INFLUENCE OF CATTLE CATEGORY, BREED AND AGEING ON THE SENSORY QUALITY OF MEAT FROM NORTHWEST OF ARGENTINA

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Abstract –The commercial category young intact male (YIM) has recently been introduced in Argentina where steers make up the bulk of beef production. Additionally the north of the country is becoming a promising new area for expansion of beef cattle production. The aim of this study was to carry out a sensory survey on meat, aged up to 14 days, of 20-23 months old bulls vs. steers of three breeds "Criollo" (C), Zebu (Z), Brangus (BB) on feedlot systems in the north-west (NOA) region of Argentina. Samples of *Longissimus dorsi* muscle (9^{th}-13^{th} rib) were collected. Sensory attributes of appearance, flavour and texture were evaluated by eight trained assessors. Data were analysed using the Proc Mixed (SAS); and differences among treatments were analysed by Minimum Significant Differences Test. Ageing time and the interaction of Category*Breed were the most important factors that influenced sensory attributes of meat. Biotypes Z and C within YIM showed tougher meat ($p<0.05$), requiring longer ageing to achieve tenderness values similar to those of steers ($p<0.05$). Instead BB had similar hardness values ($p>0.05$) for both categories, improving this further at the longest ageing ($p<0.05$).

Key Words – NOA, sensory analysis, entire male.

I. INTRODUCTION

At the end of 2010 by resolution 4906/2010, the Ministry of Agriculture, Livestock and Fisheries of the Nation created the commercial category young intact male (YIM) for the slaughter of all cattle breeds. This proposed category may increase feed conversion efficiency through faster growth rates and leaner finished carcasses.Argentine consumers associate the entire male category with a low quality product and unattractive. However, YIM can produce meat comparable to those of the best quality steers. The information available in Argentina on the meat quality of this new category of animals is scarce, especially when it comes from "Criollo" and Zebu breeds. Physical and sensory meat quality of beef are affected by a number of factors, such as breed [1], nutrition [2], ante-mortem treatment of animals [3], post-mortem treatment & ageing [4, 5], and cooking methods [6], being tenderness the primary determinant of the eating quality and acceptability of meat [7, 8]. In the last two decades, expansion of crop sown area at the expense of livestock production has been verified particularly in regions of good quality soils such as the Argentinian "pampas"[9]. Reduction of the cattle area is not temporary because normally land taken by agriculture never returns to livestock [10]. An alternative has been moving cattle production to environmentally poorer regions, such as the north of the country. This new scenario shows that demand is growing at a faster rate than the current supply of commodities for food. That is why in current production systems there is pressure to increase every aspect of efficiency as there are constraints to horizontal growth due to the fact that land is a limited resource. In this regard, meat production is no exception and YIMis an alternative to achieve a significant increase in production [11]. Our objectives were to determine the sensory meat quality from steers and young bullsaccording to the productive area on "Criollo", Zebu and Brangus/Braford cattle raised on feedlot system production and to study the effect of different ageing times, up to 14 days,under refrigerated conditions.

II. MATERIALS AND METHODS

This work was conducted withsteers (S) and young intact males of three different breeds "Criollo" (CR), Zebu (Z) and Brangus/Braford (BB) breeds, produced on a confined system in the North-western

region of Argentina (region III). Animals were slaughtered at the same age (20-23 months old) within each breed.

Samples: Longissimusdorsi muscle (9^{th} to 13^{th} ribs) from 67 animals were sampled, frozen (-18ºC±1) and sent to the Sensory Analysis Laboratory of the Faculty of Agriculture (Buenos AiresUniversity).The samples were vacuum-packed (Multivac packaging A300-16) as a method of conservation, to be subsequently storedin a refrigeration chamber (2.5± 0.5°C) during 4 or 14 days.After ageing, samples were frozen (-18.0± 0.5°C) until further analysis.

Sensory analysis: Twenty four hours before sensory performance, samples were thawed at 2,5± 0,5°C. Beef samples (2,5cm of thickness) were cut and cooked in a double contact grill to reach 71ºC ± 1ºC in the centre of the sample (cold point, monitored by thermocouples). For sensory evaluation, samples were analysed by an analytical panel of 8 trained assessors according to international standards and experience in sensory analysis of meat [12, 13, 14, 15]. Each assessor received the samples (cubes: 1x1x1cm) in Petri dishes coded with three-digit, randomized numbers. The following descriptors were assessed from the three different sensory attributes: overall colour and colour homogeneity in appearance attributes; intensity and typicity odour/flavour; acid, sweet, salty and bitter tastes, metallic, aftertaste and persistence; toughness, chewiness, number of chews, unctuosness, fiber amount, residue and juiciness, using an unstructured linear scale of 10cm, without anchorage where 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, a lot of chews (upper limit: 10). Statistical analysis of data was performed using the Proc Mixed of SAS [16]. Differences among treatments were analysed by Minimum Significant Differences Test ($p<0,05$).According to the criterion of Akaike, the structure of the covariance matrix was variance components (VC) for the variables: Colour Homogeneity, OdourIntensity, Typically Odour, Off-Odours, Salty, Sour & Bitter Taste, Metallic, Typically Flavor, Chewiness, Juiciness, Persistence, and Aftertaste.For Variables Global Colour, Sweet Taste, Flavor Intensity, Off-Flavours, Toughness, Number of Chews, Fibber Amountand Residue, the matrix of variance-covariance was unstructured.

III. RESULTS AND DISCUSSION

Significance of breed, ageing, category and their interactions on sensory attributes are shown in Table 1. Table 2 shows the average of the sensory parameters. Table 3 presents the significance in the interaction Category*Breed. From the results of Table 1, it was verified that Ageing time and Category (interacting with Breed) were the factors that most influence had on sensory descriptors, being ageing time the most relevant influential factor coinciding with the results obtained by Bureš et al. [17] and Miller etal. [18]. Contrary, breed was the least influential factor on sensory descriptors, only significantly affected on Typically Flavour ($p<0,05$), we found that the Zebu and Brangus/Braford samples had significantly higher values of typically flavour than "Criollo". Texture attributes were more affected by ageing and the interactions category x biotype ($p<0,05$) than the others parameters. The main textural differences were found in tenderness values and number of chews (Table 2), in agreement with other authors [19, 20]. The results of this study accords with those obtained by Monson et al. [5] and Sañudo et al. [21], where they found that ageing time decreases toughness meat between breeds. Likewise, Olsson et al. [22] and Franco et al. [23], which evaluated the effect of different ageing times on the tenderness of*Longissimusdorsi* muscle, found that from 2 to 8 until 15 days, the values of shear force decreased and decreasing thus, the hardness. Miller et al. [24] concluded in their studies that the enzyme activity is responsible for the lower hardness of the meat by increasing the ageing time. In this survey, significant differences were observed at 4 and 14 days of ageing. Also other authors [5, 17, 19, 20] have reported that ageing time reduces the toughness differences among breeds. Differences in tenderness between breeds could bedue to the quantity, solubility and space organization of the collagen, fatness and calpain and calpastatin activity. In general, sensory values for toughness were lower as the ageing time increased, which agrees with Monsón et al. [5]. Toughness, one of the most relevant characteristics of the consumer sensorial quality [25], in this case coincides with the number of perceived chews, due to the relationship between them. These descriptors were influenced significantly ($p<0,05$), when subjected to different times of storage and the interaction Category * Breed, coinciding to Marshall [28], who demonstrated the existence of differences in

tenderness (inverse of hardness) between and within cattle breeds. In this sense, young bulls of Z and C, which showed no statistical difference between them (p>0,05) were those that were harder and with more meat chews registered, compared to steers of Z and young bulls of BB (p<0,05), which were tendermeats, perceived fewer chews. Flavour intensity was affected by the interaction Breed*Ageing time (p<0,05).Meat nitrogen-containing compounds may be formed by the natural degradation that occurs during ageing, and some of them have been reported to have a variety of meat flavours [29], which might partially explain the increased scores for odour.Mandell et al. [27],found differences in flavour between different biotypes and attributed it to different fat percentage between them.In this study the ageing time did not significantly affect the typically and intensity of flavour, but effects on typicity and odour intensity were observed.In accordance with that reported by Revilla et al. [30], we found no differences due to sex or breed during the ageing time in juiciness.

Table1. Sensory descriptors: significance of factors and interactions.

	Probability						
Sensory descriptors	**Category**	**Breed**	**Ageing**	**C* B**	**C*A**	**B* A**	**C* A* B**
Global Colour	---	ns.	---	ns.	0,02	ns.	ns.
Colour Homogeneity	ns.	ns.	ns.	ns.	ns.	ns.	ns.
Odour intensity	---	---	< 0,0001	0,0220	ns.	ns.	ns.
Typically Odour	---	---	< 0,0001	0,0134	ns.	ns.	ns.
Off Odours	---	ns.	---	ns.	0,0132	ns.	ns.
Sweet Taste	ns.	ns.	ns.	ns.	ns.	ns.	ns.
Salty Taste	ns.	ns.	ns.	ns.	ns.	ns.	ns.
Acid Taste	ns.	ns.	0,0076	ns.	ns.	ns.	ns.
Bitter Taste	ns.	ns.	< 0,0001	ns.	ns.	ns.	ns.
Metallic	ns.	ns.	ns.	ns.	ns.	ns.	ns.
Flavour Intensity	ns.	---	---	ns.	ns.	0,0298	ns.
Typically Flavour	ns.	0,033	ns.	ns.	ns.	ns.	ns.
Off Flavours	ns.	ns.	ns.	ns.	ns.	ns.	ns.
Toughness	---	---	< 0,0001	0,0079	ns.	ns.	ns.
Chewiness	---	---	---	---	---	---	0,044
Number of Chew	---	---	< 0,0001	0,0080	ns.	ns.	ns.
Juiciness	---	---	ns.	0,0160	ns.	ns.	ns.
Fibber Amount	---	---	---	---	---	---	0,0355
Untuosness	---	---	0,0028	0,0038	ns.	ns.	ns.
Residue	---	---	< 0,0001	0,0245	ns.	ns.	ns.
Persistence	ns.	ns.	ns.	ns.	ns.	ns.	ns.
Aftertaste	0,0306	ns.	ns.	ns.	ns.	ns.	ns.

Br: Breed; C: Category; A: Ageing Time / S: steer; YIM: young intact male / Breeds: CR: "Criollo"; Z: Zebu; BB: Brangus/Braford / RMSE: Root Mean Square Error / Different letters meansignificant differences p<0,05.

Table 2: Sensory meat descriptors, average values for each breed, ageing time and category.

Sensory descriptors	**Category**		**Ageing**		**Biotype**		
	YIM	**S**	**4 Days**	**14 Days**	**Criollo**	**BB**	**Zebu**
Global Colour	3,95	4,02	4,20	3,78	3,70	3,96	4,31
Colour Homogeneity	6,10	6,32	6,10	6,30	6,40	6,15	6,10
Odour intensity	4,80	4,95	4,60 **b**	5,20 **a**	4,70	4,90	5,00
Typically Odour	3,93	3,76	3,60 **b**	4,10 **a**	3,65	3,91	3,97
Off Odours	1,28	1,38	1,30	1,37	1,34	1,29	1,37
Sweet Taste	1,27	1,45	1,21	1,51	1,65	1,22	1,20
Salty Taste	2,34	2,44	2,40	2,38	2,35	2,49	2,33
Acid Taste	1,37	1,47	1,27 **b**	1,57 **a**	1,42	1,29	1,56
Bitter Taste	0,40	0,40	0,23 **b**	0,57 **a**	0,39	0,40	0,41
Metallic	1,64	1,68	1,63	1,68	1,67	1,63	1,66
Flavour Intensity	5,43	5,57	5,28	5,72	5,29	5,63	5,57
Typically Flavour	4,29	4,11	4,10	4,31	3,95 **b**	4,33**a**	4,32 **a**
Off Flavours	1,70	1,46	1,46	1,70	1,55	1,70	1,50
Toughness	4,10	3,22	4,19 **a**	3,11 **b**	3,71	3,29	3,93
Chewiness	5,23	3,86	4,93	4,16	4,59	4,30	4,73
Number of Chew	29,38	25,86	30,76 **a**	24,48 **b**	27,52	26,70	28,64
Juiciness	2,30	2,68	2,51	2,48	2,46	2,58	2,44
Fibber Amount	3,91	3,49	4,12	3,28	3,79	3,54	3,78
Untuosness	2,36	2,49	2,25 **b**	2,60 **a**	2,39	2,58	2,30
Residue	3,74	3,10	3,80 **a**	3,04 **b**	3,46	3,34	3,47
Persistence	6,05	5,78	5,88	5,95	5,85	6,03	5,88
Aftertaste	1,25 **b**	1,55 **a**	1,29	1,50	1,49	1,37	1,33

Different letters meansignificant differences p<0,05.

The amount of residue decreased with increasing storage time (p <0,05), Table 1, coinciding with Geesink et al. [31], and Wheeler et al. [32], who found a decrease in the perception of the residue, increasing maturation time, attributing it to the degradation of the miofibrillar structure and connective tissue. Regarding aftertaste, only category had influence on it (p<0,05), being higher steers in than bulls. Persistence did not show significant differences.

Table 3.Significance of Category*Breed Interaction

	Steers			**YIM**		
	CR	**BB**	**Z**	**CR**	**BB**	**Z**
Toughness	3,18ab	3,45ab	3,04a	4,2bc	3,14a	4,82c
Number of chews	25,1a	27ab	25,4a	29,9bc	26,4ab	31,8c
Juiciness	2,9a	2,43abc	2,72ab	2,02c	2,73ab	2,16bc
Untuosness	2,53bc	2,41ab	2,54bc	2,24ab	2,76c	2,08a
Residue	2,87a	3,47ab	2,97a	4,04b	3,22ab	3,98b

Different letters meansignificant differences p<0,05.

CONCLUSION

The ageing time showed to be the most influential factor on main sensory descriptors of meat from typical cattle breeds fattened in feedlots in the Northwest of Argentina,obtaining enhanced tenderness with fewer chews, presenting more characteristic odour, with a higher odour intensity, as well as decreased residue perceived after chewing. Vacuum packaged meat, with longer storage time, improved levels of tenderness. In conclusion, the production of YIM, for Z and C Breeds, showed tougher meat, requiring higher ageing times to achieve tenderness values, similar to the obtained for steers. Instead the BB showed similar hardness values for both categories, improving these further when undergoing major ageing time.

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