INFLUENCE OF BREEDS AND AGEING TIME ON THE PHYSIC-CHEMICAL QUALITY OF BEEF FROM THE 'PAMPEANA' REGION IN ARGENTINA

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***Abstract*—Beef quality from animals raised in different regions of Argentina has only been partially characterized, and to the best of our knowledge there has not been a detailed and complete study about beef quality from all productive regions. The objective of the present study was to carry out a survey on beef quality produced in Region I (*Pampeana*), looking at its physical, chemical and rheological aspects. In a second step, the effect of ageing on vacuum-sealed beef cuts was investigated. The samples were collected from slaughter houses in the region I previously selected, taking part of *Longissimus dorsi* muscle (9 to 13 rib) The following measurements were performed: final pH, color index L * (lightness), a * (red index) and b * (yellow index) with Minolta, cooking loss, Warner Bratzler shear force (Instron 1140) and the lipid oxidation (TBAR's index; µg of malonaldehyde/g meat). Data were analyzed statistically using the Proc Mixed of SAS and the differences among treatments were analyzed by Tukey test. Continental breed animals and their crosses were heavier at slaughter without differences in dressing percentage. Neither breed nor diet had significant effects on quality parameters but showed 'breed x diet' interaction for red meat yield and the parameters a * and C * of the meat aged for 7 days. Fresh meat derived from production systems where supplementation was used was brighter. The WB-shear force at 4 and 7days showed a significant interaction between breed and diet, while 45 days aged meat was similarly tender. Both WB toughness and lipid oxidation decreased with storage time for all breeds. Regardless of biotype and diet, meat from the 'pampas region' showed physic-chemical characteristics suitable for consumption either as fresh meat (4 days) or up to 45 days of storage**

***Index Terms*— breed, ageing, grazing, 'pampeana region', meat quality, Argentina**

I. INTRODUCTION

In recent years, and in particular in developed countries, a debate about the productive and economic results of different cattle production systems with particular emphasis about the overall quality of the meat obtained has been initiated, both from a scientific and from a technical point of view. In this context, cattle is produced under extensive (grazing), semi-intensive (grazing with supplementation) and intensive systems, where animals are confined and receive a balanced, complete diet. Energy costs, manure management, high investment in accommodation and equipment, environmental pollution and social pressure looking for more humane treatment of animals, encourage extensive or semi-intensive production based on forage as the main feed.

Argentinean consumers are very demanding in terms of high quality beef. In a recent study about consumption habits presented by the Institute for Promotion of Argentinean Beef, it was well established that consumers consider beef as the ideal meat (IPCVA, 2005). Both the internal and export markets classification of meat according to their quality increase the added value to the product. Argentina have been divided in five beef cattle producing areas, namely Pampeana Region (I), Northeast (II), Northwest (III), Central semi arid Region (IV) and Patagonian Region (V) (http://www.sagpya.mecon.gov.ar/new/0-0/prensa/publicaciones/ganaderia/GANARGEN/tapa.php). Beef quality from animals raised in some of these regions has only been partially characterized (Picallo, Martínez and Margaría, 2000; Schor,Cossu, Picallo, Martínez Ferrer, Grigera Naón and Colombatto, 2008), and to the best of our knowledge there has not been a detailed and complete study about beef quality from all productive regions.

Our objectives were to determine the qualitative properties of the meat according to breed and feed used in response to the characteristics of the cattle from the 'Pampeana' region (I) and to study the effect of different ageing times, using simulated commercial conditions, on the physic-chemical and rheological characteristics.

II. MATERIALS AND METHODS

Due to the heterogeneity of environments, breeds and production systems, the characterization study was conducted inside region one (I) and feature breed (British, Continental, Dairy , British-Continental crosses and Zebu crosses) on two production systems (grazing and grazing + supplementation) for animals slaughtered at the same commercial stage of fattening within each category.

A. Samples

Samples were collected from previously selected slaughter houses; general beef cattle population were sampled to obtain the *Longissimus dorsi* muscle (9 to 13 ribs; 180 samples) and transported (4 ° C± 1) to the laboratory. Physic-chemical and rheological analysis as well as determination of its nutritional value and effects of storage time were evaluated in the Meat Quality Laboratory of the Faculty of Agriculture (University of Buenos Aires). Samples were vacuum packed (Multivac packaging A300-16) as a method of conservation. The packaged samples were placed in a refrigerator with temperature and light control to simulate retail conditions of exhibition. Ageing times were 4, 7 and 45 days.

B. Determinations

Measurements were: final pH (pH meter Hanna with fine-tipped electrode Ingold 406 M3), color according to the CIELAB System, L * (lightness), a * (redness) and b * (yellowness) while saturation was calculated as [C *= $(a^{*2} + b^{*2})^{0.5}$] using a Minolta Chroma Meter-CR300 (CIE, 1976); tenderness was measured with an Instron 4442 Universal Testing Machine (Canton, MA, USA) with a Warner Bratzler shearing attachment on cooked samples (water bath heated at 70ºC for 50 minutes); lipid oxidation (Tbar's index; µg of malonaldehyde / g meat) (Gray and Pearson, 1987). Samples of dried ground beef were chemically analyzed to determine the residual moisture content (Brabender), lipids (Soxhlet), ash (muffle oven at 550 ° C) and crude protein (Kjeldahl), (AOAC1984).

Statistical analysis of data was performed using the Proc Mixed of SAS (1990). Differences among treatments were analyzed by Tukey test ($p < 0.05$).

III. RESULTS AND DISCUSSION

As expected (table 1), animals of Continental breeds and their crosses were heavier at slaughter without showing differences in dressing percentage. Except for the brightness of fresh meat (4d), neither breed nor diet had significant effects but showed interaction for red meat yield (higher % for the grass + supplements diets for breeds C and BxI BxC) and parameters a * and C * of the meat which was aged for seven days (only in crosses BxI the red index and chrome were higher for meat derived from non supplemented grazing systems). The dietary energy concentration influenced only the determination of the lightness at 4days: meat derived from supplementation was more luminous ($p <0.10$).

Table 1. Influence of breed and diet on dressing percentage, pH and colour of fresh and aged meat

Parameter /breed*	B		BxC		BxI		C		Probability			RMSE **
Diets***	G+suppl	Grass	G+suppl	Grass	G+suppl	Grass	G+suppl	Grass	Breed	Diet	BxD	
Slaughterweight kg	480	449	405	490	419	475	517	552	0.0062	ns	ns	85.4
Dressingperc.%	59.8	58.4	59.7	60.6	58.0	58.8	62.7	58.7	ns	ns	ns	4.13
% red meat	66.1	67.6	66.6	65.9	67.3	65.4	72.8	68.9	<.0001	ns	0.0008	3.08
pH 4d	5.53	5.50	5.48	5.51	5.51	5.51	5.51	5.52	ns	ns	Ns	0.08
pH 7d	5.55	5.58	5.42	5.55	5.57	5.49	5.51	5.53	ns	ns	Ns	0.10
pH 45d	5.40	5.34	5.32	5.35	5.44	5.33	5.32	5.37	ns	ns	Ns	0.15
L* 4d	38.3	38.1	43.7	37.5	39.6	38.9	39.6	38.8	ns	0.0753	Ns	3.15
a* 4d	22.9	22.2	22.9	21.4	21.9	22.5	23.4	22.7	ns	ns	Ns	2.64
C*4d	25.3	24.8	31.1	23.7	24.7	25.5	26.2	25.3	ns	ns	Ns	3.18
L* 7d	40.3	40.8	42.4	39.9	41.7	41.4	40.8	39.8	ns	ns	Ns	2.47
a* 7d	23.1	22.3	26.5	23.7	21.2	23.3	23.6	23.7	0.0176	ns	0.0236	1.82
C*7d	26.0	25.0	29.8	26.7	23.8	28.6	26.6	26.6	ns	ns	0.0128	3.22
L* 45d	42.2	42.4	44.5	41.2	43.5	43.0	43.0	41.7	ns	ns	Ns	2.48
a* 45d	21.8	22.8	22.6	23.4	20.3	22.6	23.2	20.9	ns	ns	Ns	1.20
C*45d	24.8	25.9	25.2	26.2	23.2	25.6	26.1	23.6	ns	ns	Ns	3.33

*B: Hereford, Angus, Red Angus; BxC: Limangus; BxI: Brangus, Braford; C: Charolais, Limousin, Holstein

** Root mean square error; *** Diets: Grass (grazing animals); G+supl.: Grass+supplementation (grazing animals + energy supplementation)

The BxC meats that were aged for 45 days (table 2) had lower cooking losses, while 7 and 45 days aged meats C and BxC showed lower rates of lipid oxidation, regardless of the diet. WB toughness showed a significant interaction between breed and diet in both fresh and aged for seven days, whereas after 45 days of ageing all meats were equally tender. Diet did not influence toughness WB of the group B meat; while the BxI meat was tenderer on the grass system breed, BxC and C groups were more tougher. Neither breed nor diet significantly influenced the intramuscular fat content of meat.

Table 2. Influence of breed and diet on the lipid content, WB-toughness and oxidation of fresh and aged meat

Parameters /breeds*	**B**		**BxC**		**BxI**		**C**		**Probability**			**RMSE ******
Diets***	**G+suppl**	**Grass**	**G+suppl**	**Grass**	**G+suppl**	**Grass**	**G+suppl**	**Grass**	**Breed**	**Diets**	**BxD**	
Dry matter%	28.1	29.2	30.9	28.8	28.2	27.0	27.3	27.9	ns	0.0081	0.0642	2.61
EE. %D.M.	20.6	20.3	23.8	19.36	17.8	20.2	15.3	19.3	ns	ns	ns	8.18
Cookingloss4d%	20.9	21.0	21.7	24.9	22.5	22.2	21.7	20.8	ns	ns	ns	2.65
Cookingloss7d%	21.5	22.3	20.3	24.1	22.4	20.8	21.8	22.8	ns	ns	ns	3.25
Cookingloss45%	21.4	23.0	15.6	16.3	23.2	22.7	19.7	23.6	0.0096	ns	ns	3.12
WBSF4d N	58.9	60.9	40.4	87.2	79.4	55.2	49.8	62.1	ns	ns	0.0191	2.27
WBSF7d N	41.8	52.5	32.5	34.4	60.6	40.5	44.4	51.3	ns	ns	0.0412	1.83
WBSF45d	33.0	36.1	20.8	26.3	41.4	31.7	33.5	36.2	ns	ns	ns	1.35
Tbars4d µg/g	0.14	0.12	0.06	0.11	0.13	0.13	0.11	0.15	ns	ns	ns	0.06
Tbars 7d µg/g	0.11	0.11	0.05	0.08	0.14	0.12	0.09	0.09	0.0116	ns	ns	0.05
Tbars45d µg/g	0.11	0.07	0.05	0.04	0.12	0.09	0.07	0.09	0.0971	ns	ns	0.05

*B: Hereford, Angus, Red Angus; BxC: Limangus; BxI: Brangus, Braford; C: Charolais, Limousin, Holstein
** Root mean square error; *** Diets: Grass (grazing animals); G+supl.: Grass+supplementation (grazing animals + energy supplementation)

The meat pH (table 3) decreased with the storage time and consequently, meat brightness increased with storage, especially for the crosses (BxC and BxI). Red index did not vary with storage time; with BxC meat being the most red and BxI meat the least. Both the WB toughness and lipid oxidation decreased with storage time, regardless of breed. Tbar index measured on fresh meat differed from the rates measured at 7 and 45 days, similar to each, and WB toughness only was statistically lower for the longer storage time.

Table 3. Influence of breed and ageing time on colorimetric parameters, WB toughness and lipid oxidation of the meat.

Parameter /breed*	**B**			**BxC**			**BxI**			**C**			**Probability**			**RMSE ******
Time days	**4d**	**7d**	**45d**	**4d**	**7d**	**45d**	**4d**	**7d**	**45d**	**4d**	**7d**	**45d**	**Breed**	**Time**	**BxT**	
pH	5.52	5.56	5.38	5.49	5.46	5.33	5.51	5.52	5.38	5.51	5.52	5.34	ns	<.0001[3]	ns	0.11
L*	38.3	40.5	42.3	41.6	41.6	43.4	39.2	41.6	43.2	39.3	40.5	42.6	0.0496	<.0001[4]	ns	2.70
a*	22.7	22.9	22.2	25.8	25.6	22.9	22.3	22.3	21.6	23.2	23.7	22.5	0.0134[1]	ns	ns	2.66
b*	10.8	11.6	11.7	12.5	13.1	11.3	11.4	13.3	11.6	11.5	12.1	11.6	ns	ns	ns	2.74
C*	25.1	25.7	25.1	28.7	28.8	25.6	25.1	26.4	24.5	25.9	26.6	25.3	ns	ns	ns	3.32
Cookingloss%	21.0	21.8	21.9	22.8	21.6	15.8	22.4	21.5	22.9	21.4	22.1	21.0	ns	ns	0.0265	3.05
WBSF, N	59.6	47.3	33.9	55.9	33.1	22.5	66.1	49.5	36.1	53.8	46.6	34.4	ns	<.0001[4]	ns	1.91
Tbarsµg/g	0.13	0.11	0.10	0.08	0.06	0.05	0.13	0.13	0.10	0.13	0.09	0.07	0.0007[2]	0.0139[5]	ns	0.05

*B: Hereford, Angus, Red Angus; BxC: Limangus; BxI: Brangus, Braford; C: Charolais, Limousin, Holstein; ** Root mean square error;
(1) Differences between BxC and BxI; (2) Differences between: BxI - BxC - C; and B- BxC;(3) Differences between 4-7d vs 45d; (4) Differences between 4d, 7d and 45d ; (5) Differences between 4d vs 7d and 45d

IV. CONCLUSION

Different breeds and crosses (B: Hereford, Angus, Red Angus, BxC: Limangus; BxI: Brangus, Braford, C: Charolais, Limousin, Holstein) determined different slaughter weights without influence on the carcasses dressing percentage. Heavier breeds (C) showed higher meat yield. The BxC and C meat samples aged for 7 and 45 days showed lower lipid oxidation rates compared to other meats, although in general, lipid oxidation values recorded in this study were negligible, probably due to consumption of natural antioxidants contained in the forage consumed by the animals . The different energy density of diets (grazing with or without supplementation of grain) only influenced the lightness of the meat, which was brighter for supplemented animals.

Toughness did not show a clear effect either on the basis of breed or on the basis of the diets but in general, all meats were 'somewhat tender to tender' for four days meat, 'tender' for seven days meat and 'very tender' for 45 days of storage.

Meat from different breeds and weight to slaughter and raised under grazing with or without energy supplementation systems in the 'Pampena' region, showed physic-chemical characteristics suitable for consumption either as fresh meat (4days) or aged up to 45 days. From the results of this work we can conclude that ageing time, although increases tenderness significativety, would not represent an important advantage in improving the physical quality of the argentine 'pampeana' beef meat. However future studies should be performed on the sensory quality of meat to confirm the present results.

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