COLOR CHANGES IN DRY-CURED HAM DURING PROCESSING

SABIO E.*, VIDAL-ARAGÓN M.C.*, FALLOLA A.*, SANABRIA C.*, BENITO J.**.

* Departamento de Tecnología Agroalimentaria. S.I.A. Aptdo 22 (Badajoz). Spain. ** Departamento de Producción Animal. S.I.A. Aptdo 22 (Badajoz). Spain.

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SUMMARY

Thirty Iberian hams were dry cured following the traditional Spanish method. Physic color measurements have been carried out upon *Semimembranosus* (SM) and *Biceps femoris* (BF) muscles, at different processing steps: (1) raw (0 days), (2) postsalting (60 days), (3) drying period (180 days), (4) 4 months' cellar (300 days), (5) 8 months' cellar (440 days), (6) final product (620 days).

The variables evaluated were: chromatic coordinates in CIE-1976 (L*, a*, b*), psychometric variables (chroma, hue, saturation), chromatic coordinates in CIE-1931 (x, y), color purity and dominant wavelength.

The results suggested that, in *Semimembranosus*, L*, a* b*, chroma, x and purity drop markedly with time, while hue angle and dominant wavelength have no a clear tendency. In *Biceps* the evolution with time is much more reduced. This different behavior seems to be related to the position of the muscle. The semimembranosus is a superficial one and it is subjected to a rapid dehydration process and, at the beginning, to a high salt concentration.

INTRODUCTION

The color in meat is due to concentration and chemical nature of the haemoproteins present on it. In most meat, the haemoprotein in the highest amount is the myoglobin, although the blood haemoglobin is also present in significant concentration (Ledward,1992). In General, the myoglobin is responsible for 95% of meat color, and the haemoglobin for the rest. The chromophore in both proteins is the haematin moiety, which consists of the protoporphyrin IX ring system with an iron atom in the middle. During the curing period, there is a modification on the oxidation state of the iron atom and the nature of the axial ligands. Moreover, the changes in humidity, pH, NO_2^-, NO_3^- and NaCl promote changes in the globin fraction. All these factors will affect the electronic arrangement of the d-electrons of the iron and, consequently, the spectral characteristic of the molecule. The result will be a gradual change in color until stability is reached.

The aim of this work is to study the color evolution during Iberian dry-cured ham processing. This knowledge is interesting because the color of ham is an important quality attribute and is the first to be perceived by the consumer (MacDougall, 1977).

MATERIALS AND METHODS

Samples

Sixty Iberian pigs, from 'Valdesequera Line', were used in this study. The pigs were fed in an extensive system, in environmentally controlled facilities at the Pig Husbandry Unit of 'Valdesequera', belonging to the Agriculture Research Service of the 'Junta de Extremadura' . The animals were slaughtered at an average weight of 160 kg and 16 months old. Then, sixty raw hams were dry-cured following the Spanish traditional method (Fallola & Osorio, 1992).

Measurements

Physic color measurements were made on *Semimembranosus* (SM) and *Biceps femoris* (BF) muscles at the following processing steps: (1) raw (0 days), (2) postsalting (60 days), (3) drying period (180 days), (4) 4 months' cellar (300 days), (5) 8 months' cellar (440 days), (6) final product (620 days).

The color measurements were made with a Minolta CR-200b photometer. The variables evaluated were: chromatic coordinates in CIE-1976 (L*, a*, b*), psychometric variables (chroma, hue, saturation), chromatic coordinates in CIE-1931 (x, y), color purity and dominant wavelength.

RESULTS AND DISCUSSION

Figures from 1 to 3 show the evolution of L*, a* and b* in *Biceps femoris* and *Semimembranosus* muscles. These parameters are a measurement of the lightness (L*=100 white, L*=0 black), redness (a>0 red, a<0 green) and yellowness (b>0 yellow, b<0 blue), respectively. In the raw Iberian ham, there are no significant differences between muscles for these parameters. The average L* value found at this stage (42.8) is very closed to that found by Van der Wal et al.(1988)in DFD meat of other genotypes (L*=53.5 normal, L*=42.7 DFD), while a* is clearly higher (a*=6.3 normal, a*=8.0 DFD). It should be noted that Iberian pigs are slaughtered quite old (16 months) and live in an outdoor system, which implies a large amount of exercise. These factors will yield muscles with an oxidative rather than a glycolitic metabolism, and thus, with a relative small amount of glycogen (Kadim et al., 1993). In fact, the pH is usually higher in Iberian pigs (pH=5.9-6.1. own data) than in others pigs (pH=5.63 normal, pH=6.62 DFD) (Van der Wal et al., 1988). This could explain the L* values found, because this parameter is affected by the pH (Warris & Brwon, 1987). On the other hand, these peculiarities of this extensive production system could yield a quite red meat with a high a* value, due to a high myoglobin concentration (Potthast, 1987).

The results indicate that, in SM, there is an important reduction on L*, a* and b* during the processing time. The BF muscle shows a similar behaviour in L* and b* to SM, but the drops are less sharp. In both muscles, there are significant differences ($P<.05$) between raw and final products for these parameters. Contrary, in BF, there are no important changes in a* values during processing.

From these data, pysichometric parameters (hue, chroma and saturation) have been calculated (figures 4-6). These parameter have the advantage that correspond more closely to what consumer perceive. Psychometric hue is easily understood as that attribute described in color names (red, yellow, brown, etc) and is usually expressed in degrees (0°= red, 90°= yellow, 180°= green, 270°= blue). Both muscles have similar hue behaviour, decreasing (becoming redder) until 180 days and then remain almost constant. Psychometric chroma is related to color intensity. The chroma value in *Semimenbranosus* decreases with time, while in *Biceps* remains nearly constant. Saturation is less easily comprehended, and is the color intensity in proportion to its brightness, being calculated as chroma/L*. After 180 days, saturation in semimenbranosus decrease markedly.

Moreover, chromatic coordinates in CIE-1931 (x, y), color purity and dominant wavelength have been calculated (figures 7-10). These parameters seem to be less sensible to color changes. Only purity and x have a drop with time in *Semimembranosus* muscle.

The final conclusion could be that there is an important color difference between muscles, being the *Semimebranosus* regarded as darker red than *Biceps*. This difference is not easily explained by the evolution on heamoproteins concentration because Garcia et al. (1992) have found that there is a similar evolution of total haem pigment, nitrosylglobin and metmyoglobin content in both muscles. The different behavior on color seems to be related to the position of the muscle. It should be noted that *Semimembranosus* is superficial one, and it is subjected to a rapid dehydration process and, at the beginning, to a high salt concentration.

CONCLUSIONS

1.- There is an important difference in color behavior of *Semimembranosus* and *Biceps femoris* muscles of Iberian pig during processing time. The results suggested that, in *Semimembranosus*, L*, a* b*, chroma, x and purity drop markedly with time, while hue and dominant wavelength have not a clear tendency. In biceps, the falling with time is much more reduced. As result *Semimebranosus* is regarded as darker red than *Biceps*. This different behavior seems to be related to the position of the muscle.
2.- The chromatic coordinates in CIE-1931 seem to be less sensible to color changes than the CIE-1976 ones.

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