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Comparison of two different methods to determine meat quality

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ABSTRACT

The objective of this study was to determine muscle colour of beef carcasses using digital image analysis. Fourteen beef carcasses were selected from slaughterhouses. Data collected on these carcasses included colorimeter measurements and digital images and measurements of muscle colour (*L**, *a**, *b** values) and muscle pH from longissimus muscle at 24 hours after slaughtering. The discrepancies between colorimeter and digital image analysis values of *L**, *a**, *b** were large (25.6±3.37, 3.01±3.38 and 2.25±3.56, respectively). There were significant differences between L* values (P <0.05) but there were non-significant differences between *a** and *b** values (P >0.05). The correlation coefficient was found significant (P <0.05) between pH and *a** values (r=0.83). The results showed that prediction ability of digital image analysis was low for prediction of muscle colour. However, it was concluded that red value (a*) can be predicted by digital image analysis and there is a need for further studies in order to develop better techniques to use for prediction.

Keywords: *Beef carcass, digital image analysis, meat colour*

INTRODUCTION

Digital image analysis was developped at 1960's to use in space research and curently started to use in food science to evaluate food quality. This technique has been argued in poultry science since 1990s (Daley and Babbit, 1991). McDonald and Ohen (1990) initiated using this technique in beef quality and they distinquished meat from fat on the base of reflection differences in muscle (*Musculus longissimus dorsi*).

The objective of this study was to determine muscle colour of beef carcasses using Digital Image Analysis (DIA) and to compare with Minolta Colourmeter (MC) measurement techniques.

MATERIALS and METHODS

Colour values (*L**, *a** and *b**) of *longissimus dorsi muscle* were determined using minolta colourmeter (MC), and then the collected measurments were compared with DIA measurements of the same muscles (n=14). Among colour values *L** indicates lightness, *a** redness and *b** yellowness value.

pH measurements were taken from 24 h post mortem longissimus muscle with pH meter (Crison instruments, Spain).

Statistical Analysis

The differences between MC and DIA *L**, *a** and *b** values were examined by "Students'*t* test" using the statistical package program Minitab v.13 for windows (Minitab, 2001). The *L**, *a** and *b** values determined by CM and DIA can also be defined as "observed" and "predicted" values respectively. The "observed" and "predicted" L*, a* and b* values were also compared using the Mean-Square Prediction Error (MSPE):

$$MSPE= \frac{1}{n}\sum_{i=1}^{n}(Oi-Pi)^2$$

Where n is the number of pairs of observed and predicted values being compared.
i = (1, 2, 3,……, n)
Oi is the observed *L**, *a**, *b** values with *i*th variable.
Pi is the predicted *L**, *a**, *b** values with *i*th variable.

The MSPE can be considered as the sum of three components described by Rook *et al.* (1990).

$$MSPE = (\overline{O} - \overline{P})^2 + S^2{}_P(1-b)^2 + (1-r^2)S^2{}_O$$

Where, S_O^2 and S_P^2 are the variances of the observed and predicted LMAs respectively. $\overline{O}$ and $\overline{P}$ are the means of the observed and predicted LMAs, b is the slope of the regression of observed values on predicted and r is the correlation coefficient between O and P.
Besides common regression analysis, MSPE has been used to determine the prediction ability of regression models and sources of error components in many studies by Smoler *et al.* (1998), Bozkurt and Ap Dewi, (2001), Fuentes-Pila *et al.* (2003), Yan *et al.* (2003), Bozkurt, (2006).

RESULTS and DISCUSSION

Descriptive statistics of *L**, *a**, *b** values measured by minolta colourmeter (MC) and Digital Image Analysis (DIA) are presented in Table 1.

Table 1. Descriptive statistics of *L**, *a** and *b** values

Variables (n=14)	Mean±SE
P*L*	51.00±1.59
P*a*	15.26±1.58
P*b*	5.88±0.79
L	25.40±0.74
a	12.25±0.57
b	3.63±1.34
pH	5.81±0.31

P*L:* Predicted *L*, P*a:* Predicted *a*, P*b:* Predicted *b*

DIA predicted *L** values 50% higher than the *L** values determined by MC and differences were found to be statistically significant (P<0.05). The "observed" and "predicted" *L**, *a** and *b** values determined by two methods are compared in Table 2.

Table 2. Comparison of L*, a* and b* values determined by MC and DIA

Observed parameters		Mean	S.D.	S.E.	Variance	R^2	r
L*	**MC**	25.40	2.77	0.74	7.7		
	DIA	51.00	5.94	1.59	35.3	0.072	0.27
a*	**MC**	12.25	2.15	0.57	4.6		
	DIA	15.26	5.93	1.58	35.2	0.046	0.21
b*	**MC**	3.63	5.02	1.34	25.2		
	DIA	5.88	2.94	0.79	8.6	0.022	0.15

DIA produced twice as high prediction as MC method (51 *v* 25.4). Coefficient of determination (R^2) and correleation coefficient (r) values were determined as 7.2% and 0.27 for *L** values respectively. It was observed that DIA predicted higher *a** value (15.26) compared to MC (12.25). R^2 and r values *a** were 4.6% and 0.21. Similarly, DIA method predicted slightly higher *b** values (5.88) compared to *b** values measured by MC (3.63). R^2 and r values for *b** were 2.2% and 0.15 (Table 2). However, while there were significant differences ($P<0.05$) in *L** values determined by DIA and MC methods, non-significant ($P>0.05$) differences were observed *a** and *b** values determined by two methods (Table 2).

Mean bias, MSPE and proportion of MSPE (%) between two prediction methods for *L**, *a** and *b** values are given in Table 3.

Table 3. Mean bias, MSPE and proportion of MSPE (%)

N=14		Mean	S.E.	Mean Bias	MSPE	Proportion of MSPE (%)		
						Bias	Line	Random
L*	**MC**	25.40	0.74					
	DIA	51.00	1.59	25.6±3.37	689.49	0.95	0.039	0.010
a*	**MC**	12.25	0.57					
	DIA	15.26	1.58	$3.01±3.38^{ns}$	43.36	0.21	0.689	0.102
b*	**MC**	3.63	1.34					
	DIA	5.88	0.79	$2.25±3.56^{ns}$	43.26	0.12	0.314	0.569

Mean bias was positive for *L** values (25.6±3.37) and differences in *L** values between two methods were statistically significant ($P<0.05$). MSPE value of predicted *L** was 689.49 and percentage values of bias, line and random error were 95, 3.9 and 1% as a proportion of MSPE (Table 3). The highest percentage was found in bias and the lowest percentage was found at random.

Mean bias was also positive for *a** values (3.01±3.38) and differences between two values were not statistically significant ($P>0.05$). MSPE value of predicted *a** was 43.36 and in terms of contribution of components to MSPE; the values of bias, line and random error were 21, 68.9 and 10.2% respectively (Table 3). The highest percentage was found at line and the lowest percentage was found at rondom.

Similarly, mean bias was positive for *b** values (2.25±3.56) and differences between two values were statistically not significant ($P>0.05$). MSPE value of predicted *b** was 43.26 and as contribution of components to MSPE; the values of bias, line and random error were 12, 31.4 and 56.9% respectively. The highest percentage was found at rondom and the lowest percentage was found at bias. (Table 3).

Correlation coefficients (r) between pH and *L**, *a* and b** values are shown in Table 4.

Table 4. Correlation coefficients (r) between pH and *L*, a* and b** values

Meat Colours	pH	*L**	*a**
L*	-0.01		
a*	0.83	0.44^{ns}	
b*	-0.41^{ns}	-0.36^{ns}	-0.41^{ns}

ns: nonsignificant (p>0.05).

values Statistically significant correlation (P<0.05) was determined between *a** values and pH of meat (P<0.05) (r=0.83). Correlation between *a** and *L** was found to be statistically insignificant (P>0.05) (r=0.44). While there were negative and statistically not significant correlations between pH, *L** and *b** values, high positive correlation was found between pH and *a** value, with increasing pH values *a** values increased (Table 4). Reason for that, with increasing pH, denaturation of myoglobin decreases. Schutte *et al*. (1998) indicated that high correlation was observed between colour values of DIA and that of well trained panalists (r=0.90). Dosiewicz *et al*. (2003) showed that there is very strong relationship between marbling score anf RGB values and they concluded that DIA can be used in chemical composition, texture and quality of meat.

CONCLUSIONS

The results showed that prediction ability of digital image analysis was low for prediction of muscle colour. However, it was concluded that red value (*a**) can be predicted by digital image analysis and there is a need for futher studies in order to develop better techniques to use for prediction.

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