Preliminary comparison between two colour measuring instruments of different optical geometries when used to measure bovine adipose and muscle tissue colour

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Introduction As with most food products, colour of beef is an important quality characteristic. Subjective assessment of colour is open to bias but environmental conditions, particularly lighting, can also strongly influence colour perception. Hence, colour measuring devices such as tristimulus colorimeters (e.g. the Minolta CR series) and spectrocolorimeters (e.g. the HunterLab UltraScan, ColorQuest and LabScan series), are frequently used to measure beef tissue colour. Numerical values can be applied conveniently to any perceived colour and hence, colours can be described objectively. However, despite the advantages of this approach, there are still some relative weaknesses. When different colour measuring devices/instruments have been used to measure colour (a cursory review of relevant literature reveals that, at least 10 devices have been commonly utilised), different data have been generated, even when measuring the same tissue, and even under the same environmental and instrument (colour space, standard illuminant) conditions. Different optical geometries of different instruments are an important source of variation in this regard (MacDougall, 1994). That the choice of instrument used to measure food colour affects the colour coordinates generated has been recognised (Baardseth *et al*., 1988) but not widely documented. Therefore, the issue of concern was how data from different instruments related to each other such that values from one instrument could be used to effectively 'predict' values from another, if such a necessity became unavoidable due to practical and/or logistical exigencies.

Materials and methods Samples of subcutaneous fat (SCF) were recovered at either 24 or 48 hours *post-mortem* from over the *Musculus longissimus dorsi* (LD) between the 9th and 13th ribs or were measured directly on the carcass at these times. The colour of LD muscle was measured by cutting a steak, 2.5cm thick, between the 10th and 13th ribs, removing adhering adipose and connective tissue and overwrapping with oxygen-permeable PVC film and permitting to bloom at 4ºC, in darkness, for 3 hours. Readings of '*L*' (lightness), '*a*' (redness) and '*b*' (yellowness) were made on SCF within 48 hours *post-mortem* and on bloomed LD at 48 hours and 14 days *post-mortem*, the latter following ageing in darkness under vacuum-packaging at 4ºC. Measurements were made using two instruments; the portable Minolta chromameter, model CR300 (CR300) and the benchtop HunterLab UltraScan XE spectrocolorimeter, equipped with Universal software Version 2.2.2 (Hunter Associates Laboratory Inc., Reston, Virginia 22090, USA) (HLabXE) coupled to a personal computer. Instruments were calibrated using their standard white calibration tiles according to manufacturer's guidelines. The measuring aperture areas of the CR300 was 8mm and that of the HlabXE was 25.4mm. All measurements were made in the Hunter *L a b* colour space and the D_{65} standard illuminant was used throughout. Where appropriate, tissue '*H*' (hue) and '*C*' (chroma/saturation) were calculated as $\tan^{-1}(b/a)$ and $\sqrt{(a^2 + b^2)}$, respectively (McLaren, 1987). Final conversion of hue from radians to degrees was achieved by multiplying $\tan^{-1}(b/a)$ by $180/\pi$ (Liu *et al*., 1996). The CR300 and the HLabXE were compared when measuring SCF colour ('*b*' and '*C*' values) and all colour coordinates of LD muscle at 2day (48 hours) and 14day *post-mortem*. For each comparison, variables were compared using simple linear regression, including terms for the regression model and error variances. Data are presented in Table 1.

Results

Table 1 Relationship between the HunterLab UltraScan XE colorimeter and the Minolta CR300 chromameter when used to measure beef carcass tissue colour.

SCF	Equations [1]				r	s.e.	P-value
	y	Slope,m	x	c			
'b' value	$_{CR300}$ b	0.339	($_{HLabXE}$ b)	4.936	0.54	1.908	<0.001
'C' value	$_{CR300}$ C	0.294	($_{HLabXE}$ C)	6.422	0.58	1.822	<0.001
Muscle	(2d and 14d pooled data)						
'L' value	$_{CR300}$ L	0.062	($_{HlabXE}$ L)	34.62	0.16	2.061	0.054
'a' value	$_{CR300}$ a	0.289	($_{HLabXE}$ a)	8.082	0.65	1.935	<0.001
'b' value	$_{CR300}$ b	0.192	($_{HlabXE}$ b)	3.53	0.30	1.517	0.0002
'H' value	$_{CR300}$ H	0.303	($_{HLabXE}$ H)	12.19	0.20	4.454	0.016
'C' value	$_{CR300}$ C	0.277	($_{HlabXE}$ C)	9.37	0.63	2.120	<0.001

Conclusion The present study while by no means exhaustive, indicates that despite a relatively small data set, there is potential to use colour coordinates generated by one instrument to predict those that would be generated by a different instrument on the same samples under the same conditions. The data also emphasise that reporting the instrument used to generate colour data is important for interpretative purposes.

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https://doi.org/10.1017/S2040470010003754 Published online by Cambridge University Press