MEASUREMENT OF VEAL COLOUR BY REFLECTANCE SPECTROPHOTOMETRY

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Background

To assure the production of pale veal, the calf is fed mainly with milk. Italy, Netherlands and France are the main European veal production countries, usually obtained from the Friesian breed, and slaughtered before 6 months of age.
Meat colour is one of the most important factors determining the value of calf carcasses. Actually the evaluation of carcass colour for classification purposes is done, quite subjectively, using different experts and different illumination conditions; instrumental techniques for a rapid screening of meat colour and properties can improve carcass control and classification and are of great interest both for industry and consumers.
The parameters of reflectance spectrophotometry are highly correlated with colour grading as reported in Gerrard *et al* (1996). The use of the spectrophotometer technique for (on-line) quality determination is well described by Brøndum *et al.* (2000) and Swatland (1995) who used visual reflectance to determine water-holding capacity and pH. Moreover several authors (Swatland, 1985, Guignot et al, 1992; Swatland, 1995; Andersen, 1999) found a negative relationship between ultimate pH and colour assessment in absorbance measures, specially in the range of 580-700 nm; in fact the effects of post-mortem changes in pH should be taken into account for a correct assessment of veal colour.

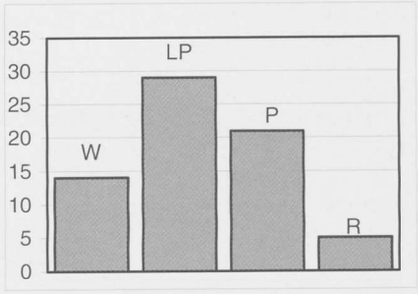
Objectives

The aim of the trial was to investigate the possibility to use visual reflectance spectroscopy to measure veal colour and to support the EU-system of classification with more objective and comparable determinations of colour. We also try to establish the possible correlation of pH and drip loss with single spectra data.

Methods

Sixty-nine Friesian calves were reared with a diet based on high milk content to produce white veal They were stunned at the age of 6 months (237Kg of average live weight). Average hot weight of the dressed carcasses was of 140 kg. 24 h after slaughtering the carcasses were evaluated by experts using the EU-system with 4 colour classes (white =W, light pinkish = LP, pinkish = P and red = R), the distribution of the animals in the different classes is reported in Fig.1. Samples of *longissimus thoracis* were then obtained from 8-6 ribs (right side of the carcass) kept in plastic bags and immediately transported to the laboratory. The samples were stored at +2°C until the 6th day after slaughtering and several physical and chemical parameters were determined: pH, measured at 6th day by putting the probe into the muscle; drip loss, by the gravimetric method on raw meat stored at 4°C for 48h; colour coordinates, measured on three points on the outside surface of slices, 2 cm thick, after exposure to oxygen for 1 hour (lightness L* redness a*, yellowness b*, chroma and hue calculated with CIELAB System using C illuminant); visual reflectance spectra between 360-740 nm (by steps of 10 nm), using reflectance spectrophotometer Minolta CM-2006d. The spectral data were expressed as percentage reflectance value (R%), data were then transformed in reflex attenuance values (RA, LOG_{10} of the inverse of reflectance, RA=2-LOG R%, Millar *et al.* 1996) and in the K/S ratio (K = absorption coefficients and S = scattering coefficients), which is used for quantifying the percentage of deoxymyoglobin (DMb% =K/S 474*K/S 525), metmyoglobin (MMb% =K/S 575*(K/S 525)$^{-1}$) and oxymyoglobin (O_2Mb% = K/S 610*(K/S 525)$^{-1}$) as reported in AMSA, 1991.

Fig.1 Animal distribution in 4 colour classes



The first difference spectra (ΔRA) were calculated from the reflex attenuance values, and represent the difference between two data with a derivative size of 20 nm (Moss *et al.*, 2000).
The data of pH, drip loss, lightness, a* redness, b* yellowness, chrome and Hue, DMb%, MMb%, O_2Mb% and, particularly, the peaks of RA and ΔRA at 420 nm, 540 nm, 560 nm and 580 nm were subjected to analysis of variance to compare the 4 colour classes and to evaluate the instrumental differences among the colour classification (GLM procedure of SAS package); moreover correlation analysis among the data was used to investigate on the possible relations among the pH, drip loss and spectra data.

Results and discussion

The distribution of carcasses in four classes (Fig 1) showed similar trends for all the animals as reported by Denoyelle and Berny (1999).
The meat of the carcasses classified like W and LP (Table 1) lost more liquids as compared to the other classes (≈0.35p.p), while the pH data were similar among the classes (5.63 in average).
Lightness decreased from the white class to the red meat (Denoyelle and Berny, 1999) but no differences were found in the two paler carcasses. The same trend was found for hue while chrome and a* yellowness did not discriminate the colour among the groups W, LP and P with the lowest value for R class. The redness did not show significant differences among classes. The colour coordinates could not discriminate among animal classes, in contrast with the results of Denoyelle and Berny (1999), although the parameter which brought more information was lightness (Table 1).
The reflex attenuance values (RA) little differed within the pale classes (Table 3) while significant differences for all colour classes were found in the values of difference spectra (ΔRA in Soret peaks - 420 nm, in 540 nm and 560 nm; Millar *et al.*, 1996 and Moss *et al.*, 2000) and in DMb% (Table 2).
The oxygenation of deoxymyoglobin caused a characteristic change in the patterns of absorbance with a loss of absorbance at 560 nm and the appearance of two new absorbance peaks at 540 nm and 580 nm.
The spectral data of RA (inverse values of reflectance) were positively correlated (negatively for R%) with pH (Swatland, 1995; Andersen *et al*, 1999) and negatively with drip loss (Brøndum *et al*, 2000 referred, in pigs, a good correlation of 0.72). High correlation coefficients for both parameters were calculated for the spectral data until 590 nm (Fig 3) except for the drip loss that showed the lowest correlation

coefficient in the Soret peaks (420 nm); similar low coefficients in Soret peaks and after 590 nm were found by Andersen *et al.* (1999) for pH.

Conclusion

It might be possible to measure the paleness with reflectance spectra from intact veal, but it is necessary to consider further analytical parameters to improve carcass evaluation as the problem requires more than a simple estimate of the myoglobin concentration from the absorbance values in the range of 540-580 nm and at the Soret peaks, because paleness of veal is also strictly related to its pH.

Pertinent literature

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Table 1 - Physical quality on longissimus thoracis samples

	Drip Loss %	Lightness	a* Redness	b* Yellowness	Chrome	Hue
W	1.23 a	58.82 a	7.88	15.70 a	17.61 a	64.63 a
LP	1.27 a	57.79 a	7.38	15.36 a	17.08 a	63.65 a
P	0.98 b	56.02 b	7.87	15.06 a	17.07 a	63.00 ab
R	0.81 b	51.90 c	8.06	13.63 b	15.88 b	59.69 b
Means	1.14	57.03	7.68	15.21	17.10	63.58
RMSE	0.431	1.962	1.783	1.171	1.724	4.369

Note: different letters mean significant difference for P<0.05.

Fig 2 - **Reflex Attenuance in four colour classes**

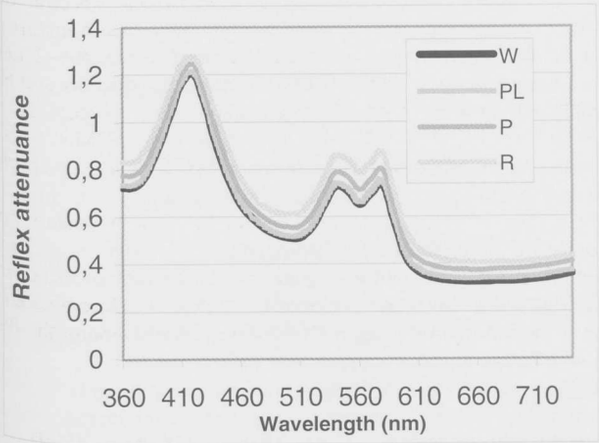

Fig 3 – Single wavelength correlations between pH or Drip Loss and RA

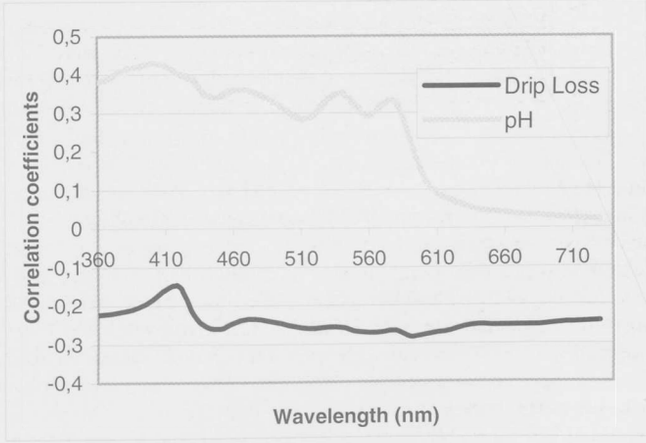

Table 2 Differences of some peaks linked with meat pigments

	RA 420nm	RA 540nm	RA 560nm	RA 580nm	ΔRA 420 nm	ΔRA 540 nm	ΔRA 560nm	DMb%	MMb%	O_2Mb%
W	1.204 b	0.728 c	0.651 c	0.733 c	-0.086 d	0.060 d	0.0122 c	1.225 d	1.350	0.287
LP	1.214 b	0.742 c	0.667 c	0.749 c	-0.080 c	0.063 c	0.0138 b	1.454 c	1.360	0.305
P	1.244 a	0.783 b	0.709 b	0.791 b	-0.072 b	0.067 b	0.0144 ab	1.739 b	1.365	0.309
R	1.275 a	0.862 a	0.796 a	0.873 a	-0.058 a	0.076 a	0.0165 a	2.829 a	1.362	0.333
Mean	1.225	0.760	0.686	0.768	-0.077	0.065	0.0139	1.573	1.359	0.305
RMSE	0.0341	0.0414	0.0380	0.0436	0.0088	0.0044	0.00286	0.3990	0.0287	0.0434

Note: different letters mean significant difference for P≤0.05.
There are not significant differences for ΔRA 580nm.