

INFLUENCE OF THE DIET ON THE PHYSICAL, CHEMICAL AND SENSORY QUALITY OF BEEF FROM THE NORTHEAST OF ARGENTINA

Cossu M.E.¹, Picallo A.B.¹, Rebak G.², Grigera Naón J.J.¹, Rozen F.M.B.³, Lamanna M.L.¹, Schor A.¹, Colombatto D.^{1,4}, von Bernard H.¹ and Ynsaurralde Rivolta E.⁵

¹Department of Animal Production, Faculty of Agriculture, Buenos Aires University, Av. San Martín 4453, (1417) Bs. As., Argentina

²Department of Food Technology, Faculty of Veterinary, Northeast University, Sargento Cabral 2139 (3400) Corrientes, Argentina.

³Department of Animal Production, Faculty of Veterinary, Buenos Aires University, Av. Chorroarín 280. (1417) Bs. As., Argentina.

⁴ CONICET, Argentina

⁵ Fellow of the Secretary General of Science and Technology, Northeast University, Sargento Cabral 2139 (3400) Corrientes, Argentina.

Abstract— Beef quality from cattle raised in different regions of Argentina has only been partially characterized. The objective of this study was to carry out a survey on beef quality (british/indicus crosses) produced in Region II (Northeast), the largest cattle second region's, looking at its physical, chemical and sensory aspects according to the production system. Samples from part of the *Longissimus dorsi* muscle were collected to obtain : final pH, colour index, cooking loss, Warner Bratzler shear force (WBSF-Instron 1140), lipid oxidation (TBAR's index) and intra muscular fatty acids. Samples were also analyzed by a sensory analytical panel of 8 trained assessors for colour, odour/flavour and texture descriptors. Data were analyzed using the Proc Mixed of SAS. Steers raised in extensive (pasture) and semi-extensive (pasture+grain) systems were heavier at slaughter than intensive (concentrated) system (483/473 vs 430 kgLW) with differences in dressing percentage (52 vs 56%). Production system did not show effects on colour, Tbar's and WBSF values but the intensive system samples were brighter and had lower cooking losses. For fatty acids, pasture systems significantly influenced the content of linolenic and w-3FA (higher) and linoleic acid (lower) compared to the intensive system. Sensory analysis showed similar tenderness among production systems with higher colour and 'characteristic odours' for the pasture's raised animals while intensive system determined more 'liver' odour meats. Regardless of the production system, beef cattle from the 'northeast-region' showed good organoleptic quality to be consumed as fresh not requiring ageing or other treatments.

Keywords— subtropical region, meat quality, Argentina

I. INTRODUCTION

Argentina are divided in five beef cattle producing areas, namely Pampeana Region (I), Northeast (II), Northwest (III), Central semi arid (IV) and Patagonian (V) [1]. Bovine raising activity is slowly but definitely moving to regions where soils do not allow crops or activities with higher income. 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. The Northeast Argentina (NEA; between 22 and 30 degrees south latitude), the second region's cattle country, has about 12,000,000 head of cattle, distributed over an area of 309,000 km², 53% of weaning rate and productivity ranging from 3-5 kg / ha / year to 30-50 kg / ha / year depending on the area within the region [2]. Cattle are mostly Zebu and its crosses with European breeds (Hereford and Angus) to obtain synthetic breeds for the production of animals adapted to the Northeast region.

It is recognized that classification of meat according to quality is important to increase its value for both internal and external markets. However, beef quality from animals fattened in some of these regions has only been partially characterized [3] [4].

Our objectives were to determine the qualitative properties of the meat according to the production system used as affected by the characteristics of the cattle from the 'Northeast' region (II), on the physical, chemical, rheological and sensory characteristics.

II. MATERIALS AND METHODS

The characterization study was conducted within region II on three production systems: Extensive (grazing), Semi-extensive (grazing+supplementation) and Intensive (feedlot) for animals slaughtered at the same commercial stage of fattening within each category. Animals belonged to Brangus, Braford and Brahman breeds; dental chronological age was: Extensive: up to 8, Semi-extensive: up to 4 and Intensive: up to 2 permanent teeth.

Samples

Samples were collected in a commercial abattoir licensed for exporting meat from Region II; general beef cattle population were sampled to obtain the *Longissimus dorsi* muscle (9 to 13 ribs; 43 samples) and transported (4°C±1) to the Meat Quality Laboratory of the Faculty of Agriculture (University of Buenos Aires) 4 days post slaughter.

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 [5]; tenderness with a Warner Bratzler shearing attachment on cooked samples (water bath heated at 70°C for 50 minutes) (Instron 4442 Universal Testing Machine; Canton, MA, USA); lipid oxidation (Tbar's index; µg of malonaldehyde/g meat) [6] and fatty acids that were extracted according to the technique described [7] and analyzed as methyl esters by gas chromatography (Shimadzu 14-B capillary column Resteck 2560). Samples of dried ground beef were chemically analyzed to determine the residual moisture content (Brabender) and lipids (Soxhlet) [8]. For sensory analysis, the slices were cooked in double contact grill to reach 71°C ± 1°C in the center of the sample (cold point), monitored by thermocouples. The samples were analyzed by an analytical panel of 8 trained assessors according to international standards and experience in sensory analysis of meat [9] [10] [11] [12]. Each assessor received samples (1x1x1m cubes) in containers coded with three digit random numbers. The following descriptors were assessed: the overall colour, odour, flavour, taste, tenderness, untuosity and juiciness, using an unstructured linear scale of 10 cm without anchorage. The ends of the scales corresponded to the

intensity of the attribute: light pink, extremely soft, very tender, dry, not oily (lower limit: 0) and red, extremely strong (intense), very tough, juicy, very oily (upper limit: 10). Statistical analysis of data was performed using the Proc Mixed of SAS [13]. Differences among treatments were analyzed by Tukey test ($p < 0.05$).

III. RESULTS AND DISCUSSION

Carcasses of animals (Table 1) raised in extensive (pasture) and semi-extensive (pasture+grain) systems were heavier than intensive (feedlot) system (483/473 vs 430 kgLW) with differences in dressing percentage (52 vs 56%) at the same fattening commercial degree. In general, production system did not show important effects on beef colour, Tbar's and WBSF values, however, the intensive system samples were brighter and had lower cooking losses.

Table 1. Influence of diet on dressing percentage, pH, colour, WB-toughness and oxidation of fresh meat

Parameter/System	Extensive	Semi Extensive	Intensive	P. value	RMSE ¹
Carcass weight, kg	257 a	242 a	197 b	<.0001	10.2
Dressing yield, %	51.0 a	51.6 a	55.9 b	<.0001	3.73
pH	5.60 a	5.42 b	5.50ab	.0006	0.10
L*	36.2 a	38.1 a	47.4 b	<.0001	2.03
a*	22.7	21.8	23.2	.2145	1.53
b*	10.6 ab	9.82 b	11.8 a	.0186	1.38
C*	25.0	24.0	26.1	0.154	1.93
Cooking loss %	25.9 a	22.8 b	19.1 c	<.0001	2.82
WBSF, Lb	6.48 a	4.28 b	5.54ab	.0019	2.42
Tbar's µg/g	0.19	0.21	0.17	0.5474	0.07

¹Root Mean Square Error

The intramuscular fat content (Table 2) was higher in the intensive system. For fatty acids, pasture-based systems influenced the content of linolenic and omega-3FA which was higher than in concentrated based system; linoleic acid content was similar in semi-extensive and intensive systems but was higher than in the extensive system. There were no differences for SFA, MUFA, PUFA and trombogenic index as a function of the production system.

Table 2. Influence of production system on lipid content and fatty acid profile (%Total FA) of fresh 'Northeast' bovine meat

Parameter/System	Extensive	Semi Extensive	Intensive	P. value	RMSE ¹
Dry matter, %	26.6	25.6	26.7	0.4086	1.84
EE % DM	11.3 a	7.41 a	16.7 b	0.0008	3.60
Myristic	2.41 a	2.42 a	3.21 b	0.0053	0.59
Palmitic	27.1	28.3	28.9	0.2436	2.89
Stearic	17.4	16.1	17.7	0.5129	3.09
Oleic	36.3	34.8	35.3	0.5005	3.49
Linoleic	3.60 a	6.17 b	5.09 b	0.0016	1.74
Linolenic	1.03 a	0.77 b	0.27 c	<0.0001	0.26
Arachidonic	1.27 a	1.45 a	2.00 b	0.0074	0.09
EPA	0.33 a	0.11 b	0.01 b	0.0006	0.20
DPA	0.24	0.18	0.22	0.9712	0.21
DHA	0.49 a	0.56 a	0.20 b	0.0269	0.28
-n3	2.42 a	2.10 a	0.88 b	0.0008	0.93
SFA ²	48.7	47.8	51.0	0.1540	3.37
MUFA ³	43.3	41.5	41.1	0.1677	3.43
PUFA ⁴	7.93	10.7	7.95	0.0659	2.91
T.I. ⁵	1.39	1.25	1.43	0.7615	0.24

¹ Root Mean Square Error; SFA² saturated fatty acids; MUFA³ monounsaturated fatty acids; PUFA⁴ polyunsaturated fatty acids. TI: Trombogenic index⁵: (C14:0+C16:0+C18:0)/(0.5 x C18:1 + 0.5 x other PUFA+ 0.5 x n6+3 x n3+ n3/n6).

Table 3. Influence of production system on sensory characteristics of fresh 'Northeast' bovine meat

Parameter/System	Extensive	Semi Extensive	Intensive	P. value	RMSE ¹
Colour	6.64 a	5.42 ab	3.44 b	<.0001	1.75
Odour intensity	6.00 a	5.86 a	4.43 b	<.0001	0.91
'Liver' odour	0.92 a	1.01 a	1.73 b	0.0002	0.53
Off odour	0.23	0.20	0.38	0.3764	0.04
Flavour intensity	5.94	5.75	5.05	0.7190	0.72
'Liver' flavour	0.96	0.67	1.43	0.0637	0.67
Sweet taste	1.47 a	1.16 a	2.15 b	0.0002	0.55
Metallic	2.27	2.19	2.13	0.8675	0.70
Salty taste	2.96	3.17	2.80	0.6647	0.82
Tenderness	4.76	4.55	3.70	0.2310	1.53
Juiciness	3.05 a	6.50 b	2.28 a	<.0001	2.51
Juiciness	3.89 a	5.01 b	2.02 a	<.0001	1.14

¹Root Mean Square Error

Sensory analysis showed lack of differences among production systems with regard to flavor intensity, tenderness and salty and metallic tastes, with higher colour and odour intensity for the pasture raised animals. Intensive production system showed stronger 'liver' odour (p<0,01), 'liver' flavour (p>0,05) and sweet taste (p<0,01) than extensive and semi-extensive production system meat. Trained evaluators found no off-flavours/odours in any sample. Samples of semi-extensive production animals were more juicier, probably due to the greater 'untuosity' perception.

IV. CONCLUSIONS

Extensive and semi-extensive systems did not affect instrumental colour and toughness but induced significant changes in the content of lipids and some fatty acids in the *Longissimus dorsi* muscle which are beneficial to human health. From a sensory standpoint, the meat from the three production systems was similar in tenderness and flavor intensity but intensive system caused light, sweet and liver smelling and taste meats. Regardless of the production system, for british/indicus breeds, meat from the 'northeast-region' of Argentina showed physical, chemical and sensory properties suitable for consumption as fresh meat.

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