EFFECT OF HYBRID TYPE AND AGEING TIME ON CARCASS COMPOSITION AND SENSORY ATTRIBUTES OF BEEF MEAT

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Abstract

This research is subscribed of an extensive project that has as main objective the production of crossbred specialized beef hybrids from reformed Romanian Black Spotted cattle's with bulls from breeds specialized in meat production (Blue Blanch Belgique, Aberdeen-Angus and Limousin). The obtained half-breeds products (fifteen bulls) were raised under semi-intensive conditions and slaughtered at 12 months of age. Vacuum packaged loin chops were aged for 1, 3, 5, 7, 11, and 15 days at 4 °C and evaluated by a trained taste panel. Ageing time had the main influence in all the studied sensorial descriptors. Hybrid type did not affect fibrosity or overall flavor intensity. Interactions between hybrid type and ageing appeared in global odor intensity, tenderness and acid flavor intensity ($P < 0.05$). All hybrid types showed higher tenderness scores as ageing period increased. Our results showed that the existing variability in the ageing evolution of meat depends on hybrid type. Because tenderness has been the main sensory attribute influenced by ageing we suggest an early consumption of RBSxBBB hybrid type meat after slaughter and a larger period for RBSxAA and RBSxLi hybrid types to obtain an optimum tenderness value according to consumer expectations.

Key words: beef meat sensory quality, carcass quality

INTRODUCTION

Dairy cattle are an important first line for the universal agriculture due to its volume, diversity and value of production and products obtained from this activity. In Romania, this activity has a tradition among the rural population, their low power consumption and their natural diets give a character of sustainable activity for the future [1].

At national level, the strategy is focused on the continuous improvement of the indigenous breeds with the economic support for the farmers. From this point of view, the indigenous cattle breeds, reformed on the basis of the annual milk production (selective reform) could be used in industrial crosses at first generation with bull breeds specialized in meat production, the resulting products being entirely fattened and slaughtered for the meat production.

This transition solution in dairy cows is a viable alternative for many farmers, especially for those who have an insufficient milk quota and for improving carcass and meat palatability characteristics of national rustic cattle breeds. A plus is the fact that consumers prefer meat that has certain desirable degrees of tenderness, juiciness, and flavor [2].

MATERIALS AND METHODS

The experiment was conducted on the affiliated farm for Cattle Breeding Research Station from Dancu - Iaşi (47°09'23.2" N, 27°38'55.8" E), Romania. Six non-castrated male yearlings beef hybrids from reformed Romanian Black Spotted cattle's with bulls from breeds specialized in meat production (Blue Blanch Belgique, Aberdeen-Angus and Limousin) were studied.

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The animals were housed in free stalls system (~ 5.0 m^2 per bull) in an uninsulated barn with straw bedding. After weaning, at the age of six months, bulls were fed with a mixed diet available ad libitum based on daily energetic and protein concentrates: approximately 56% dry matter (DM) (6.09 kg DM), 0.599 kg PDIN, 0.559 kg PDIE and minerals as: 0.038 kg Ca and 0.025 kg P. The animals were deparasitised (Dectomax) and vaccinated (Antravac, Cattlemaster 4). The bulls were weighted once a month to determine daily live weight gain.

After reaching the target slaughter age of 12 months, the animals were transported to an EU-licensed commercial abattoir and slaughtered.

After chilling at 4ºC for 24 h, carcass conformation (SEUROP) and fatness scores were assessed. The samples of m. longissimus lumborum et thoracis were collected from between the 9th and 11th rib. Four-centimetre thick chops were cut, randomly assigned to one of the six postmortem ageing periods and vacuum packaged individually, the samples with one day of ageing being frozen immediately. The rest of samples were kept at 4ºC until the ageing time reached 3, 5, 7, 11 or 15 days, before being frozen and stored at -20ºC.

The samples were thawed at 4ºC overnight, 24 h before each panel session. Meat was cooked in a conventional oven, at 200ºC inside aluminum paper, until it reached 70ºC of internal temperature. Every steak was then trimmed of any external connective tissue, cut into 2 cm^2 samples, wrapped in codified aluminum paper and stored (approximately 10 min) in warm pans at 60ºC until tasted.

Samples were randomly served to a trained four member sensory panel. A comparative multisampling test, with three samples each time, was used to detect differences in sensory attributes among each hybrid and ageing time, by means of a balanced incomplete block design, as described by Meilgaard, Civille and Carr (1991). In every session, samples were presented in different order to each panelist for 15 sessions.

Beef meat sensory profile was defined on a nine-point scale trough overall odour intensity, tenderness (defined as the opposite of the force required to bite through the sample with the molars), juiciness (amount of moisture released by the sample after the first two chews), fibrosity (amount of fibers perceived after four chews), global, acid and livery flavor intensity.

A sample from the m. Longissimus dorsi thoracis was used for assessing the percentage of intramuscular fat content (IMF) according to procedures of the AOAC (2007).

Statistical analyses were made with SPSS v.20 software package (SPSS Inc., Chicago, IL). The results were evaluated using GLM procedure, fitting a two-way model with a fixed effects of hybrid type (3 levels) and ageing time (6 levels: 1, 3, 5, 7, 11 and 15 days for) plus the interaction effect. The principal component analysis (PCA) was used on all samples and variables to unravel the differences between beef hybrids among sensory attributes, being used as a comparative evaluation. We didn't applied LSD test because the number of animals / genotype was only two.

RESULTS AND DISCUSSION

A summary of individual production and carcass characteristics are shown in Table 1.

Since retention of the principal components is based on PCA with Eigen values > 1, four principal components fit these criteria for the sensory attributes initial data (Fig. 1).

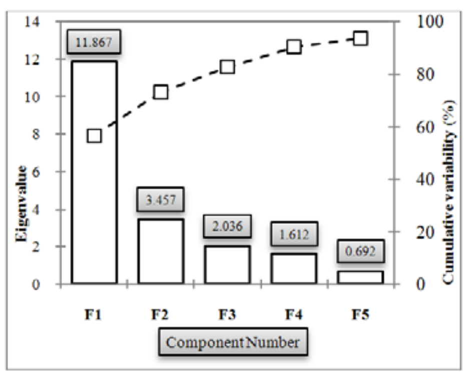

Fig. 1 PCA screen plot of sensory attributes on all samples and variables

Table 1 Production carcass characteristics and intramuscular fat content of cattle hybrid types included in the experiment

	RBS*BBB	RBS*AA	RBS*Li
Slaughter weight (kg)	370.14±12.16^a	312.10±4.46^b	328.84±9.10^c
Daily weight gain (kg)	1.02±0.13^a	0.8±0.15^b	0.90±0.12^c
Hot carcass weight (kg)	212.29±6.94^a	167.30±2.14^b	178.30±4.79^c
Cold carcass weight (kg)	208.05±6.81^a	163.95±2.10^b	174.73±4.68^c
Carcass yield (%)^d	56.21±0.15^a	52.53±0.27^b	53.14±0.16^c
EUROP conformation	U+	R+	R-
Fatness classification	2-	2+	2+
IMF (%)	1.54±0.32	2.07±0.52	1.54±0.70

$^{a, b, c}$ significant differences between hybrid type P < 0.01;
^{d} Cold carcass weight * 100 / slaughter weight;

Significance of sensory attributes main effects is shown in Table 3. Ageing time has been the most important factor in every sensory descriptor studied. No significant hybrid type effect was observed in overall odour intensity, fibrosity, global flavor intensity and liver flavor intensity. There was an interaction between ageing time and hybrid type in juiciness (P < 0.01), tenderness, global and acid flavor intensity (P < 0.05).

Table 3 Significance of main effects in the studied sensory descriptors

	Ageing	Hybrid	A*H
Overall odour intensity	**	n.s.^{a}	n.s.^{a}
Tenderness	***	**	*
Juiciness	***	***	**
Fibrosity	***	n.s.^{a}	n.s.^{a}
Global flavor intensity	***	n.s.^{a}	*
Acid flavor intensity	***	***	*
Liver flavor intensity	***	n.s.^{a}	n.s.^{a}

^{a} n.s.=no signifcant effects;
*P < 0.05; **P < 0.01; ***P < 0.001.

Overall odour intensity and liver flavor intensity has fluctuated throughout ageing (Table 4), increasing especially at 15 days, respectively starting with the 7th day, as previously found by Campo et al. (1999). The oxidation process that could produce off-flavour affecting overall odour intensity was probably reduced with the vacuum packaged methodology and the intact loin steak used [9].

Liver flavour had an average value of 1.67 with a small influence on the perceived global flavour intensity. The rest of the overall odour could be due to many volatile compounds, which have been described as components of cooked meat [6].

Texture was the most influential factor in meat throughout ageing, especially tenderness. In all the hybrid types, sensory values for tenderness were higher as the ageing time increased (Table 5), according to other previous findings [2].

Juiciness showed a different evolution along ageing, depending on the observed hybrid type. The degradation of the myofibrilar and connective structure [5] could have been responsible for the decreasing fibrousness scores throughout the ageing process (Table 5). Acid flavour intensity also increased with ageing (P < 0.001), as described by Spanier et al., (1997), especially started with the 7th day.

Table 4 Overall odour intensity, global flavor intensity, acid flavor intensity and liver flavor intensity values (mean ± S.D.) in every hybrid type (RBSxBBB, RBSxAA, RBSxLi) at every ageing time (1, 3, 5, 7, 11 and 15 days)

Ageing (days)	Overall odour intensity[a]			Global flavor intensity[a]			Acid flavor intensity[a]			Liver flavor intensitya[d]		
	RBSxBBB	RBSxAA	RBSxLi	RBSxBBB	RBSxAA	RBSxLi	RBSxBBB	RBSxAA	RBSxLi	RBSxBBB	RBSxAA	RBSxLi
1	5.11±0.53	5.44±0.47	4.88±0.40	5.13±0.15	5.35±0.15	5.23±0.26	1.89±0.34	1.63±0.20	2.13±0.52	1.34±0.19	1.48±0.40	1.13±0.19
3	5.42±0.30	5.31±0.52	5.00±0.31	5.15±0.11	5.10±0.06	5.16±0.23	2.10±0.42	1.73±0.31	1.79±0.14	1.66±0.20	1.50±0.18	1.53±0.23
5	5.53±0.25	5.05±0.37	5.18±0.24	5.20±0.27	5.31±0.17	5.23±0.15	2.51±0.23	1.94±0.42	2.00±0.29	1.77±0.27	1.58±0.26	1.62±0.72
7	5.39±0.20	4.91±0.22	5.26±0.18	5.26±0.17	5.47±0.32	5.35±0.61	2.81±0.12	2.06±0.45	2.17±0.15	2.03±0.16	1.64±0.22	1.91±0.39
11	5.31±0.22	5.48±0.24	5.31±0.29	5.47±0.19	5.51±0.26	5.61±0.29	2.26±0.14	2.3 ±0.26	2.42±0.17	2.13±0.35	1.63±0.29	1.64±0.28
15	5.85±0.15	5.65±0.33	5.55±0.13	5.57±0.18	5.63±0.33	5.78±0.22	2.12±0.11	1.96±0.27	2.25±0.21	1.73±0.15	1.94±0.18	2.10±0.37

a 1, very low intensity – 9, very high intensity;

Table 5 Tenderness, juiciness and fibrosity values (mean ± S.D.) in every hybrid type (RBSxBBB, RBSxAA, RBSxLi) at every ageing time (1, 3, 5, 7, 11 and 15 days)

Ageing (days)	Tenderness[b]			Juiciness[c]			Fibrosity[d]		
	RBSxBBB	RBSxAA	RBSxLi	RBSxBBB	RBSxAA	RBSxLi	RBSxBBB	RBSxAA	RBSxLi
1	5.34 ± 0.19	5.10± 0.18	4.86 ± 0.32	4.63 ± 0.36	4.29 ± 0.20	4.33 ± 0.48	4.32 ± 0.38	4.58 ± 0.11	4.62 ± 0.13
3	5.40 ± 0.27	5.16 ± 0.21	4.91 ± 0.17	4.08 ± 0.09	4.41 ± 0.08	4.01 ± 0.18	4.28 ± 0.24	4.13 ± 0.22	4.19 ± 0.33
5	5.58 ± 0.23	5.31 ± 0.20	5.27 ± 0.13	4.49 ± 0.32	5.05 ± 0.28	4.59 ± 0.35	4.44 ± 0.20	4.27 ± 0.15	4.05 ± 0.12
7	5.60 ± 0.22	5.59 ± 0.29	5.46 ± 0.31	4.12 ± 0.10	4.26 ± 0.12	4.22 ± 0.14	4.53 ± 0.24	4.31 ± 0.11	4.14 ± 0.10
11	5.77 ± 0.31	5.85 ± 0.28	5.63 ± 0.30	4.20 ± 0.16	4.71 ± 0.26	4.00 ± 0.41	3.94 ± 0.19	4.12 ± 0.16	4.00 ± 0.24
15	6.05 ± 0.21	5.94 ± 0.18	5.82 ± 0.23	4.32 ± 0.26	4.61 ± 0.22	4.49 ± 0.19	3.72 ± 0.49	3.97 0.14	3.88 ± 0.31

b 1, very tough – 9, very tender;
c 1, very dry – 9, very juicy;
d 1, very low fibrosity – 9, very high fibrosity;

As shown in Fig. 2, 74.12% of the total variation of initial data for sensory attributes is represented throughout PC1 and PC2. The fibrousness is represented opposite to tenderness and juiciness, separated by PC1 and PC2. Fibrousness could be characteristic of the unaged muscle fibre and tenderness and juiciness could define the evolved muscle throughout ageing. Long ageing periods would be related to more tender meat. Flavor compounds were related to late post-mortem times, showing the necessity of an ageing period for their development longer than 11 days.

In the present study, in agreement with Campo et al., (1999), the influence of the intramuscular fat content (IMF) was less important in textural characteristics than ageing or other factors.

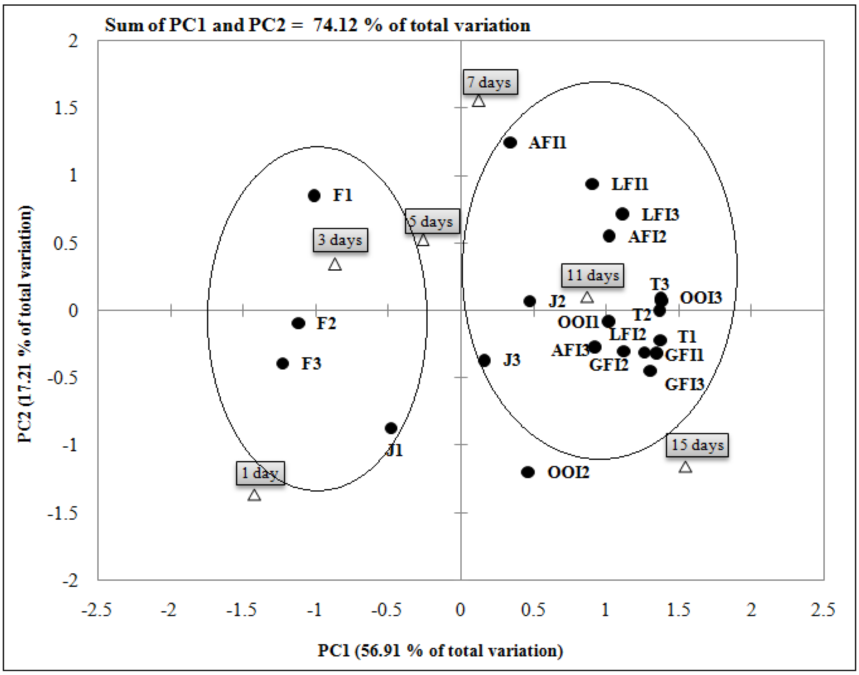

Fig. 2 PCA plot depicting the modeling of meat sensory attributes and beef group by ageing (Hybrid type: 1 = RBSxBBB, 2 = RBSxAA, 3 = RBSxLi; Sensory attributes: OOI = Overall odour intensity, T = Tenderness, J = Juiciness, F = Fibrosity, FGI = Global flavour intensity, AFI = Acid favour intensity, LFI = Liver flavor intensity; Ageing time: 1, 3, 5, 7, 11, 15 days)

CONCLUSION

Our results showed that the existing variability in the ageing evolution of meat depends on hybrid type. Because tenderness has been the main sensory attribute influenced by ageing we suggest an early consumption of RBSxBBB hybrid type meat after slaughter and a larger period for RBSxAA and RBSxLi hybrid types to obtain an optimum tenderness value according to consumer expectations.

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