Touch						Campden BRI						
Analysis	**Sample**				**Mean**	**Std Dev**	**SE Mean**				**Mean**	**Std Dev**	**SE Mean**	***P-Value***
	1	5.32	5.23	5.24	**5.26**	0.049	0.028	5.10	5.08	5.08	**5.09**	0.012	0.007	***0.026***
pH	2	5.48	5.47	5.44	**5.46**	0.021	0.012	5.41	5.40	5.40	**5.40**	0.006	0.003	***0.041***
	3	5.56	5.47	5.48	**5.50**	0.049	0.028	5.50	5.50	5.50	**5.50**	0.000	0.000	***0.918***

Table 4 Summary of pH analysis results for the different beer samples

		BeerLab Touch						Campden BRI						
Analysis	**Sample**				**Mean**	**Std Dev**	**SE Mean**				**Mean**	**Std Dev**	**SE Mean**	***P-Value***
	CB44[1]	3.98	4.02	4.00	**4.00**	0.020	0.012	3.98	4.00	3.99	**3.99**	0.010	0.0058	***0.520***
pH	A	4.10	4.08	4.09	**4.09**	0.010	0.006	4.21	4.20	4.20	**4.20**	0.006	0.003	***0.000***
	B	3.99	3.99	4.00	**3.99**	0.006	0.003	4.08	4.08	4.08	**4.08**	0.000	0.001	***0.001***
	C	4.55	4.56	4.54	**4.55**	0.010	0.006	4.58	4.59	4.59	**4.59**	0.006	0.003	***0.012***
	D	4.25	4.27	4.25	**4.26**	0.012	0.007	4.30	4.31	4.31	**4.31**	0.006	0.003	***0.022***
	E	3.99	3.99	3.97	**3.98**	0.012	0.007	4.02	4.02	4.02	**4.02**	0.000	0.001	***0.032***
	F	3.90	3.90	3.91	**3.90**	0.006	0.003	3.88	3.88	3.88	**3.88**	0.000	0.001	***0.020***
	G	4.22	4.25	4.23	**4.23**	0.015	0.009	4.23	4.23	4.22	**4.23**	0.000	0.004	***0.573***

[1]This is the QC sample (a commercially available lager)

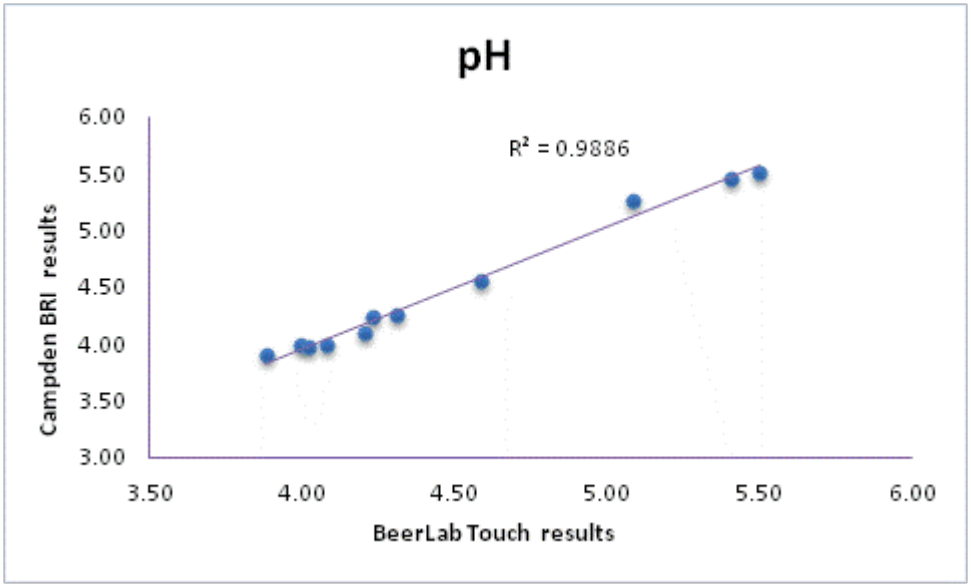

Figure 1 Correlation between pH results

The standard deviations of the triplicate samples showed that the precision of the BeerLab Touch Analyser to the reference pH method was similar for beers and worts (with the BeerLab Touch being more precise in measuring the pH of beer compared to wort). Overall the precision of the BeerLab Touch Analyser in measuring pH was slightly lower than that of the reference method but was still well within acceptable tolerances for such an instrument.

Statistical analysis using the two-sample *t*-test and the one-way ANOVA test suggested that in the majority of cases and based on current data there was statistically significant evidence (p-value is less than 0.05) for a difference in pH measurements for beer and wort when using the BeerLab Touch Analyser versus the reference pH method. A reason for this observation is because both the BeerLab Touch pH method and the reference Campden BRI pH method have very good precision (low SD values) so therefore any difference between repeat readings is low. The statistical test chosen uses the difference between mean results and the precision of the individual methods to produce a p-value. Therefore, highly precise methods such as pH can result in a t-test result showing a significant difference when the actual difference between mean results is low.

Colour Analysis

Samples were analysed for colour using the BeerLab Touch and the reference UKAS accredited spectrophotometric method (Campden BRI Method AM/028 based on Analytica EBC, 9.6 2000)

Table 5 Summary of colour analysis results for three different wort samples

		BeerLab Touch						Campden BRI						
Analysis	**Sample**				**Mean**	**Std Dev**	**SE Mean**				**Mean**	**Std Dev**	**SE Mean**	***P-Value***
	1	25.00	25.00	25.00	**25.00**	0.000	0.000	26.89	26.83	26.89	**26.87**	0.035	0.020	***0.000***
Colour	2	13.00	13.00	13.00	**13.00**	0.000	0.000	14.08	13.99	13.88	**13.98**	0.100	0.058	***0.003***
(EBC)	3	7.00	8.00	8.00	**7.67**	0.577	0.330	7.75	8.40	8.56	**8.24**	0.429	0.250	***0.263***

Table 6 Summary of colour analysis results for the different beer samples

		BeerLab Touch						Campden BRI						
Analysis	**Sample**				**Mean**	**Std Dev**	**SE Mean**				**Mean**	**Std Dev**	**SE Mean**	***P-Value***
	CB44[1]	9.00	9.00	9.00	**9.00**	0.000	0.000	8.93	8.90	8.93	**8.92**	0.014	0.010	***0.015***
Colour	A	18.00	18.00	17.00	**17.67**	0.577	0.330	17.25	17.30	17.33	**17.29**	0.038	0.022	***0.378***
(EBC)	B	15.00	15.00	15.00	**15.00**	0.000	0.000	14.40	14.35	14.38	**14.38**	0.025	0.014	***0.001***
	C	9.00	9.00	9.00	**9.00**	0.000	0.001	9.25	9.20	9.18	**9.21**	0.038	0.022	***0.011***
	D	47.00	48.00	48.00	**47.67**	0.577	0.330	48.75	48.85	48.75	**48.78**	0.058	0.033	***0.079***
	E	126.00	126.00	126.00	**126.00**	0.000	0.000	123.75	123.75	124.13	**123.88**	0.217	0.130	***0.003***
	F	14.00	14.00	14.00	**14.00**	0.000	0.000	13.58	13.75	13.58	**13.63**	0.101	0.058	***0.024***
	G	69.00	68.00	67.00	**68.00**	1.000	0.580	68.07	67.90	68.07	**68.02**	0.100	0.057	***0.982***

[1]This is the QC sample (a commercially available lager)

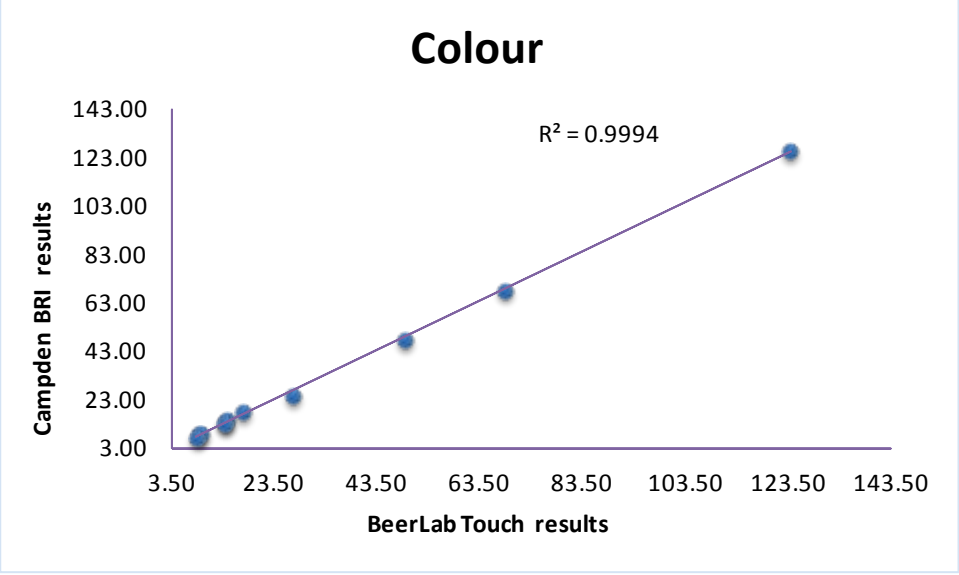

Figure 2 Correlation between colour results

The standard deviations of the triplicate samples showed that the precision of the BeerLab Touch to the reference colour method was similar for both beers and worts. Overall the precision of the BeerLab Touch in measuring colour was better than that of the reference method and was still well within acceptable tolerances for such an instrument.

Statistical analysis using the two-sample *t*-test and the one-way ANOVA test suggested that in the majority of cases and based on current data there was statistically significant evidence (p-value is less than 0.05) for a difference in colour measurements for beer and wort when using the BeerLab Touch the reference colour method. Again this observation may be due to the fact that both methods have very good precision (low SD values) so therefore any difference between repeat readings is low and as result the statistical test chosen views the mean results from the two methods as being the correct value and therefore if they do not agree with each other the *t*-test assigns that the two methods must be different.

Bitterness Analysis

Samples were analysed for bitterness content using the BeerLab Touch and the UKAS accredited spectrophotometric method (Campden BRI Method AM/003 based on EBC Analytica 9.8, 2004)

Table 7 Summary of bitterness analysis results for the different beer samples

		BeerLab Touch						Campden BRI						
Analysis	**Sample**				**Mean**	**Std Dev**	**SE Mean**				**Mean**	**Std Dev**	**SE Mean**	***P-Value***
	CB44[1]	15.80	15.00	16.30	**15.70**	0.656	0.380	14.00	14.05	13.90	**13.98**	0.076	0.044	***0.046***
Bitterness	A	26.10	26.10	23.30	**25.17**	1.617	0.930	24.70	24.65		**24.68**	0.035	0.025	***0.651***
(BU)	B	37.90	34.20	35.80	**35.97**	1.856	1.100	36.90	36.75		**36.83**	0.106	0.075	***0.508***
	C	9.20	8.90	9.10	**9.07**	0.153	0.088	9.55	9.30		**9.43**	0.177	0.130	***0.257***
	D	36.60	33.20	34.00	**34.60**	1.778	1.000	34.00	34.00		**34.00**	0.000	0.000	***0.618***
	E	26.40	25.60	27.80	**26.60**	1.114	0.640	27.80	27.95		**27.88**	0.106	0.075	***0.188***
	F	15.20	16.00	15.20	**15.47**	0.462	0.270	15.55	15.60		**15.58**	0.035	0.025	***0.725***

[1]This is the QC sample (a commercially available lager)

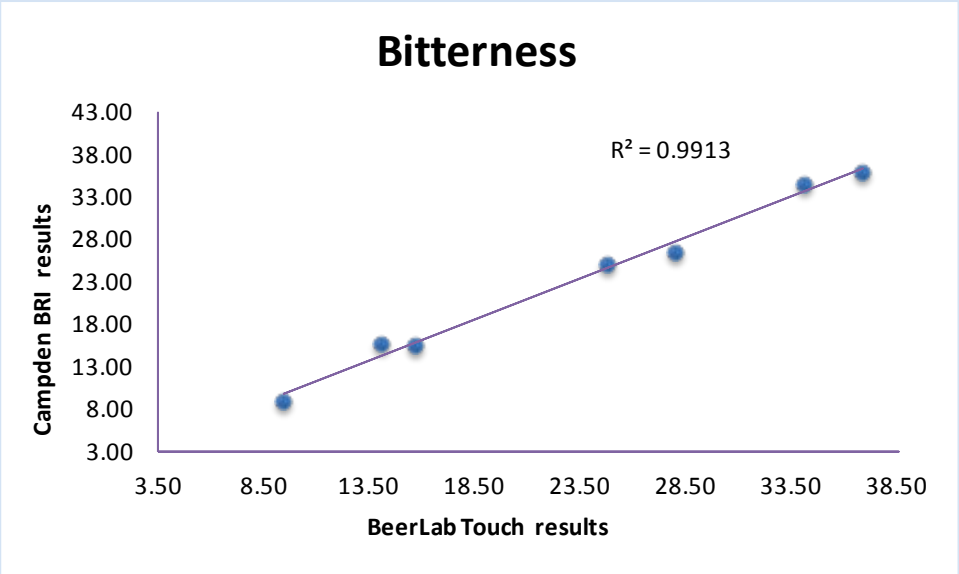

Figure 3 Correlation between bitterness results

The standard deviations of the replicate samples showed that the precision of the BeerLab Touch Analyser to the reference bitterness method was higher but was still well within acceptable tolerances for such an instrument. As stated elsewhere in this report a key step in the BeerLab Touch bitterness method is the manual extraction and if the current study had been undertaken for longer it is anticipated that the user would have optimised this further thereby improving precision.

Statistical analysis using the two-sample *t*-test and the one-way ANOVA test suggested that in the majority of cases and based on current data there is no statistically significant evidence (p-value is greater than 0.05) for a difference in bitterness measurements for beer when using the BeerLab Touch versus the reference bitterness method.

Alcohol Analysis

Samples were analysed for Alcohol using both the BeerLab Touch and the UKAS accredited gas chromatography (GC) method (Campden BRI Method AM/018 based on IOB Methods of Analysis, 1997, 9.10)

Table 8 Summary of alcohol analysis results for the different beer samples

		BeerLab Touch						Campden BRI						
Analysis	**Sample**				**Mean**	**Std Dev**	**SE Mean**				**Mean**	**Std Dev**	**SE Mean**	***P-Value***
	G44[1]	5.30	5.20	5.20	**5.23**	0.058	0.033	5.05	4.99	5.06	**5.03**	0.040	0.023	***0.016***
Alcohol	**A**	3.30	3.40	3.40	**3.37**	0.058	0.033	3.51	3.49	3.50	**3.50**	0.011	0.006	***0.059***
(%)	**B**	4.40	4.30	4.30	**4.33**	0.058	0.033	4.23	4.24	4.21	**4.23**	0.016	0.009	***0.092***
	C	5.00	4.90	4.90	**4.93**	0.058	0.033	5.00	4.99	4.99	**4.99**	0.005	0.003	***0.229***
	D	5.70	5.50	5.40	**5.53**	0.153	0.088	5.55	5.45	5.47	**5.49**	0.054	0.031	***0.665***
	E	6.30	6.20	6.10	**6.20**	0.100	0.058	6.21	6.18	6.14	**6.18**	0.034	0.019	***0.749***
	F	8.90	8.60	8.70	**8.73**	0.153	0.088	8.72	8.91	8.79	**8.80**	0.096	0.055	***0.542***

[1]This is the QC sample (a commercially available lager)

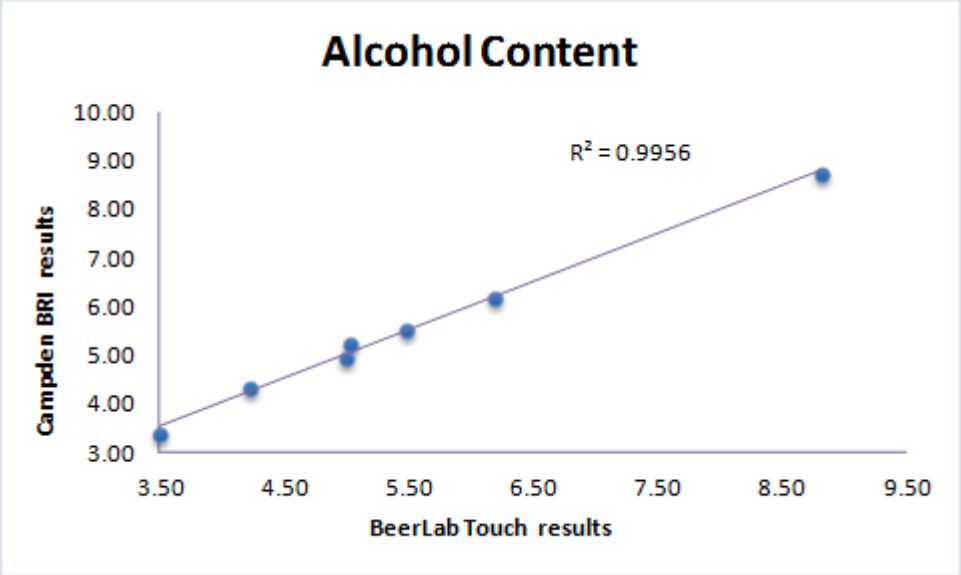

Figure 4 Correlation between Alcohol results

The standard deviations of the replicate samples showed that the precision of the BeerLab Touch Analyser to the reference alcohol method was similar with overall the reference method being more precise. The precision of the BeerLab Touch was well within acceptable tolerances for such an instrument. Accuracy of the BeerLab Touch with regards to agreement with the declared values of ABV was very good for all sample types (the actual ABV must not differ the declared ABV by more +/-0.5% for beers less than 5.5% and +/-1.0% for beers greater than 5.5%)

Statistical analysis using the two-sample *t*-test and the one-way ANOVA test suggested that in the majority of cases and based on current data there is no statistically significant evidence (p-value greater than 0.05) for a difference in alcohol measurements for beer when using the BeerLab Touch Analyser versus the reference alcohol method.

Repeatability

Ten samples of a commercially available canned lager were analysed for pH, colour, bitterness and alcohol using the BeerLab Touch and the traditional reference methods.

Tables 9-12 summarise the mean and precision data for the analyses.

Table 9 Summary of pH analysis results for 10 samples of a single brand of beer

	pH	
Beer	**BeerLab Touch**	**Campden BRI**
D	4.25	4.30
D	4.22	4.31
D	4.26	4.31
D	4.23	4.31
D	4.23	4.31
D	4.24	4.31
D	4.25	4.31
D	4.27	4.31
D	4.25	4.31
D	4.28	4.31
Mean	**4.25**	**4.31**
SD	**0.019**	**0.003**
95% Confidence Interval for Mean	**4.23, 4.26**	**4.31, 4.31**

Table 10 Summary of colour analysis results for 10 samples of a single brand of beer

	Colour (EBC)	
Beer	**BeerLab Touch**	**Campden BRI**
D	48.00	47.9
D	48.00	48.3
D	47.00	48.65
D	47.00	49.05
D	47.00	48.65
D	47.00	48.85
D	48.00	49.1
D	48.00	48.5
D	48.00	49.4
D	48.00	49.4
Mean	**47.60**	**48.78**
SD	**0.516**	**0.479**
95% Confidence Interval for Mean	**47.23, 47.97**	**48.44, 49.12**

Table 11 Summary of bitterness analysis results for 10 samples of a single brand of beer

	Bitterness (BU)	
Beer	**BeerLab Touch**	**Campden BRI**
D	37.30	34.45
D	35.70	34.45
D	36.60	35.05
D	33.20	35.15
D	34.00	34.50
D	34.90	34.80
D	34.20	34.05
D	37.60	34.20
D	35.10	34.35
D	34.80	34.10
Mean	**35.34**	**34.51**
SD	**1.449**	**0.379**
95% Confidence Interval for Mean	**34.40, 36.38**	**34.34, 34.78**

Table 12 Summary of alcohol analysis results for 10 samples of a single brand of beer

	Alcohol (%)	
Beer	**BeerLab Touch**	**Campden BRI**
D	5.70	5.55
D	5.50	5.42
D	5.40	5.45
D	5.70	5.46
D	5.50	5.50
D	5.40	5.52
D	5.40	5.47
D	5.60	5.54
D	5.40	5.53
D	5.30	5.46
Mean	**5.49**	**5.49**
SD	**0.137**	**0.044**
95% Confidence Interval for Mean	**5.39, 5.59**	**5.46, 5.52**

The precision of the BeerLab Touch, as expressed in the standard deviations of the ten replicates showed with the current data and this brand of beer, that precision was good and was greatest for pH measurement and least for bitterness. The current data also suggested that for all tests the BeerLab Touch had lower precision than the reference methods but was well within the accepted tolerances for such an instrument.

Summary

Based on the data obtained during this study, the CDR BeerLab Touch Analyser has been shown to give comparable performance in the measurement of pH, colour, bitterness and alcohol to established methods. Statistical analysis suggested that in the majority of cases and based on current data there is no statistically significant evidence for a difference in bitterness and alcohol measurements for beer when using the BeerLab Touch versus the reference methods.

Accuracy of the BeerLab Touch with regards to agreement with the declared values of ABV was very good for all sample types. Analysis of ten replicates of the same brand of beer showed that the BeerLab Touch had greatest precision in the measurement of pH and least for bitterness and in all instances precision was lower for the BeerLab Touch compared to the reference methods used. However, precision values for the BeerLab Touch, for all analyses, are well within the tolerances expected for spectrophotometers in the brewing industry and it is expected that precision would improve with continued use of the machine as the user becomes more familiar with specific techniques of each test. QCL offers training courses so users not familiar with sampling/pipetting techniques can receive a solid grounding right from the start. The low reagent and sample volumes required for analysis not only reduces reagent costs but also reduces the amount of waste produced, thereby providing analysis with a low environmental impact.

The BeerLab Touch is straightforward to use with a comprehensive touch screen menu that includes instructions that can be brought up even whilst a test is being performed. In the case of alcohol and bitterness, the BeerLab Touch methods are faster than more traditional methods (in the case of bitterness significantly faster) and all methods tested during this evaluation show close agreement to the reference method.