EXTENTED DRY AGEING TIME EFFECT ON WATER HOLDING CAPACITY AND COLOUR OF PIEMONTESE CULL COW BEEF

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Abstract – The aim of this study was to determine the effect of extended dry aging time on water-holding capacity and colour of *Longissimus thoracis and lumborum* muscle from 10 Piemontese cull cows.
At d1, d9, d15 and d44 *post mortem*, water-holding capacity by the filter paper press method (M/T and pressing losses), cooking losses, colour parameters (L*, a*, b*) and reflectance spectra (R, %) were measured. From CIEL*a*b* values and reflectance curve, Chroma, Hue, colour differences (ΔE*), Mb, OMb and MetMb percentages were calculated. The results indicate that ageing strongly affected water-holding capacity. Between d15 and d44 M/T ratio values increased from 0.53 to 0.62 ($P<0.01$) and pressing losses decreased from 38.31% to 31.98% ($P<0.01$). Cooking losses decreased significantly until 9 days of ageing, then it remained relatively constant. No differences of colour were observed apart from Mb percentage, which decreased from d1 to d9 ($P<0.05$).
Extended dry ageing time influenced water-holding capacity significantly and had little effect on colour.
Extended dry aging can be used with Piemontese cull cows beef because a niche market of consumers who prefer this meat and are willing to pay extra money for it exists.

Key Words – beef, ageing time, water-holding capacity, colour.

I. INTRODUCTION

In Italy, the national cow herd contributes 436.315 animals to total beef production, which are 17.4% of all cattle slaughtered, thus representing an important source of meat for beef market [1]. However, cow meat is often less tender than that of younger animals due to increased mature collagen cross-links associated with the age of animals. One of the most effective management practices for improving beef eating qualities, and in particular tenderness, is ageing.

Today, there are two types of ageing: wet and dry ageing. Wet ageing involves storing the product at refrigerated temperature in vacuum sealed package, whereas in dry ageing, the primals end or subprimals are unpackaged and exposed to air at controlled temperature and relative humidity [2; 3].

Wet ageing is widely used in commercial beef production, but there is increasing interest in the use of extended dry ageing to produce a premium product. Extended dry ageing is believed to produce a unique and desirable flavor due both to the development of different compounds in the presence of oxygen and to the reduction of moisture in meat due to evaporation, with the subsequent concentration of the flavor-responsible [4].

However, the benefits found in some palatability traits for increasing dry ageing time could be not effective if the ageing time is extended for more than 14 days.

The main disadvantage of extended dry ageing is the weight loss, as a consequence of evaporative loss, resulting in reduced water content and the discolouration and/or desiccation of externally exposed muscles resulting in the necessity of trimming [5].

The other disadvantage is that during extended dry ageing beef muscles undergo several changes that could negatively affect beef colour. Therefore the objective of this study was to assess the effect of extented dry aging time on water-holding capacity and colour of beef cull cows.

II. MATERIALS AND METHODS

This study used 10 animals which were divided into two groups: five cows, EU grading U2 with an average age of 4 years and average carcass weight of 466 kg, and five cows, EU grading U2 with an average age of 10 years and average carcass weight of 409 kg. Animals were slaughtered in a EU approved slaughterhouse and chilled at 4°C. Twenty four hours *post mortem* carcasses were shipped via refrigerated truck to a commercial facility for ageing. Upon arrival, the portion of LTL of the right side, from 8th thoracic vertebra to the 4th lumbar vertebra, was exicised and divided into four equal size sections (about 12 cm in length), which were assigned to 1, 9, 15 and 44 days of ageing according to a latin square design. This was done to remove the muscle location effect.

The d9, d15 and d44 sections were placed in a dry-aging cooler (Maturmeat®), set at 1°C and 85% R.U. with intensive air circulation. This procedure was adopted to make sure that the fresh beef dries as quickly as possible on the surface to stop bacteria growth. However, at each ageing time microbiological investigations, which will be not discussed here, were performed.

Immediately after, the d1 section was shipped under refrigeration to the Laboratory of the DISAFA.

One steak from d1 section was removed for chemical and physical analyses including pH, water-holding capacity and colour measurements. The same analyses were performed on the other sections at appropriate ageing time after removing the dry surfaces.

Muscle pH was measured at 30 h *post mortem* (d1) using a Crison pH-meter equipped with a combined electrode, which was inserted into the lumbar region.

The water-holding capacity was measured by two methods: filter paper press method [6] and cooking losses.

The ratio of meat area to expressed juice area adsorbed by the filter paper (M/T) is an index of water-holding capacity [7]. The amount of water released was also evaluated by pressing losses (PL) weighing meat sample before and after pressure applied [8].

Cooking losses (CL) was determined by weighing meat samples before and after cooking in a water bath at 80°C to an internal temperature of 70°C.

Colour was measured on the freshly-cut surface of the steack after 1 h of blooming, by a Minolta CM600d spectrophotometer using CIEL*a*b* colour space with a D65 illuminant, 10° standard angle observer and specular component excluded [9]. CIE L* (lightness), a* (redness), b* (yellowness) values and reflectance spectra (R, %) were collected.

Hue, Chroma and CIEL*a*b* difference (ΔE*) were calculated. Total colour changes (ΔE*) express the magnitude of difference between d9, d15, and d44 vs d1.

Reflectance spectra data were used to calculate myoglobin, oxymyoglobin and metamyoglobin values according to Kryzwicki [10].

Data were analysed using the GLM procedure of SPSS (Inc., Chicago, IL), considering as factors age at slaughter, ageing and their interaction. A GLM of reflectance spectra at each wavelength was also performed in order to find significant differences among ageing times.

III. RESULTS AND DISCUSSION

As no significant age at slaughter x ageing interaction occurred, only the main effects are reported in the tables. The results for pH and water-holding capacity, are reported in table 1 and 2.

Ultimate pH was in the normal range, with an average of 5.47 and indicate a regular development of *post-mortem* glycolisis.

The results indicate that ageing strongly affected water-holding capacity.

In the period between d1 and d44, M/T ratio values increased from 0.46 to 0.62, but a significant increase ($P<0.01$) was observed only between d15 and d44 (+16.98%). This certify that during ageing meat lost a large amount of water by evaporation and drip.

The decrease of water content as a consequence of ageing length was also evident when pressing and cooking losses were considered. As regard pressing losses a significant lower percentage was observed at d44 in comparison with the other ageing times. Cooking losses decreased significantly until 9 days of ageing then it remained nearly constant. During ageing, muscle structures become looser because of degradation of myofibrillar and cytoskeletal proteins [11]. In addition, the ion-protein interactions change and capillary space accessible for water becomes bigger. These changes enable meat to hold water.

Table 1. Effect of age at slaughter on pH_u, and water-holding capacity of beef from Piemontese cull cows

	Age at slaughter		
	Young Cows	Old Cows	sem
pH	5.48	5.47	0.02
M/T	0.52	0.52	0.02
PL (%)	37.69	38.49	1.04
CL (%)	21.55	20.22	0.71

Table 2. Effect of ageing times on water-holding capacity of beef from Piemontese cull cows

	Ageing time				
	d1	d9	d15	d44	sem
M/T	0.46B	0.48B	0.53B	0.62A	0.02
PL (%)	42.37A	39.71A	38.31A	31.98B	1.47
CL (%)	23.78A	19.81B	20.26B	19.69B	1.01

A, B means in the same row with different letters differ significantly (P<0.01).

Colour is mainly dependent on the concentration and chemical state of the meat pigments, primarily myoglobin, and on the physical characteristics of meat, such as light scattering and absorbing properties [12].
Ageing did not affect CIEL*a*b* parameters (table 3 and 4). Therefore, colour differences were very small (ΔE*~2) and difficult to distinguish.

Table 3. Effect of age at slaughter on colour of beef from Piemontese cull cows

	Age at slaughter		
	Young Cows	Old Cows	sem
L*	38.89	37.43	0.85
a*	16.09	16.26	0.71
b*	13.74	13.27	0.64
Chroma	21.18	21.00	0.94
Hue	40.26	39.27	0.55
ΔE*	---	1.54	---
Mb (%)	15.00	18.04	1.34
OMb (%)	65.07	62.72	1.90
MMb (%)	19.93	19.24	1.70

However, colour parameters tended to be higher especially in steaks aged d44 in comparison with that of d1. The degradative structural changes in meat during ageing could explain an increase in lightness due to changes in the light scattering properties of the meat surface [13].

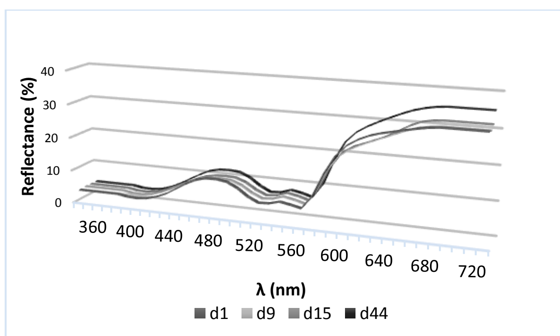
Table 4. Effect of ageing times on colour of beef from Piemontese cull cows

	Ageing time				
	d1	d9	d15	d44	sem
L*	37.98	37.62	37.76	39.28	1.20
a*	16.56	15.21	15.29	17.65	1.01
b*	13.67	12.65	13.06	14.64	0.91
Chroma	21.49	19.80	20.13	22.95	1.33
Hue	39.47	39.39	40.47	39.73	0.78
ΔE*	---	1.73	1.43	1.95	---
Mb (%)	23.10A	14.63B	12.90B	15.46B	1.90
OMb (%)	61.78	64.06	64.24	65.51	2.68
MMb (%)	15.12	21.32	22.86	19.03	2.40

A, B means in the same row with different letters differ significantly (P<0.01).

In general, the increase of the *post-mortem* ageing time decreases the color stability of fresh meat.
In fact, regardless of the chemical state of myoglobin, ageing significantly decreased Mb content from d1 to d9 and increased the amount of OMb and MMb, throughout the aging time, but not significantly.
In figure 1, the average reflectance spectra between 360 and 740nm of the four ageing times are shown.

Figure 1. Reflectance spectra of the four ageing times



The differences between the four reflectance spectra in the range 360 and 680nm were not marked.

The d44 reflectance spectrum was always above of the d1 spectrum and between 680 and 740nm showed significantly higher values in comparison with d1 spectrum.

The increase in reflectance values in this range could be related to water-holding capacity. Its decrease might cause the meat structure to close up, driving out the intracellular water, thus hindering light penetration into the myofibrils and increasing light scattering, hence reducing light penetration [13].

Changes in meat during ageing would also facilitate increased oxygen penetration into the meat, thus causing increased meat redness and intensity of redness after ageing [14].

IV. CONCLUSION

Even if the majority of beef consumed in Italy today is wet aged, dry aging of beef is largely applied to improve palatability characteristics.

The effect of extended dry ageing time on colour was little but a significant reduction of water-holding capacity was observed.

Extended dry aging can be used with cull cows beef because a niche market of consumers who prefer this meat and are willing to pay extra money for it exists.

Only in this way it is possible to recover the value added by the marked additional weight loss.

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