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A Research Note

Evaluation of Venison Color by an Objective Method using CIELAB Values

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ABSTRACT

A trained color panel was used to score both venison color and color acceptability for comparison with instrumental color measurements. Panel color scores were highly correlated with acceptability (r = 0.97) and could be predicted from CIE L*, a* and b* values by regression (R^2 (adj) = 0.84). The use of a* alone explained the greatest amount of variation R^2 (adj) = 0.78), and the inclusion of both L* and b* significantly improved the model. The use of hue angle and chroma either individually or in combination with L* did not provide better relationships. The use of L*, a* and b* is recommended for satisfactory prediction of panel color scores of venison with no less than three observations per sample.

INTRODUCTION

MEAT COLOR is important since it is subject to critical appraisal by consumers and is often the basis for product acceptability. Color is a sensory attribute and it's instrumental evaluation must relate to sensory assessment (Setser, 1984) which may, however, be difficult to perform and control (Strange et al., 1974). Visual scoring by a trained panel is the preferred method of subjective analysis and CIE L*, a* and b* (CIELAB) values are appropriate measures of color. CIE 1976 a, b chroma and hue-angle may also be calculated as psychometric correlates of perceived chroma and hue (Hunter and Harold 1987; Setser, 1984).

The purpose of the present study was to investigate relationships between the perceived color and acceptability of venison loin, as judged by a trained panel, and measured color. The effect of simulated retail storage time at 4°C was also investigated.

MATERIALS & METHODS

SAMPLES were obtained from six, two year old red deer stags (*Cervus elaphus*) which were slaughtered pre-rut, electrically stimulated (45 V, 45mA RMS, 90 sec) and dressed using standard practices. Carcasses were placed in a chiller immediately and held overnight at 2 ± 3°C prior to boning. Both loin muscles (M. Longissimus dorsi) were removed, placed in plastic bags and frozen at -25°C until evaluation. Sample steaks were cut about 4 cm thick from thawed loins and refrozen. For evaluation they were thawed at 4°C, trimmed to 2.5 cm thick, placed on white polystyrene trays with the freshly cut face uppermost, wrapped with polyvinylchloride (PVC) film (oxygen transmission rate of 11,000 mL m^{-2} 24 hr^{-1} at 20°C and 0% RH) and placed in a refrigerated display case.

Perceived color and acceptability were judged by a trained panel of 13 who viewed the samples in a retail display case under cool white flourescent lighting (1800 lux). A scale of 1 to 5 was used for perceived color with 5 = bright fresh venison color to 1 = extremely dark or brown. For acceptability, a scale of 1 to 3 was used with 3 = purchase without reservation, 2 = purchase with reservation and 1 = would not purchase. The evaluations were repeated on four occasions with 18 different samples each time. Color measurements were made with a LabScan 6000 spectrocolorimeter (Hunter Associates Laboratory Inc.) with O°/45 geometry - specular component excluded. The cut surface of the wrapped samples was placed over a 25 mm open port with a 20 mm illuminated area. Readings were made at 10 locations on the cut surface of each slice and the L*, a* and b* values recorded for Standard Source C and the CIE 10° Standard Observer. From these CIE 1976 a, b chroma and hue-angle were calculated (Hunter and Harold, 1987). Ten readings on 18 samples took about 30 min.

Analysis of variance was performed on the data, classified by refrigerated storage time with an adjustment for animal effects. Correlation coefficients were calculated between color measurements and panel scores using 72 mean observations. Regression relationships for predicting panel scores from measurements are presented with R^2 (adj) values given by (1-[Residual mean square]/[total mean square]).

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RESULTS & DISCUSSION

COLOR AND ACCEPTABILITY scores covered the range of the rating scale, and the mean values (Table 1) show significant differences between refrigerated storage times. The changes from day 1 to 3 were greater than from day 3 to day 5. For acceptability the decreases were 0.86 and 0.41 and for perceived color 1.2 and 0.69. CIELAB a* and b* means also decreased with storage time and the psychometric functions, chroma and hue, also showed significant differences ($p<0.05$). The changes in both a* and hue followed the same trend as the panel scores with a larger change over the first interval.

Within sample variation made only minor contribution to treatment comparisons for CIELAB values, and the number of observations per sample could have been smaller (e.g., relative to using only one observation, using three would have reduced the standard error for a* by 9%, whereas using 10 reduced it by 12%).

Color and acceptability were highly correlated (r=0.973). There were high correlations between perceived color and CIE a* (0.892), hue (-0.885), chroma (0.806) and b* (0.517), while its correlation with L* was -0.043. Univariate and multiple regression equations for panel color scores on CIELAB values are given in Table 2. Using multiple regression with L*, a* and b* gave a high R^2 (adj) value (0.844) as did the use of L*, chroma and hue and these were significant improvements ($P<0.05$) on single and double component models. The use

Table 1—Means of color panel scores and CIELAB data at each refrigerated storage time and components of variance between and within samples

	Storage time				Variance	
Characteristic	1 day	3 days	5 days	SED	Between sample	Within sample
Acceptability	2.85	1.99	1.57	0.085		
Color	4.37	3.17	2.48	0.104		
Hunter						
L*	27.69	27.90	28.30	0.288	1.086	0.375
a*	15.70	12.09	10.16	0.306	0.640	0.349
b*	15.11	13.80	12.82	0.239	0.927	0.716
chroma	21.80	18.38	16.39	0.348	1.371	0.627
hue-angle	43.89	48.99	51.74	0.573	4.132	0.947

SED = standard error difference

Table 2—Regression relationships between panel color scores vs CIELAB values (n = 72)

Regression equations	R^2 (adj)
Single component	
−0.045 (0.070)L* + 4.60 (1.93)	0
0.299 (0.019)a* − 0.445 (0.241)	0.783*
0.364 (0.062)b* − 1.72 (0.87)	0.317*
0.271 (0.023)chroma − 1.778 (0.446)	0.652*
−0.186 (0.012)hue-angle + 12.28 (0.58)	0.771*
Double component	
0.307 (0.019)a* + 0.067 (0.032)L* − 2.422 (0.972)	0.793*
0.385 (0.027)a* − 0.207 (0.051)b* + 1.341 (0.495)	0.822*
−0.197 (0.012)hue-angle + 0.108 (0.032)L* + 9.79 (0.91)	0.801*
−0.131 (0.016)hue-angle + 0.114 (0.026)chroma + 7.51 (1.19)	0.820*
Triple component	
0.409 (0.027)a* − 0.237 (0.049)b* + 0.093 (0.028)L* − 1.14 (0.89)	0.844*
−0.145 (0.016)hue-angle + 0.107 (0.024)chroma + 0.098 (0.028)L* + 5.56 (1.24)	0.844*

* Indicates that adding the last variable in the model is a significant improvement ($p<0.05$). Standard errors are bracketed after their parameter estimates.

of polar coordinates (hue and chroma) did not provide a better fit than Cartesian coordinates (a* and b*) for any order model.

This study supports the finding of Hoke and Davis (1970) and Setser (1984) that the use of L*, a* and b* or L*, hue and chroma rather than any one or pair of these variables yields a significantly better relationship. The conclusion was reached that the three component equations could be used in place of a trained color panel as long as the characteristics to be evaluated were clearly defined. They could also be used as the basis of accept/reject decisions, particularly since there was a high correlation between panel color and acceptability scores.

Eagerman (1977) found that the correlation coefficients for psychophysical functions versus perceived color were lower for beef and lamb than for pork. This may have been due to the difficulty in measuring meat color when there is a large amount of marbling. Venison has very little marbling. Hunter and Harold (1987) point out that color is observed for samples as a whole and suggest averaged color measurements when within sample irregularities exist. Our findings suggest that only three observations per sample are necessary for venison. This emphasizes though, the need to train a panel to consider only the attribute one wishes to evaluate and to adopt an appropriate measurement strategy.

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