OBJECTIVE MEASUREMENT OF BEEF MEAT COLOR

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INTRODUCTION

The color of beef meat is an important factor of quality. Indeed, the color of meat is one of the few factors which may be appreciated by consummers at the time of the purchase.
Thus, after the weight and the grading, the color of meat often takes part in the trend of carcasses to a specific market. For example, industrials constitute groups of homogeneous carcasses according to the color. In the supermarkets, heterogeneous color represents a problem for the presentation of meat. Finally, the color of meat is more and more integrated in the specifications of quality procedures (e.g. Label rouge, ...).
However, at the moment, in France, an official method to measure the beef meat color does not currently exist, neither with a color scale, nor with an instrument. This poses a problem for industrials who want to group their carcasses according to the color, as well as for researchers who want to study the different factors of color variation.

This experiment reports the developement of a color scale and the test of different instruments to measure obectively the color of beef meat.

MATERIALS AND METHODS

Initially, a color scale was developed based on 4 classes from light red to dark red. Several people were trained to measure the color by visual assessment and constituted a panel of judges.
Then, 6 instruments (colorimeters, spectrocolorimeters, reflectrometer) were compared to select the best method of measuring the color of meat : repeatability and reproducibility were tested and regressions were calculated between L*, a*, b* measurements (CIELAB system) and visual assessment. 2 colorimeters were selected : the CR300 and CR310 from Minolta. The only difference between these 2 instruments is the reading head, the diameter of the CR300 is 5 mm and 50 mm for the CR310.
Finally, the color of meat was measured on 1059 carcasses on the 6th rib on *longissimus dorsi* one hour after the primary cut, with colorimeters (CR300 and CR310 : 3 measurements) and visual assesment by 3 judges. At the same time, intramuscular fat (IF) on the 6th rib was estimated according to the USDA scale (from 3 : poor in IF to 12 : rich in IF)in order to study its effect on the color measurement.
Data were analysed with SAS (1988) by ANOVA and regression in order to calculate the R^2 value. The equations of prediction were developed with 80 % of the sample and tested with 20 %.

RESULTS

Animal characteristics are given in the table 1. Animals are well distributed in the different classes of color with young bulls having on average a lighter color than cows. Concerning intramuscular fat, cows are fatter than young bulls.

Table 1

	Color classes				IF classes (USDA scale)							
	1	2	3	4	3	4	5	6	7	8	9	12
Cows (%) n = 417	12,71	23,02	41,25	23,02	10,31	25,90	25,42	22,30	10,31	3,6	1,68	0,48
Young bulls (%) n = 619	48,47	37,0	14,22	0,32	82,55	10,66	4,36	2,26	0,16	0	0	0

ANOVA were realised between the L*, a*, b* means according to the classes of color. The results are showed in table 2.

Table 2

		Color classes			
		1	2	3	4
CR 300	L*	41,89 ^{a}	38,20 ^{b}	35,70 ^{c}	33,24 ^{d}
	a*	24,18 ^{a}	25,41 ^{b}	24,36 ^{a}	22,23 ^{c}
	b*	12,07 ^{a}	12,10 ^{a}	11,36 ^{b}	3,97 ^{c}
CR 310	L*	40,76 ^{a}	37,70 ^{b}	36,50 ^{c}	35,75 ^{d}
	a*	27,14 ^{a}	26,53 ^{b}	24,55 ^{c}	21,19 ^{d}
	b*	12,55 ^{a}	11,91 ^{b}	10,99 ^{c}	9,50 ^{d}

(2 different letters on the same line indicate signicatively different means, $\alpha = 5\ \%$)

These results indicate, in the case of the CR300, that only L* measurement indicated a differentiation betwenn the 4 classes of color. For the CR310, it was possible to differenciate the 4 classes with L*, a* and b* measurement.

Then, 5 models of regression with different variables were studied, the results are given in the table 3. R^2 value are the best for models 4 (variables L*, a*, b*, L^{2*}, a^{2*}, b^{2*}, IF) with around 78 % for the CR300 and 80 % for the CR310.

Table 3

	R^2 (%)	
	CR300	**CR310**
Model 1 (L*, a*, b*)	62.30	61.06
Model 2 (L*, a*, b*, IF)	70.92	70.97
Model 3 (L*, a*, b*, L^{2*}, a^{2*}, b^{2*})	73.54	74.98
Model 4 (L*, a*, b*, L^{2*}, a^{2*}, b^{2*}, IF)	78.26	80.97
Model 5 (L*, a*, b*, L^{2*}, a^{2*}, b^{2*}, animal kind)	76.06	76.56

The models 2 and 4 showed an important effect of intramuscular fat, above all with the CR310 where IF is the first explicative variable (40 %): when *Longissimus dorsi* was fatty, it was impossible to measure only the color of meat with the large reading head : inevitably, fat was measured with meat in opposite with the CR300 with a smaller reading head. For the rest of the study, we kept only the results of the CR300.

Finally, since IF measurement is subjective, model 2 and 4 were eliminated. Then, 2 models were selected to develop equations of prediction : model 3 (variables L*, a*, b*, L^{2*}, a^{2*}, b^{2*}) and model 5 (variables L*, a*, b*, L^{2*}, a^{2*}, b^{2*}, animal kind). Their interest was estimated by the percentage of carcasses well graded between the grade obtained by the colorimeter and the visual assessment. These 2 models are similar with 68 % and 67 % of carcasses well graded, but we noticed a difference between young bulls and cows. Indeed, around 78 % of young bulls are well graded compared with only 51 % of cows. This difference could be explained by the intramuscular fat which disturbed the color measurement and by the distribution of animals in the different classes of color : an equivalent ditribution in the 4 classes for the cows and an unequal distribution for the young bulls in only 3 classes (see table 1). To compare with panel of judges, the percentage of carcasses well graded between 2 judges was 68.8 % on average.

CONCLUSION

The results showed that the colorimeters CR300 and CR310 are able to reproduce visual assessment with 68 % of carcasses well graded. Practically, L*, a*, b* values could be operated in 2 ways : first, with a computer, a software would give from an equation of prediction the class of color. Second, with abacus, to L* and a* values would correspond a class of color.

Consequently, we could envisage different uses for the colorimeter in industry. For example, beyond the simple grading in 4 classes of color, we could imagine the introduction of the color in some quality procedures by fixing L*, a*, b* values to not exceed.

Industrials could use colorimeters to constituate group of homogeneous carcasses according to the color.

The same study is currently realised on the color of veal meat with the same purposes.

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