# CHROMATIC ASPECTS OF STEERS REARED UNDER ORGANIC PRODUCTION

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## Introduction

The bright, cherry-red colour of fresh beef is used by consumers as an indicator of meat quality. Pigmentation in beef is principally due to the oxidation state of myoglobin. Meat discoloration along ageing time is inevitable because the colour stay stable during a relatively short period. With prolong stored red oxymyoglobin ($MbO_2$) oxidises to metmyoglobin (MetMb), which gives meat an unattractive brown colour. Various reflectance values have been used often to measure meat colour, to follow colour changes and to quantify myoglobin forms. One factor that influences meat colour is animal nutrition regimen, because this can vary the marbling content being a factor of especially important in organic production when the animal feed ratios are being studied. So, the aim of this work is to reveal the changes in colour characteristics of beef meat during various postmorten storages and different feeding regimen of organic production.

## Materials and methods

Ten male yearlings from Avileña-Negra Ibérica breed (a bovine breed from the Central area of Spain) reared under two systems of organic production were studied. Lot HC (high concentrate) is formed for animals reared with 9 kg of maximum concentrate/day, and animals of Lot LC (low concentrate) were reared with 5 kg of maximum concentrate/day plus grass hay, both with straw *ad libitum*. The feed consumed by animals was entire of organic agricultural and the feed consumed was controlled by the use of an individual transponder. The forage: concentrate ratio on a DM basis was 35:65 in lot A and 55:45 in lot B. Animals were slaughtered at 17-19 months old, 320 kg of hot carcass weight and a carcass classification value of R3 (1).

M. *longissimus dorsi* was removed from left half of carcasses 48 h post mortem, and steaks (1.5 cm thick) were cut. Subsequently, pH was calculated using a pH-meter equipped with a penetrating electrode, water-holding capacity (WHC) was determined by a pressure method (2) and intramuscular fat were extracted (3). Dissection to obtain muscle, total fat and bone was made of a 6th rib of LD muscle. Measurement of colour (CIE L*, a*, b*) was performed at the surface of meat samples 1 h after to cut the steaks allowing blooming (day 2) and the colour was measured again on 9 and 16 days postmortem vacuum packaged during this time. The measurements were made using a spectrophotometer (Minolta CM-2006d), with illuminate D65 and 10º observer angle (4). Therefore in order to measure colour stability was calculated $A_{580}$-$A_{630}$ value (5). Each value is the mean of twelve measurements. Spectral reflectance values were collected between 360 and 740 nanometer and spectral data were used to calculate the relative content of myoglobin, oxymyoglobin and metmyoglobin (6). Statistical analysis was carried out by analysis of variance (ANOVA) and computed by using the GLM procedure (SPSS vs. 14, 2004). Differences among means were determined by Post Hoc Comparison procedure by Student Newman Keuls test. The Correlation procedure was used to generate coefficients and probability values.

## Results and discussion

Meat characteristics of steers fattened by different systems of organic production are presented in Table 1. Animals of lot LC (low concentrate) obtain less liquid expelled ($p<0.01$), and a higher muscle/bone and muscle/fat ratios ($p<0.05$) than animals of lot HC (high concentrate). pH values were normal, so "dark- cutting" beef was not an issue with the steers in this study.

Table 1. Means of meat characteristics of steers fattened by different systems of organic production.

| | Lot HC (n=10) | Lot LC (n=10) | sig | m.s.e. |
|---|---|---|---|---|
| pH | 5.49 | 5.48 | ns | 0.01 |
| Intramuscular fat (%) | 2.20 | 2.06 | ns | 0.28 |
| WHC (% liquid expelled) | 15.01 | 13.79 | ** | 0.29 |
| M/B (%) | 1.68 | 3.12 | * | 0.51 |
| M/TF (%) | 5.18 | 8.19 | * | 0.95 |

**Lots: HC = 9 kg/d of concentrate; LC = 5 kg/d of concentrate. M= muscle, B= bone, TF= total fat. ns: non significance, * ($p<0.05$), ** ($p<0.01$). m.s.e.: mean square of the error.**

Effects of meat chromatic characteristics on days 2, 9 and 16 days postmorten ageing of steers fattened by two different systems of organic feed are shown in Table 2. The animal's meat of lot HC had a greater L* and Mb percentage and a lower a* and MetMb percentage. There were no significant differences in b*, C*, h* or a*/b* ratio between lots. In the present study, the difference in meat colour from both lots might be related to the different diets, as lot LC had grass hay in the diet and to obtain a less liquid expelled in the meat.
The metmyoglobin (MetMb) significantly increased after the first 7 days of vacuum storage (of 14.67% to 19.18%). It's reported that 40% MetMb caused beef meat rejection by a consumer panel [7]. The myoglobin diminished significantly during storage possibly due to a loss of sarcoplasmic fluid (i.e. purge). $MbO_2$ percentage significantly increased after storage at vacuum. Similar trends are found for $A_{580}$-$A_{630}$ as for a* values, although the effect of ageing on colour stability is more clear with this parameter than with a* values [8]. $A_{580}$-$A_{630}$ (%) measurement in 2, 9 and 16 days postmorten ageing had a high correlation with a* (r=0.877) and C* (r=0.810) parameters. Mb (%) had a high and negative correlation with a* (r=-0.77) and C* (r=-0.78) parameters, although $MbO_2$ (%) had a positive correlation (r=0.764 y r=0.822) respectively.

Table 2. Means of meat chromatic characteristics on days 2, 9 and 16 days postmorten ageing of steers fattened by different systems of organic production.

| | Lot HC (n=27) | Lot LC (n=30) | PM 2 days (n=19) | PM 9 days (n=19) | PM 16 days (n=19) | LxPM | m.s.e. |
|---|---|---|---|---|---|---|---|
| L* (D65) | 38.72 [a] | 37.72 [b] | 37.67 [a] | 37.87 [a] | 39.12 [b] | ns | 3.36 |
| a* (D65) | 15.74 [a] | 16.42 [b] | 14.65 [a] | 16.03 [b] | 17.55 [c] | ** | 1.29 |
| b* (D65) | 13.31 | 13.35 | 12.02 [a] | 13.17 [b] | 14.81 [c] | * | 1.10 |
| C* (D65) | 20.63 | 21.18 | 18.97 [a] | 20.77 [b] | 22.98 [c] | ** | 1.69 |
| h (D65) | 40.22 | 39.09 | 39.35 | 39.38 | 40.23 | ns | 5.46 |
| a* (D65)/b* (D65) | 1.19 | 1.24 | 1.23 | 1.23 | 1.19 | ns | 0.01 |
| MetMb (%) | 15.83 [a] | 17.73 [b] | 14.67 [a] | 19.18 [b] | 16.48 [c] | ns | 5.65 |
| Mb (%) | 31.44 [a] | 28.44 [b] | 41.80 [a] | 28.34 [b] | 19.67 [c] | ns | 25.82 |
| $MbO_2$ (%) | 52.74 | 53.84 | 43.53 [a] | 52.48 [b] | 63.85 [c] | ns | 22.44 |
| $A_{580}$-$A_{630}$ (%) | 66.49 | 67.66 | 65.49 [a] | 65.34 [a] | 70.40 [b] | ns | 11.72 |

**Lots: HC = 9 kg/d of concentrate + straw *ad libitum*; LC = 5 kg/d of concentrate + straw + grass hay *ad libitum*. C* = $(a^{*2} + b^{*2})^{1/2}$, h = tan -1 (b*/a*). Means in the same row not followed by a common letter differ significantly. ns: non significance, * ($p<0.05$), ** ($p<0.01$). m.s.e.: mean square of the error.**

## Conclusions

Animals reared with high concentrate (lot HC) presented a meat more lightness and with a lesser tendency to oxidation due to least MetMb proportion and greater Mb than animals of lot LC (low concentrate). The difference in meat colour from both lots might be related to the different diets, as lot LC had grass hay in the diet. Ageing period modify meat colour due to $MbO_2$ percentage reduction and red index and $A_{580}$-$A_{630}$ proportion increases.


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## References


1. CEE 1208/81, 2930/81 y 1026/91, Modelo comunitario de clasificación de canales de bovinos pesados. Oficina de Publicaciones Oficiales de las Comunidades Europeas. L-2985 Luxemburgo.
2. Grau, R., Hamm, R., 1953. Eine einfache Methone zur Bestimmurg der Wassesbindung mi Muskel. (A easy method for determination of muscle link water). Die Noturwisswnschaften 40 (1), 29-30.
3. Hanson, S.W.F., Olley, J. 1963. Application of the Bligh and Dyer method of lipid extraction to tissue homogenates. Biochemical Journal, 89 (3): 101P- 102P.
4. Centre Internationale de l´Eclairage. 1976. Définition d´un space de colour por deux coordonées de cromaticité et la luminosité. Supplement no.2 to CIE, publication no. 15 (E-1.3.1) 1971 /(TC-1-3), Centre Internationale de l´Eclairage, Paris.
5. Van den Oord A.H.A., Wesdorp J.J. (1971). Analysis of pigments in intact beef samples. J. Food Tech, 6: 1.
6. Krzywicki (1982). The determination of haem pigments in meat. Meat Science, 7: 29-36.
7. Greene B.E., Hsin I.M., Zipser M.W. (1971). Retardation of oxidative color changes in raw ground beef. Journal of Food Science, 36: 940-942.
8. Hood D.E. (1980). Factors affecting the rate of metmyoglobin accumulation in pre-packaged beef. Meat Science, 4: 247-265.