Effect of packaging and aging time on shelf-life of beef meat

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ABSTRACT: The present study aimed to determinate beef meat shelf-life packaged in modified atmosphere (MAP). The experiment was carried out on young bulls Longissimus dorsi肌肉 and considered 2 thesis (meat portioned and conserved in MAP after 3 days “NA” and after 7 days “7A” of ageing), 2 types of packaging (with or without water absorbent pad) and 3 different conservation times (3, 7 or 11 days). The analysis regarded: water loss, colour, TBArs and protein oxidation. Liquid loss showed higher value in packaged meat with absorbent pad than the other (10.38% vs 2.42% P<0.001), while the evaporate liquid was highest in no absorbent pad samples. The positive effect of pad was found in metmyoglobin percentage (13.98% vs 15.10% respectively for its presence and absence) and protein oxidation (67.32 vs 79.26 nmol thiol/mg protein P<0.05). TBArS increased with conservation times from 0.88 to 2.57 mg/100g, while it didn’t show differences between the two thesis and the two different packaging methods. In conclusion the use of absorbent pad improved meat nutritive quality despite produced more water loss.

Key words: Meat quality, Packaging, Lipid and protein oxidation.

INTRODUCTION – In recent years, in response to the dynamic changes in current consumer demand of fresh meat, the food packaging industry has rapidly developed new methods to improve the shelf life in modified atmosphere packaging (MAP) (Ssuppakul et al. 2003; Sonneveld 2000). One of this, is the inclusion of a moisture absorption pad to improve a good appearance of meat and to reduce microbial growth (Veremein et al. 1999). The aim of the present study is to evaluate the effects of absorbent pad used with MAP packaging on fresh meat quality.

MATERIAL AND METHODS – The experiment was carried out on 108 Longissimus dorsi muscles of 18 young bulls subdivided into 2 thesis (meat portioned and conserved in MAP after 4 days aged time “NA” and after 7 days “7A”); each thesis was divided into 2 types of packaging (with or without water absorbent pad) and analysed in 3 different conservation times (3, 7 or 11 days). The physical analysis regarded: percentage of liquid loss (liquid absorbed by pad or deposited on wrapping bottom), evaporate water and organic-inorganic substance loss, colour (lightness (L*), redness (a*), yellowness (b*), hue angle and chrome) by spectrophotometer Minolta CM-2600d, using D65 illuminant according to Cassens et al. (1995). Reflectance spectra between 360 and 740 nm (by steps of 10 nm) were also measured to obtain metmyoglobin percentage (MetMb %) and oxymyoglobin percentage (OxyMb %) as reported in AMSA, 1991. TBArS test expressed as mg of malonaldehyde/100 g of fresh meat (Raharjo and Sofos methods 1993) to determinate lipid oxidation, thiol and carbonyl (Mercier 1998) to calculate the protein oxidations were determinated. Data were analysed using GLM procedure following this tri-factorial model with interactions: Y=μ + Ai+ Bj+ Ck+ (A*B)+ (A*C)+(C*D)+ E ijk; where A= thesis (NA, 7A); B=pad (Yes, No) C= times (3, 7, 11days). Besides the relationships among variables by a principal component analysis (PCA) using PRINCOM procedure (SAS 1986) were considered.

RESULTS AND CONCLUSION – The samples with absorbent pad lost more liquid (10.38% vs 2.42%) and dry matter (2.18% vs 0.76%) than the other (Figure 1), while samples without absorbent pad showed highest value of evaporate water (1.93% vs 0.62%). The liquid loss increased with conservation times from 3 to 11 days (5.23% and 7.35% in average ). No differences were found between the two thesis.
Absorbent meat pad and aging time (Table 1) showed significant effects on colour. The highest lightness, the lowest yellowness and hue values were found in samples packaged without absorbent pad because of drops presence on meat surface, while the two type of packaging did not show significant difference on red index and chrome. Regarding ageing time effect, NA samples showed lower redness, yellowness and chrome values, and higher hue value according to Renerre and Bonhomme (1991). Pigment oxidation, measured by MetMb percentage, were higher without absorbent pad samples (+7%) and it increased with conservation times from 14.24% to 15.11% (P < 0.05).

Lipid oxidation did not show any differences between type of packaging and thesis but TBArs values (table 2) were influenced by storage times, in fact higher values were found in samples analysed at 11 days respect to 3 and 7 storage days (Mercier et al. et al. 1998). Free thiol contents were significantly higher in samples packaged without absorbent pad than other (+15%), like in 7A thesis compared to NA (80.54 vs 66.04 nmol/mg) and along the conservation times its quantity increase from 69.30 to 80.15 nmol/mg, reaching similar values reported in literature.

Table 1. Colour parameters and myoglobin pigments in the two different packaging and thesis.

| Packaging | L*  | a*  | b*  | C   | H   | MetMb% | OxyMb% |
|-----------|-----|-----|-----|-----|-----|--------|--------|
| Without pad | 41.05 | 15.40 | 13.44 | 20.48 | 41.26 | 15.10 | 60.98 |
| With pad   | 39.00 | 14.93 | 14.51 | 20.88 | 44.71 | 13.98 | 61.92 |
| Sig. diff. | *** | ns | ** | n.s | ** | ** | Ns |
| Thesis NA  | 39.90 | 14.23 | 13.57 | 19.73 | 43.96 | 14.99 | 60.07 |
| Thesis 7A  | 40.11 | 16.09 | 14.38 | 21.62 | 42.00 | 14.09 | 62.84 |
| Sig. diff. | ns | ** | ** | ** | * | ns | Ns |
| 3 days     | 39.74 | 14.82 | 13.74 | 20.33 | 42.48 | 14.24 | 61.99 |
| 7 days     | 39.29 | 15.07 | 13.79 | 20.42 | 43.21 | 14.28 | 62.05 |
| 11 days    | 40.54 | 15.59 | 14.39 | 21.28 | 43.26 | 15.11 | 60.32 |
| Sig. diff. | ns | ns | * | ns | ns | * | Ns |
| RMSE       | 2.42 | 2.68 | 1.30 | 2.61 | 3.97 | 1.85 | 5.83 |

ns: not significant effect; * P < 0.05; P < = 0.01 **; P < 0.001 ***.
Carbonyl content didn’t show any differences for all parameters. Multivariate analysis (Figure 2) pointed out the strong effect of pad on meat shelf life, in fact the two groups scores were splitted in noticeable way and PCA1 and PCA2 explained the 73% of variability. The loading analysis showed an high effect of liquid loss in opposite side of lipid oxidation and lightness. The pigment, lipid and protein degradation was marked in samples without pad at 11 conservation days showing a low shelf life, but the excessive absorbent capacity of pad removed from meat much liquid. In conclusion the use of packaging with absorbent pad improve nutritional quality but causes excessive meat dehydration.

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Table 2. Protein and lipid oxidation.

|                  | Carbonyl (nmol/mg) | Thiol (nmol/mg) | TBArs (mg/g) |
|------------------|-------------------|-----------------|-------------|
| Without pad      | 5.59              | 79.26           | 1.45        |
| With pad         | 5.88              | 67.32           | 1.75        |
| Sig. diff.       | Ns **             | ns              |             |
| Thesis NA        | 5.03              | 66.04           | 1.64        |
| Thesis 7A        | 6.44              | 80.54           | 1.56        |
| Sig. diff.       | Ns ***             | ns              |             |
| 3 days           | 4.83              | 69.30           | 0.88        |
| 7 days           | 6.12              | 70.43           | 1.35        |
| 11 days          | 6.25              | 80.15           | 2.57        |
| Sig. diff.       | Ns                 | * ***           |             |
| RMSE             | 3.65              | 18.86           | 0.81        |

ns: not significant effect; * P < 0.05; P <= 0.01 **; P < 0.001 ***.

Figure 2. Loading and score of PCA analysis

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