ASSESSMENT OF RELATIVE CONTENT OF DEOXYMYOGLOBIN, OXYMYOGLOBIN AND METMYOGLOBIN AND OXIDATIVE CHANGES AT THE SURFACE OF PORK SLICES AND SALTED GROUND MUSCLES.

Lassarre, M.* & Vendeuvre, J.-L.
CTSCCV, 7 avenue du Général de Gaulle, 94704 Maisons –Alfort cedex, France.
* present address : IMRN, Université Aix-Marseille III, Faculté des Sciences et Techniques de Saint Jérôme 13397 Marseille Cedex 20, France

Background

Myoglobin is the pigment responsible for meat color. Its content is intrinsic to the muscle. During storage, the processes of oxygenation and oxidation of myoglobin influence color. Myoglobin exists under three chemical forms : desoxymyoglobin (reduced myoglobin), oxymyoglobin (oxygenated myoglobin) and metmyoglobin (oxidized myoglobin).
For years, a lot of recommandations has been established to measure meat color (1–4). Many parameters for meat color follow-up were published in scientific literature, but they only deal with beef meat (5-10). The majority of research works carried out on pork meat color uses the L*a*b* coordinates (CIE 1976).

Objectives

Developing a reliable method to check pork meat color and color changes due to oxidation, applicable to intact muscle as well comminuted and salted pork , whatever the metabolic type of muscle.

Methods

Slices (S) and salted ground muscles (G) (1.6%NaCl) were prepared from four different metabolic types of muscle (11) : *Infraspinatus-Supraspinatus*(ISSS) as the whole, oxidative red meat, *Triceps brachii lateralis* (TBL) and *Pectoralis profundus* (PP), meats of intermediate type , *Longissimus thoracis lumborumi* (LD), white glycolytic meat. To obtain specifically one of the three defined chemical forms of myoglobin, samples were processed as following :

- 100% Metmyoglobin (MMb) : Soak samples in potassium ferricyanide and store under oxygen permeable film at 2°C for 12 hours,
- 100% Desoxymyoglobin (DMb) : Place samples in vacuum package at 2°C for 12 hours,
- Oxymyoglobin (OMb) : Place samples under oxygen permeable film at 2°C for 12 hours.

Reflectance measurements were carried out with a portable spectrocolorimeter Minolta CM2002 (standard observer 10°, specular-included data, illuminant type D65).

Results and discussions

Using a dendrogram, L*a*b* coordinates have been tested to discriminate the three chemical forms of myoglobin (figure1). Those parameters failed to enable the discrimination between MMb, OMb and DMb samples. Likewise criteria used for beef discoloration have failed to be applicable in pork. However two reflectance ratios $R_{\lambda=474nm}/R_{\lambda597nm}$ and $R_{\lambda=582nm}/R_{\lambda=525nm}$ have shown valuable to discriminate MMb, DMb and OMb samples (figure2).
The use of a principal component analysis shows that the $R_{\lambda=474nm}/R_{\lambda597nm}$ ratio mirrors DMb while the $R_{\lambda=582nm}/R_{\lambda=525nm}$ the stands for MMb (figure3).
In a muscle, the three chemical forms of myoglobin are represented and their sum is 100%, which means that the percentage of OMb is calculated by using the following equation : %OMb = 100% – (%MMb +%DMb).
Relative content of MMb, DMb and OMb can be calculated by using a graph (figure 4). Every vertex of the triangle represents exclusively one of the three pigment chemical forms. To use this method for pork slices and salted ground muscles, whatever the metabolic type of muscle, the means of their reflectance ratios have been compared (table1). There are no significant differences between slices and salted ground muscles, for the same chemical form of pigment. Significant differences, over both reflectance ratios, are observed between DMb, OMb, MMb slices and between DMb, OMb and MMb salted ground muscles. As a consequence those results enable the discrimination between the three pigment chemical forms and point out that the method is suitable for slices and salted ground muscles. Selected values for graph vertex are slice values. For 100%MMb, $R_{\lambda=474nm}/R_{\lambda=597nm}$ is 0.80 and $R_{\lambda=582nm}/R_{\lambda=525nm}$ is 1.20 and for 100%DMb, $R_{\lambda=474nm}/R_{\lambda597nm}$ is 1.19 and $R_{\lambda=582nm}/R_{\lambda=525nm}$ is 0.96.
For a slice or salted ground muscle, reflectance measurements are carried out, thus reflectance ratios are calculated. By locating these two reflectance ratios on the graph $R_{\lambda=582nm}/R_{\lambda=525nm} = f(R_{\lambda=474nm}/R_{\lambda=597nm})$, relative contents of DMb, OMb and MMb respectively are obtained on each triangle side.

Conclusions

This method allows the follow-up of the MMb formation rate at the pork surface. It is a rapid and non-destroying method. It can be used in laboratory or in the production line. It was used successfully for different unpublished works to check the myoglobin oxidation on sliced, ground, salted ground, frozen and unfrozen pork muscles.

Pertinent Literature

(1) RENERRE, M. et MAZUEL, J-P., 1985. Relations entre méthodes de mesures instrumentales et sensorielles de la couleur de la viande. Sciences des aliments, 5, 541-557.
(2) AMSA. 1991. Guidelines for meat color evaluation. National live stock and meat board.
(3) CASSENS, R.G., *and al.*, 1995. Recommandation of reference method for assessment of meat color. 41th ICoMST, San Antonio, Texas.
(4) HONIKEL, K.O., 1998. Reference methods for the assessment of physical characteristics of meat. Meat Science, 49 ; 447 – 457.
(5) DEAN R.W. *and al.* 1960. Analysis of the myoglobin fractions on the surfaces of beef cuts. Food technology 14, 271-276.
(6) EAGERMAN B.A. *and al.* . 1978 A rapid reflectance procedure for following myoglobin oxidative or reductrice changes in intact beef muscle. Journal of Food Science 43, 468-469.
(7) HARRISON A.R.*and al.* 1980. Relationship of spectrophotometric reflectance measurements to beef muscle visual color. Journal of Food Science 45, 1052-1053.

(8) KRZYWISKI K. 1979. Assessment of relative content of myoglobin, oxymyoglobin and metmyoglobin at the surface of beef. Meat Science 47, 1-16.
(9) STEWART M.R. *and al.* 1965. The use of reflectance spectrophotometry for the assay of raw meat pigments. Journal of Food Science 30, 464-496.
(10) VAN DEN OORD A.H.A. *and al.* 1971. Colour rating and pigment composition of beef. Journal of Food Technology 6, 15-20.
(11) LABORDE, D., 1984. Etude de facteurs de variation du pouvoir de rétention d'eau de la viande de porc. Thèse de Doctorat, Université Clermont II.

Acknowledgments : This work was partly funded from a french Meat and Livestock Commission OFIVALgrant

Figure 1. Dendrogramm of samples with L*a*b* coordinates

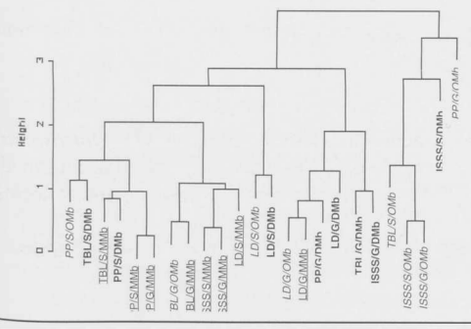

Figure 2. Dendrogramm of samples with $R_{\lambda=474nm}/R_{\lambda=597nm}$ and $R_{\lambda=582nm}/R_{\lambda=525nm}$

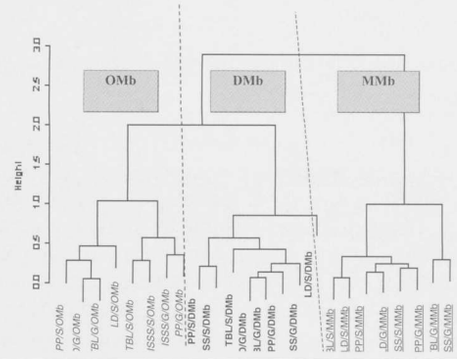

Figure 3. Principal Component Analysis of samples with $R_{\lambda=474nm}/R_{\lambda=597nm}$ and $R_{\lambda=582nm}/R_{\lambda=525nm}$

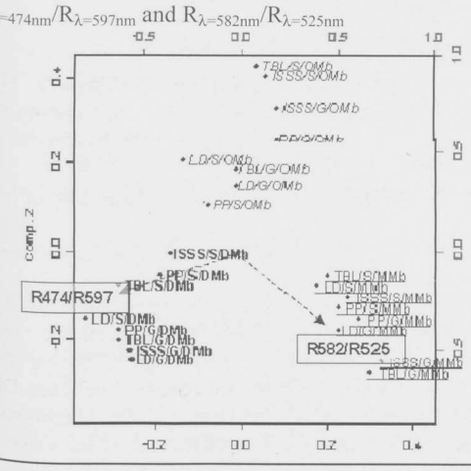

Figure 4. Graph for determining relative content of three chemical forms of myoglobin

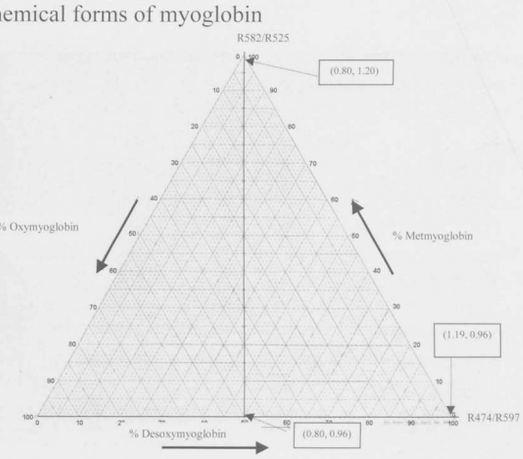

Table1. Means of reflectance ratios for slice and ground meat, any confused muscles

	$R_{\lambda=474nm}/R_{\lambda597nm}$	$R_{\lambda=582nm}/R_{\lambda=525nm}$
Slice 100% DMb	1.19 ± 0.09^{a}	0.96 ± 0.02^{b}
Slice 100% MMb	0.80 ± 0.02^{c}	1.20 ± 0.03^{c}
Slice OMb	0.90 ± 0.10^{b}	0.91 ± 0.03^{a}
Ground meat 100% DMb	1.18 ± 0.01^{a}	1.01 ± 0.02^{b}
Ground meat 100% MMb	0.78 ± 0.04^{c}	1.282 ± 0.05^{c}
Ground meat OMb	0.86 ± 0.08^{b}	0.96 ± 0.02^{a}

Different superscripts within a column, stand for significant differences. P<0.01