COLOUR STABILITY OF BEEF STORED UNDER VACUUM PACKAGING AND ITS RELATIONSHIP TO CARCASS FATNESS

K. Insausti, G. Indurain, M.V. Goñi, V. Sarriés, B. Hernández, and M.J. Beriain*

Escuela Técnica Superior de Ingenieros Agrónomos, Universidad Pública de Navarra, Campus Arrosadía sn, 31006 Pamplona, Spain. Email: mjberiain@unavarra.es

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Introduction

Beef colour and its relationship with beef palatability are important quality factors for the industry (Faustman *et al.*, 1992). Beef colour depends on the muscle structure and the concentration and chemical state of myoglobin in the muscle surface which varies with time and packing conditions (Renerre and Labadie, 1993). Myoglobin can be present in the muscle surface as reduced myoglobin (deoxymyoglobin, Mb), oxygenated myoglobin (oxymyogobin, MbO_2) and oxidised myoglobin (metmyoglobin, MMb) (Rosset and Roussel-Ciquard, 1978). Half of consumers would refuse beef when MMb percentage in the muscle surface achieves 20% (Renerre and Mazuel, 1985). A brown colour is evident with 40% of MMb and this beef is unacceptable in all cases (Van den Oord and Wesdorp, 1971). Vacuum packaging allows increasing time of storage of beef (Jeremiah and Gibson, 2001) and it can be associated with an improvement of the organoleptic quality of beef and a higher quality assurance. However, chemical reactions, oxidation in particular, are responsible for changes in colour and often determine the practical storage life of meat products. Besides, it has also been shown that shelf-life of retail cuts on display decreases when stored for long periods (Greer and Jones, 1991). Fatness parameters, related to lipid oxidation, have been related to meat pigment oxidation (Mercier *et al.*, 1995; Insausti *et al.*, 1999).

The objectives of the current research were to study beef colour parameters after ageing under vacuum packaging and display and its relationship with carcass colour and fatness.

Materials and Methods

Sixty yearling bulls were slaughtered and carcasses were classified according to the European classification scales for conformation and fatness. Conformation and fatness scales were subdivided in 15 points. After 24 h *post-mortem*, carcasses were sliced at the 6th rib and colour coordinates were measured on *longissimus dorsi* muscle (LM) after the muscle was oxygenated at 4ºC for 60 minutes (LM60). Colour measurements were taken using a spectrocolorimeter (Minolta CM2002, Japan) (λ: 400-700 nm; $\Delta\lambda$: 10 nm; D65; 10º). The representation scheme was based on the CIE (1976) L*a*b* colour coordinates, hue (H*) and chroma (c*). Five readings were taken for each sample at different locations on the muscle. Fat thickness was measured and marbling was measured on the sliced surface of LM by computer image analysis software (Optimas 6.5, Media Cybernetics Inc., USA) (Table 1). For each carcass a steak (1.5 cm thick) was collected at the 8th rib, vacuum packaged and stored 7 days (4 Cº). After storage, samples were removed from the vacuum bags and placed in plastic foam trays and overwrapped with a gas permeable film. Colour coordinates and reflectance between 400 and 700 nm were measured with the spectrocolorimeter after 1 h blooming (7days + 60min) and 48 h display (7 + 2 days) at 4ºC. Mb, MbO_2 and MMb percentages were calculated (Mancini et al., 1991). A t-student test was used to compare the pigment oxidation state of beef after display. Pearson correlation coefficients between %MMb of beef aged 7 days and carcass conformation and fatness, marbling, fat thickness, and early colour measurements were calculated.

Results and Discussion

The 48 h display led to the increase in MMb percentage, in beef aged 7 days, and a reduction in percentage of the other two chemical states of myoglobin (Table 2). The accumulation of MMb on the meat surface after display could be related to a decrease in reducing activity in meat during storage (Faustman and Cassens, 1990). Beef aged 7 days did not show MMb percentages higher than 20% after 1 h blooming. However, after 48h display, 29% of samples showed %MMb higher than 20% and 5% of samples higher than 40%. As lipid oxidation is a promoter of myoglobin oxidation during aerobic storage, (Mercier *et al.*, 1995; Insausti *et al.*, 1999), in the present study, the correlation between marbling and %MMb was studied (Table 3). Beef colour stability could be explained by the differences in intramuscular fat content, but this difference is not reflected by the current carcass grading system. In an attempt to predict colour stability by early measurements on-line, colour coordinates recorded on the LM after cutting the carcasses and 1 h blooming were correlated to %MMb after 7 days of ageing. Beef samples with higher %MMb showed higher a*, b* and C* but lower L* coordinate values. Haem pigment is related to a* coordinate, so that beef with higher pigment content showed lower colour stability after ageing 7 days and less acceptable colour scores (Renerre et al., 1996).

Table 1: Carcass characteristics for conformation, fatness and *longissimus dorsi* colour After 24 h *post-mortem*, and oxygenation at 4ºC for 60 minutes. Mean and standard deviation (SD).

	Mean	SD
Conformation score	10.90 (U-)	0.77
Fatness score	4.97 (2-)	1.16
Marbling	0.03	0.01
Fat thickness	0.32	0.17
L* LM60	38.39	3.54
a* LM60	14.78	2.12
b* LM60	10.23	2.99
C* LM60	18.09	3.04
H* LM60	34.00	7.08

Table 2: Mean and standard error of myoglobin states of *longissimus dorsi* muscle from yearling bulls aged 7 days plus 1 hour blooming or 48 hours display.

	7 days + 60min Mean ± SE	7 days + 2 days display Mean ±SE	
%Mb	5.98 ± 1.14	2.52 ± 1.08	***
%MMb	2.33 ± 1.40	14.37 ± 1.33	***
$\%MbO_2$	97.45 ± 1.35	88.47 ± 1.28	***

Table 3: Correlation coefficients between %MMb of beef aged 7 days and blooming 1 hour or display 2 days, with carcass conformation and fatness, marbling, fat thickness and early colour measures at *longissimus dorsi* muscle.

	7 days + 60min	7 days + 2 days display
Conformation score	0.09	-0.08
Fatness score	0.02	0.12
marbling	0.31(*)	0.34(*)
Fat thickness	-0.04	0.00
L*LM 60'	-0.31(*)	-0.23
a*LM60'	0.30(*)	0.29(*)
b*LM60'	0.34(*)	0.43(**)
C*LM60'	0.35(*)	0.38(**)
H *LM60'	0.22	0.40(**)

Conclusions

It can be stated that after 48h display a high percentage of beef samples aged 7 days under vacuum packaging might be rejected by consumers. There was a relationship between colour stability and fatness, but not with carcass fatness score. Besides, there was observed a relationship between early instrumental colour measurements on the carcass (*longissimus dorsi* muscles) and colour stability of beef after 7 days of ageing.

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SESSION 4: CONSUMER TOPICS