



Standardisation of a method to measure barley grain colour

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Abstract

The objective measurement of grain colour has recently become an important issue for grain handlers buying and selling malting grade barley. For convenience, speed and reduced capital expenditure, grain handlers have introduced barley brightness ("L") calibrations into NIR systems that are also used for the prediction of grain protein and moisture at delivery. The primary aim of this study was to establish any variability between Minolta instruments used as the reference instrument for NIR calibrations. This study consisted of thirteen laboratories with eight samples of sorghum, wheat and barley, where most laboratories used a Minolta CR310. Brightness values were recorded from samples sub-sampled into a granular materials attachment. The range in values of brightness was 44.0 to 65.0 L units. The results indicate that the method developed for barley grain brightness using the Minolta colour meter, is robust and precise.

Introduction

Australia supplies some of the highest quality malting barley and malt onto a very competitive world market. Market requirements include specific biochemical grain properties. In addition to tight grain quality requirements, the market demands that grain and malt is free from fungal contamination which until recently was evaluated visually at receipt. To provide a fair classification system to growers an objective system was required. A number of state barley handling authorities have implemented NIR as the routine objective method for grain "brightness" assessment in recent years, including Western Australia, Queensland and New South Wales. As for all NIR calibrations, a robust and precise reference method is required. A number of studies have investigated the differences between colour instruments (ASBC 1996; Blakeney *et al.* 1994) as well as the application of colour instruments as the reference method for grain lightness calibrations (Fox *et al.* 1999, Blakeney and Sturat 1998).

The aim of this study was to standardise a reference method for measuring grain colour. This standard method would then be used by grain handling and breeding programs to calibrate NIR instruments and apply those calibrations to their specific needs.

Materials and Method

Samples of sorghum, wheat and barley were collected from breeder's trials in 1999. Samples were selected on a range of visual variation in grain lightness. A final set of ten samples was included in the collaborative trial.

Previous studies showed that the variability in the measurement grain lightness between subsamples was reduced when readings were taken with samples in the Granular Materials Attachment of the Minolta instrument (Fox *et al.* 1999). Although this procedure is somewhat more labour intensive than using the Light Projection Tube, the level of precision is much greater. Hence collaborators were asked to use the granular attachment in this study.

Collaborators were provided with a method outlining the procedure. Collaborators were asked to record the "Lightness" ("L") values, "Chroma" ("a") and "Hue" ("b"), although only L results will be reported in this paper. A list with the randomisation order of their samples for each respective collaborator accompanied the samples.

Data were analysed by following AOAC method to calculate the repeatability (r95) and reproducibility (R95) values.

Results and Discussion

Initial analysis identified one laboratory (Laboratory 2) as an outlier and their data was rejected from the analysis. Upon checking with Laboratory 2 it was discovered that there was a major problem with the calibration of the instrument. For the remainder of the analysis, another laboratory was identified as an outlier and removed for most samples, leaving 11 values for those samples. All data are shown in Table I. This data was used to calculate summary results along with repeatability (r95) and reproducibility (R95) (Table D).

Table I. Results from collaborative colour study

	Sample															
	1		2		3		4		5		6		7		8	
Lab	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1	46.33	46.67	55.68	55.3	56.24	56.49	58.38	58.95	61.66	61.66	62.68	62.49	64.4	64.03	65.08	65.03
2	37.14	37.05	40.79	41.13	41.71	41.55	42.4	42.38	43.8	43.67	44.21	44.52	45.34	45.18	45.79	45.83
3c ^a	45.81	46.04	55.35	55.78	56.34	56.59	57.69	58.44	61.57	62.09	62.73	63.5	64.33	64.35	65.23	64.98
3d ^b	46.02	45.14	55.14	55.32	56.61	56.22	58.39	58.8	61.6	61.56	62.35	62.39	64.13	63.88	65.32	64.97
4	44.52	44.64	55.42	55.17	56.17	56.62	57.85	58.56	61.92	61.64	63.55	63.04	64.19	64.49	65.89	65.61
5	44.03	43.47	53.7	53.3	47.55	48.13	56.15	55.53	59.07	57.75	60.90	60.55	61.43	61.43	63.43	63.1
6	42.7	42.8	52.7	53.4	54.1	54.1	56.3	56.3	59.0	59.0	60.8	60.4	61.8	61.9	63.2	63.2

7	45.96	45.75	55.81	55.51	56.35	56.61	58.76	58.48	61.54	61.53	63.38	63.43	64.67	64.36	65.31	65.57
8	46.07	46.2	54.44	55.01	56.00	55.75	58.01	57.9	60.75	60.95	61.87	61.95	63.54	63.51	64.53	65.02
9a ^c	43.86	43.83	54.70	54.59	56.09	56.3	58.14	57.5	61.66	61.9	62.81	63.1	64.65	65.0	65.68	65.4
9 ^d	47.07	45.39	55.92	55.63	56.98	56.92	58.78	58.53	61.28	61.3	63.18	62.98	64.8	64.79	64.65	64.62
10	45.64	45.12	55.76	55.47	56.4	56.9	59.0	58.4	61.7	61.8	62.8	62.76	64.77	64.67	65.8	65.25
11	39.35	41.68	53.78	50.2	53.7	52.38	54.16	61.47	59.8	59.72	60.7	59.96	61.15	66.7	62.86	63.93
No of Labs	10		9		9		10		9		10		9		10	
No of outliers	1		2		2		1		2		11		2		1	
Mean	44.75		54.96		55.90		57.95		61.16		62.26		63.87		64.74	
S _r	0.64		0.28		0.35		0.36		0.15		0.28		0.16		0.30	
S _R	1.83		0.94		1.23		1.02		0.95		1.13		1.17		0.96	
RSD _r	1.43		0.51		0.62		0.62		0.24		0.45		0.24		0.47	
RSD _R	4.09		1.71		2.20		1.76		1.55		1.81		1.84		1.48	
r	1.80		0.78		0.97		1.01		0.41		0.78		0.43		0.85	
R	5.13		2.62		3.45		2.85		2.65		3.16		3.28		2.67	

^a Lab 3 with light source set at C

^b Lab 3 with light source set at D65

^c Lab 9 with Minolta CR310

^d Lab 9 with BYK Gardner instrument

Problems reported back included one with the Light Projection Tube where scratching on the glass surface caused by the long term usage in measuring coarse grains. For one lab, a comparison was conducted with the two light sources (C and D65). There was no statistical difference for the two light sources. Another laboratory compared the Minolta with a BYK Gardner Colour instrument, again there was no statistical difference between these two instruments.

Excluding the sorghum sample (samples 1), the remaining samples provided a range of "L" values that could be seen in samples delivered within a single harvest. The decrease in "L" values would be attributed to increased rain during harvest. Overseas research has associated grain discolouration with heavy infection of *Fusarium* causing the disease Fusarium Head Blight (FHB) (de la Pena *et al.*, 1999). Under Australian conditions few cases of FHB have been reported (ref). Preliminary assessment of discoloured Australian grain samples have shown no Fusarium present but high levels of saprophytic fungi including *Alternaria alternata*.

The release of Australian barley varieties with improved grain colour remains a high priority. Early studies by Young (1997, 1999) and Fox (unpublished) have shown the genetic differences between barley lines and hence it is possible to select for improved grain colour.

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