COLOUR AND TEXTURE OF VEAL AS INFLUENCED BY BREED AND AGEING

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Abstract – The aim of this study was to evaluate the effects of breed and ageing on colour and texture of veal. Twenty-eight male calves, 14 Holstein-Friesian (F) and 14 Crossbreds (C), were slaughtered at 6 months of age at 268 kg and 280 kg of live weight for F and C group, respectively.
At 24 h after slaughter, the carcasses were weighed and a sample of *longissimus thoracis* muscle was collected, weighed and aged for 5 and 10 days at 4°C, then frozen and stored until analysis. Thawing loss, pH, CIELab parameters, heme pigment, collagen content, heat solubility of collagen, Warner-Bratzler and Hardness at 20% and 80% were determined.
Live weight, cold carcass weight and dressing percentage in the C group were higher than in F group.
Under these experimental conditions, the veal quality of the two groups was similar even if C group showed a more vivid colour. No effects due to ageing were observed for all the characteristics.
The higher market value of crossbred calves sold at livestock auctions is probably due to the effect of sire breed that contributes to a higher dressing percentage and to a higher proportion of high-value cuts in the carcass.

Key Words – calves, physical analyses, meat quality.

I. INTRODUCTION

Veal is a significant meat source of substantial value in Italy. According to the 2014 ISTAT data, veal represented 26% of the cattle slaughtered [1] and contributed for 13% to the total beef production in Italy [2]. However, the self-supply of calves born, raised and slaughtered for meat production in Italy covered only 60% of the national demand. Forty percent of the national deficit is covered by importing both fresh or frozen meat of animals raised and slaughtered abroad, mainly in the Netherlands, and calves from Poland, Austria and France [3].
Tipically, the animals are reared in closed barns for the whole fattening period and are fed milk replacer supplemented by small amounts of roughage, to obtain the so called "white meat" characterized by a pale pink colour due to the low content of myoglobin in the muscle. The fattening cycle lasts 26-28 weeks and calves are slaughtered at a final weight of 260-290 kg. Due to the young slaughtering age of the animals, veal is very tender.
Calves reared for veal production are purebreds from dairy breeds, mainly Holstein-Friesian and Brown Swiss, but crossbred dairy calves are also commonly used. As the market value of dairy crossbred calves (euro/calf) sold at livestock auctions is higher than that of dairy purebred, the aim of this study was to evaluate whether breed and ageing affect the veal quality characteristics.

II. MATERIALS AND METHODS

In this study, 14 Holstein-Friesian (F) and 14 Crossbreds (C) male calves were fed the same diet based on solid feed in addition to the liquid diet, as set by the 97/2/EC Directive by the Council of Europe [4]. The calves were kept on slatted floor, in groups for the all fattening period.
The animals were slaughtered in the same slaughterhouse when they reached 6 months of age, 268 kg and 280 kg of live weight for F and C group, respectively.
At 24 h after slaughter, the carcasses were weighed and a sample of *longissimus thoracis* muscle from the 8th to the 11th rib of the right-half carcass of each calf was excised.

The samples were weighed, vacuum packaged, and aged for 5 and 10 days (d5, d10) at 4°C, then frozen and stored at -25°C until analysis. The samples were thawed in individual bags overnight and the following analyses were performed:

- thawing loss (TL), using the formula TL(%) = (W0-W1)/W0x100, where W0 and W1 are the weights before freezing and after thawing.
- pH, using a Crison pH-meter fitted with a spear type electrode.
- colour on the freshly-cut surface after 1 h of blooming, with a Minolta CM600d spectrophotometer using CIEL*a*b* colour space, set with Specular Component Excluded and D65 illuminant. CIE L* (lightness), a* (redness), b* (yellowness) values and reflectance spectra (R, %) were collected and Chroma (C*) and Hue (H*) were calculated. In addition, the colour CIEL*a*b* difference (ΔE*), was calculated by the following equation: $\Delta E^*=(\Delta L^{*2}+\Delta a^{*2}+\Delta b^{*2})^{1/2}$ [5].
  Reflectance spectra data were used to calculate myoglobin (Mb), oxymyoglobin (OMb) and metmyoglobin (MMb) values according to Kryzwicki [6].
- heme pigment content according to Hudzik [7].
- collagen content by colorimetric analysis of hydroxyproline according to the ISO 3496 procedure and multiplication of hydroxyproline content by factor 8 [8]. Heat solubility of collagen was determined according to Sörensen (2h at 80°C) [9].
- Warner-Bratzler shear force (WBsf). Raw meat samples of rectangular cross section 1x1x3 cm were removed parallel to the muscle fibres direction. Samples were sheared perpendicular to the fibre direction with a V-shaped cutting Warner-Bratzler device which measures the peak force (PF) required to cut the meat block in half perpendicular to its length [10]. An Instron 5543 was used, with the crosshead speed set at 200 mm/min.
- Texture Profile Analysis (TPA), with a square compression cell (10 x 10 mm square) equipped with two lateral walls to avoid transversal elongation of the samples. The raw samples were compressed twice perpendicular to the fibre axis to 20% and 80% of their original height. Among the TPA parameters, hardness was considered [11].

Data were analysed using the GLM procedure of SPSS (Inc., Chicago, IL), considering as factors breed, ageing and their interaction.

III. RESULTS AND DISCUSSION

A summary of the live weight, cold carcass weight and cold dressing percentage of the two groups is given in table 1.
All the traits in the C group were significantly higher than in F group.

Table 1. Least square means for live weight, cold carcass weight and dressing percentage as influenced by breed

	Breed		
	F	C	SEM
Liveweight (kg)	268.5B	280.0A	1.78
Carcass weight (kg)	146.3B	160.6A	1.84
Dressing percentage (%)	54.5b	57.3a	0.60

a,b: P<0.05
A, B: P<0.01

As regards veal quality traits, no significant breed x ageing interactions were observed, therefore only the main effects are presented.
Muscle pH, thawing loss and colour values are reported in table 2.
Muscle pH varied from 5.45 to 5.47 and remained constant during the ageing period. These values indicate a regular development of *post-mortem* glycolysis and are similar to those reported by other Authors [12, 13]. In agreement with data previously reported for calves, no significant differences were observed due to the breed [12] at any of the two ageing times studied.
Also the TL differences for F and C groups at d5 and d10 were not significant.
In most countries, the pale colour of meat is one of the criteria by which consumers judge the veal quality.
Colour is related to the concentration of pigments, mainly myoglobin, and their chemical state, and meat structure, such as light scattering and absorbing properties [14].
As a general result, veal had a very light colour due to high L* values together with low a* and

high b* values. This characteristic depends on the milk-based feeding system and the young age of the animals.

Table 2. Least square means for muscle pH, thawing losses, colour parameters and Fe heme, as influenced by breed and ageing

	Breed		Ageing		
	F	C	5d	10d	SEM
pH	5.47	5.45	5.45	5.47	0.01
TL (%)	10.58	11.63	10.98	11.23	0.33
L*	53.37	54.19	53.62	53.94	0.67
a*	6.91	7.78	7.36	7.33	0.37
b*	15.15b	16.20a	15.53	15.82	0.24
C*	16.76b	18.04a	17.29	17.51	0.29
H*	65.75	64.57	65.13	65.18	1.11
Fe (μg/g)	3.77	4.14	3.94	3.70	0.14
Mb (%)	25.72	20.30	27.72	18.29	2.77
OMb (%)	62.68	67.57	62.51	67.75	2.12
MMb (%)	11.60	12.13	9.77	13.96	1.14

a,b: P<0.05

Significant differences were observed due to the breed. C calves had higher b* and Chroma values and consequently had a more vivid colour than F animals. Chroma, or color saturation, high values denote a lack of greyness.

No differences were observed for lightness (L*), redness (a*) and hue (H*) values, with a trend for higher values in L* and a* in veal of C group.

As a whole, colour differences between groups were small (ΔE* < 2) and therefore difficult to be distinguished with the naked eye according to the scale proposed by Abril *et al*. [15]. As in Revilla *et al.* [12], no colour differences due to the ageing were observed.

Because of the young age of the animals and the diet, the Fe heme concentration was very low (< 5mg/g of raw meat) and no significant difference between the groups was observed.

During the ageing, the MMb percentage of the two groups increased, but the differences between the d10 and d5 were not significant. Besides, the MMb values were in any case considerably lower than 20%, that is suggested as threshold under which the meat should be considered satisfactory. In fact, when around 20% of the surface pigment has oxidized, the colour change can be large enough to cause consumer discrimination [16].

For consumers, tenderness is the most important veal meat palatability characteristic.

Tenderness and texture is influenced by connective tissue, myofibres and the sarcoplasmic protein components of meat. However, collagen, the major component of intramuscular connective tissue, is a key factor affecting meat tenderness. Therefore, the amount of collagen molecules and its solubility can all influence meat texture and ultimately veal quality.

The results of tenderness and texture are reported in table 3.

Table 3. Least square means for Warner Bratzler shear force, Hardness at 20% and 80%, collagen content and collagen solubility as influenced by breed and ageing

	Breed		Ageing		
	F	C	5d	10d	SEM
WBsf raw meat (N)	43.07	43.26	43.66	42.66	1.27
Hardness 20% (N)	23.26	22.50	22.84	22.92	0.83
Hardness 80% (N)	67.05	64.99	67.53	64.51	1.46
Collagen (mg/g)	4.73	4.60	4.61	4.72	0.11
Collagen solubility (%)	27.0	28.1	27.41	27.74	0.66

Nor breed neither ageing influenced peak force because the measurements were carried out on raw meat and consequently the tenderizing effect of cooking on connective tissue was lacking. In fact, shear force on raw meat mainly reflect background or collagen toughness.

Compression test at 20% and 80% with fibres perpendicular to the tool can be used to estimate the relative contribution of myofibres and connective tissue to texture [11].

No significant differences in the compression values at 20% (H20%) between groups and ageing were observed. Generally, compression values at 20% are lower when ageing time increases due to the enzyme activities which produce myofibrillar degradation. We did not observe any reduction of compression values at 20%, which confirms that in veal an aging period of 5 days is enough to induce most of the myofibrillar degradation. In fact, Buchter [17] showed that no significant increase of tenderness occurs after 4 to 5 days for calves.

Because ageing does not influence the mechanical resistance of connective tissue, no significant differences were detected between d5 and d10 for hardness at 80% (H80%). These results are in agreement with Eikelenboon *et al.* [18], who reported that connective tissue did not change during ageing.

No significant differences in the collagen content and solubility between groups and ageing were observed.

The solubility of the collagen of both groups was high, as expected in young animals. This factor is said to favour the accumulation of new, very soluble, collagen.

IV. CONCLUSION

In conclusion, the present findings indicated that, under these experimental conditions, ageing had no effect on veal quality. The meat quality of the two groups was very similar. C group showed only a more vivid colour. The higher market value of dairy crossbred calves (euro/calf) sold at livestock auctions is probably due to the effect of the sire breed that contributes to a higher dressing percentage and to a higher proportion of high-value cuts in the carcass.

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