PE1.67 Acceptability of Beef from Different Breeds and mh-Genotypes and its Relationship with Physicochemical Quality Attributes. 419.00

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Abstract—Sensory properties of meat remain as one of the most influencing factors on consumer satisfaction after purchase. The aim of this study was to assess the evolution along maturation of consumer's acceptance of beef from yearling bulls of different genetic groups and its relationship with physicochemical quality traits. Physicochemical traits (pH, water holding capacity (WHC), composition, Warner-Bratzler (WB), oxidation (TBARS)) were measured, and sensory attributes (flavour, tenderness, juiciness, and overall acceptability) were evaluated in five different genetic categories of two local meat breeds "Asturiana de los Valles" (AV) and "Asturiana de la Montaña" (AM) and their cross (AVxAM) along aging (3, 7, 14 and 21 days). Significant differences between genotypes were found for physicochemical variables, and a significant effect of aging time was found on sensory attributes, WB and TBARS. The sensory parameters evaluated were highly correlated between them (r= 0.817 p<0.001) but they did not correlate significantly to physicochemical data. Intramuscular fat (IMF) was positively related to mioglobin. IMF also showed significant but negative correlation to meat juice losses. From this study we can conclude that for the different beef types from local breeds AV (different presence of muscular hypertrophy (mh)) and AM and its cross AVxAM, which produce meat of different physicochemical quality, an appropriate ageing time, was more relevant for consumers' acceptability than the effect of genetic type. In addition, the physicochemical parameters that were more related to final meat quality perception were IMF, instrumental toughness and water holding capacity.

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I. INTRODUCTION

INCREASINGLY, the choices made by meat consumers are influenced by food safety, health, environmental impact and animal welfare [1]. However, the sensory quality of meat still remains as one of the primary factors influencing consumer satisfaction after purchase. Furthermore, the premium price paid for superior carcass yield and the consumer preferences for leaner meat have increased the interest on genetic factors, such as the presence of mutations of the myostatin gene producing muscular hypertrophy (mh). The aim of this study was to quantify the physicochemical characteristics and to evaluate consumer's acceptance of beef from different genetic categories of the local breeds "Asturiana de los Valles" and "Asturiana de la Montaña" and to establish the relationship between them.

II. MATERIALS AND METHODS

ANIMALS AND MEAT SAMPLES:

Forty yearling bulls of two local breeds "Asturiana de los Valles" (AV) and "Asturiana de la Montaña" (AM), and its crossbreed (AVxAM) were used in this study. Within AV breed, animals had different presence of the double-muscling character (due to a mutation in the myostatin gene), being homozygous (mh/mh), heterozygous (mh/+) and normal (+/+). Eight animals of each genotype and breed were used. Animals were fattened by feeding concentrate meal and barley straw ad libitum and slaughtered between 14 and 18 months of age, at approximately 500 kg live weight. After 24h stored at 4ºC, the ultimate pH (ph24) of the Longissimus dorsi (LD) muscle of the 5th rib was determined using a penetration electrode. The muscle was sliced, vacuum packed, aged at 4ºC for 3, 7, 14, 21 days, frozen and stored at –20ºC for subsequent analysis.

A. Physicochemical analysis

Myoglobin concentration was assessed following the Hornsey method [2]. Moisture content was measured with an oven drying method (ISO 1442-1973), intramuscular fat content (IMF) by Soxhlet extraction (ISO 144-1973) and protein content using Kjeldahl analysis (ISO 937-1978). Water holding capacity (WHC) was measured at 7 days post-mortem as expressible juice (EJ, gKg-1) according to a modification of the method of Grau and Hamm described by Sierra [3] and drip loss (DP) was determined at 48h post-mortem as proposed by Honickel [4]. The instrumental evaluation of texture (maximum load kg) (WB) was conducted in an Instron 1011 equipment with a Warner-Bratzler shearing device. Thiobarbituric acid reactive substances (TBARS, mg malonaldehyde/kg muscle) were measured by the method of Botsoglou et al. [5].

B. Sensory Analysis

Samples for sensory analysis were thawed at 4ºC for 24 h, then wrapped in aluminum foil and cooked in an industrial oven grill at 200ºC to reach an internal temperature of 70 ºC. 40 animals (8 from each genotype) and 4 aging times per animal were evaluated by a sensory panel of 140 untrained consumers (49 males and 65 females, age range between 18-60 years) organized in 14 sessions of 10 consumers each and testing six samples per session. Consumers were asked to evaluate flavour, juiciness, tenderness and overall acceptability using a hedonic scale of nine points, ranging from like extremely to dislike extremely.

C. Statistical Analysis

The effect of genetic group on the physicochemical variables was analyzed by means of Analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of SPSS (12.0). For physicochemical variables measured along aging (TBARS and WB) the effect of genotype, aging time and its interaction was studied. For sensory attributes, once the interaction between genotype and ageing was discarded, the effect of genetic group and the effect of ageing period (with animal and ageing time as fixed factors) were tested over the mean values per sample corrected by the residuals of the session effect. When significant, differences were tested by means of Tukey post-hoc tests (Games-Howell when variances were not homogeneous). Relationship between variables was evaluated using Pearson Correlation Coefficients.

III. RESULTS AND DISCUSSION

Genetic type significantly affected most of the physicochemical traits of meat (Table 1 and 2). Animals with muscular hypertrophy (homozygous or heterozygous) showed lower ultimate pH, which could be due to the higher proportion of fast twitch fibres and the higher and faster glycolytic metabolism of the LD of double-muscled animals [6, 7]. Genotype also affected significantly ($P<0.001$) the water holding capacity of meat, with mh-animals showing higher juice losses, measured both as expressible juice and as drip loss, which also reflects the more glycolytic metabolism of these animals. There was also a significant effect of genotype on the chemical composition of meat, with lower IMF content for mh-animals and higher for AM bulls, having meat from AVxAM crossbreed intermediate values between breeds. Meat from AV(mh/mh) bulls had also lower pigment content than the rest of categories and therefore lighter meat. Regarding meat oxidation, measured as TBARS, no significant effect of genotype was found but there was a general increase with storage time (Table 2), being significant for the -mh genotype, which could be related to the higher PUFA proportion described in meat of double-muscled animals [8]. However, the level of lipid oxidation was low, even after long storage period, due to the fact that in this study meat was conserved under anoxic conditions (vacuum) where lipid oxidation is limited and it did not produce rancidity or off-flavours that could be detected by consumers. Table 2 shows also the evolution of WB shear force of meat along ageing. No significant effect of genotype was found but there was a significant decrease of toughness along ageing in almost all the genetic categories, being meat of mh-animals (mh/mh and mh/+) the most tender at short aging times. There was no significant effect of genotype on sensory traits evaluated by consumers (Table 3). On the contrary, significant differences were found between different ageing times for juiciness, tenderness and acceptability for the mh-genotypes (mh/mh and mh/+). According to these results, it seems that the optimal ageing time for doubled-muscled genotypes is in between 7 to 14 days while other genotypes

(AV +/+, AM) reached the maximum acceptability at longer times (14 to 21 days). This is in clear agreement with the assumption that double-muscling is highly related to a faster metabolism requiring shorter aging times [7]. When studying the Pearson correlation matrix (Table 4) high positive correlations were found between the sensory parameters evaluated, being tenderness and acceptability the best correlated ($r=0.817$, $p<0.001$). Tenderness seems to be the main parameter affecting meat sensory consumers' opinion. Also, sensory tenderness was negatively correlated with WB, as expected ($r=-0.572$; $p<0.01$). Intramuscular fat was positively related to mioglobin content ($r=0.649$, $p<0.001$), due to the fact that meat with higher pigment content came from the rustic breed (AM) and its crossbreed (AVxAM), with higher fat content. IMF also showed significant but negative correlation to meat juice losses (EJ and DP) ($r=-0.360$ and $r=-0.338$, $p<0.05$, respectively), probably due to the fact that meat with more glicolitic metabolism (mh-genotypes) has lower IMF content and it has been postulated that higher fat content facilitate water retention in meat [9].

IV. CONCLUSION

We can conclude that for the different beef types from local breeds AV (different presence of muscular hypertrophy (mh)) and AM and its cross AVxAM, which produce meat of different physicochemical quality, an appropriate ageing time, was more relevant for consumers' acceptability than the effect of genetic type. Meat from mh-genotypes requires shorter aging periods than others. In addition the physicochemical parameters that were more related to final meat quality perception were IMF (positively), and instrumental toughness and WHC (both negatively).

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Table 1: Effect of genetic group on physicochemical variables.

	GENOTYPES					
	AV (*mh/mh*)	AV (*mh/+*)	AV (+/+)	AM	AVxAM	Sign.
pHLD	5.57a	5.58 a,b	5.62 b	5.60 b	5.59 b	***
Drip loss	2.574a	2.13 a, c	1.22 b	0.91 b	1.59 c	***
Expressible juice	26.30a	24.44 a,b	23.41 b	20.55 c	23.12 b	***
Moisture	74.32a	73.56 b	73.85 b	73.28 b	73.51 b	***
IMF	1.71a	2.70 b	2.77 b,d	3.73 c	3.19 c,d	***
Protein	22.85a	22.82 a	22.51 b	22.41 b	22.46 b	***
Mioglobin	3.24a	4.26 b,c	3.73 b	4.78 c	4.36 c	***

a-c: Means in the same row followed by different letters are significantly different; ***: P≤0.001.

Table 2: Effect of genetic group (in rows) and aging time (in columns) over the mean values of TBARS and WB.

		GENOTYPES					
	Aging period	**AV (*mh/mh*)**	**AV (*mh/+*)**	**AV (+/+)**	**AM**	**AVxAM**	**Sign.**
TBARS	3d	0.22 a	0.15 a	0.15	0.19	0.17	NS
	7d	0.19 a	0.19 a,b	0.14	0.19	0.18	NS
	14d	0.33 b	0.28 a,b	0.24	0.20	0.17	NS
	21d	0.39 b	0.37 b	0.24	0.24	0.28	NS
	Sign.	***	*	NS	NS	NS	
WB	3d	5.27	5.14 a	6.05 a	7.35 a	5.88 a	NS
	7d	4.62	5.12 a	5.09 b	5.34 b	5.10 a,b	NS
	14d	4.25	4.84 a,b	5.01 b	4.88 b	4.79 a,b	NS
	21d	4.39	4.17 b	4.84 b	4.40 b	4.52 b	NS
	Sign.	NS	**	*	***	NS	

a-b: Means in the same column with different letters are significantly different. ***: P≤0.001;**: P≤0.01; *: P≤0.05; NS: not significant.

Table 3: Effect of genetic group (in rows) and aging time (in columns) on sensory attributes evaluated by consumers.

		GENOTYPES					
Sensory Attibuttes	**Aging period**	**AV (*mh/mh*)**	**AV (*mh/+*)**	**AV (+/+)**	**AM**	**AVxAM**	**Sign.**
Flavour	3d	5,67	5,70	5,85	5,84	6,30	NS
	7d	6,37	6,42	6	6,07	5,97	NS
	14d	6,14	6,50	6,05	6	6,45	NS
	21d	5,80	6,10	6,40	6,45	6,22	NS
	Sign.	*	NS	NS	NS	NS	
Juiciness	3d	4,95 a	5,22 a	5,80	5,36	5,52	NS
	7d	5,50 a,b	5,92 a,b	5,40	5,7	5,52	NS
	14d	6,14 b	6,60b	5,475	5,85	6,25	NS
	21d	5,55 a,b	5,82 a,b	5,86	6,10	5,42	NS
	Sign.	*	*	NS	NS	NS	
Tenderness	3d	4,75 a	4,87 a	5,87	5,18	5,7	NS
	7d	5,77 a,b	5,90 a,b	5,57	5,65	5,5	NS
	14d	6,06 b	6,625 b	5,32	5,85	6,32	NS
	21d	5,6 0a,b	5,9 a,b	5,82	6,32	5,65	NS
	Sign.	*	*	NS	NS	NS	
Overall Aceptability	3d	4,95	5,17 a	5,8	5,56	5,87	NS
	7d	5,9	5,9 a,b	5,65	5,77	5,57	NS
	14d	5,98	6,47 b	5,47	5,72	6,35	NS
	21d	5,45	5,8 a,b	5,98	6,37	5,62	NS
	Sign.	NS	*	NS	NS	NS	

a-b: Means in the same column with different letters are significantly different. *: P≤0.05; NS: not significant.

Table 4: Pearson correlation matrix.

	Flav.	Juic.	Tend.	Accep.	phLD	DL	EJ	Moist.	IMF	Prot.	Mio.	TBARS	WB
Flavour	1,000	***0,679	**0,546	***0,660	-0,211	0,399	0,266	0,041	-0,170	0,018	-0,264	0,159	*-0,540
Juiciness		1,000	***0,738	***0,774	0,056	0,124	0,133	-0,007	0,035	-0,266	0,138	-0,118	-0,368
Tenderness			1,000	***0,817	0,148	0,188	0,061	0,153	-0,202	0,038	-0,097	-0,110	**-0,572
Acceptability				1,000	0,009	0,126	-0,003	0,185	-0,174	-0,012	-0,068	-0,020	-0,428
phLD					1,000	*-0,384	-0,270	0,291	-0,076	-0,223	-0,114	-0,153	0,208
Drip loss						1,000	***0,615	0,131	*-0,36	*0,391	-0,286	-0,097	-0,222
Expr. Juic.							1,000	0,216	*-0,338	0,149	-0,296	-0,054	-0,247
Moisture								1,000	***-0,889	0,227	***-0,561	-0,046	0,061
IMF									1,000	***-0,575	***0,649	0,047	0,053
Protein										1,000	**-0,432	-0,123	0,057
Mioglobin											1,000	0,085	0,259
TBARS												1,000	-0,240
WB													1,000

*** : p<0.001; **: p<0.01; *: p<0.05.