INFLUENCE OF MUSCLE TYPE, PRODUCTION SYSTEM AND AGEING TIME ON TENDERNESS OF BEEF

A. Sanchez-Escalante[1]*, K. Cabrera[1], G. Torrescano[1], M. Valenzuela[1], J.P. Camou[1], F. Figueroa[2], C. Perez[2] and G. Hernandez-Watanabe[1]

[1]*Department of Meat and Seafood Products. Meat Science Laboratory. Centro de Investigación en Alimentación y Desarrollo, A.C. PO Box 1735. Hermosillo, Sonora, 83000, Mexico.*
Research Institute in Veterinary Sciences, Universidad Autonoma de Baja California. Mexicali, B.C., Mexico.

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Introduction

An inadequate tenderness is the most important cause of consumer dissatisfaction and any improvement in tenderness would increase the value of the final product. Tenderness is the most relevant consequence of ageing, thus is necessary to know how time can affect the changes induced by ageing. Throughout ageing, the structure of myofibrilar and associated proteins, and, to a lesser extent, of collagen, weakens during the ageing process (Campo *et al.,* 1998; Ngapo *et al.*, 2002; Nishimura *et al.*, 2002). Therefore, potential tenderness depends on the effect of ageing period (Shackelford and Wheeler, 1997; Chambaz *et al.*, 2003). Espejo *et al.* (1998) and Ciria *et al.* (2000) reported that meat from rustic breeds require a longer ageing period than meat from breeds specialized in meat production.

Beef cattle production is a strategic activity in Mexico due to its high social and economic impact. Therefore it is urgent for producers to look for other production alternatives which optimize available resources to be able to compete in price and quality with meat imports.

The objective of this work was to determine the effect of muscle type, production system and ageing time on shear value, sarcomere length and myofibrillar fragmentation index of beef like indicator of quality meat from two different producers localized in Northwest of Mexico.

Materials and Methods

In this study, 72 heifers were used: 36 from A Producer and 36 from B from rustic crossbreed. All of the animals were reared under the traditional production system. After weaning, and until slaughter, the calves were fed *ad libitum* with concentrate and cereal straw. The main ingredients of the concentrate were cereals (barley and corn) and soybean meal. The animals were slaughtered in an authorized Mexico slaughterhouse. Taking into account local market preferences and slaughtering was established in age range of 18-24 months.

At 24 h after slaughtering, the Longissimus *thoracis* (LT) and *lumborum* (LL) muscles were removed and used to carry out the ageing process. All boneless sections were sliced into 5 cm thick portions and vacuum-packed. These samples were kept at 0 and 5ºC for 2, 7, 14 and 21 days. After ageing, each vacuum-packed section was divided into two steaks. One of them, about 2.5 cm thick, was assigned for fresh textural analyses, myofibrilar fragmentation index (MFI), and sarcomere length. The remaining steak, about 2.5 cm thick, was used for cooked textural analysis. Samples for MFI were packed under vacuum again, and frozen and stored at –18ºC until further analysis according to methodology of Culler *et al*. (1978); and for sarcomere length determination small cubes of about 3 g taken from muscles studied were fixed by immersion in a glutardialdehyde solution until analysis, according to Torrescano *et al*. (2003), using a phase contrast Olympus microscope model CX31. Samples were cooked in a grill until the temperature reached 70ºC, measured using a thermocouple placed in the centre of the sample. The instrumental parameters of texture, in raw and cooked meat, were determined with Warner-Bratzler Shear Force (WBSF) test in a texture analyzer Instron (Instron Co., USA). From each steak, a minimum of 10 strips were obtained, each with a 1 × 1 cm cross-section and the fibre parallel to a long dimension of at least 2.5 cm, so that the fiber axis was perpendicular to the direction of the cell. For the WBSF test the value taken from the force deformation curve was the maximum force.

Results and Discussion

Table 1 shows the results of WBSF (fresh and cooked), MFI and sarcomere length. WBSF values of all muscles (fresh and cooked) decreased with increasing time of postmortem storage ($P<0.05$). In general, WBSF value of both muscles stored at 5°C decreased more from 2 to 21 day postmortem; results that is in agreement with those reported by Gruber *et al.* (2006), who determined the effects of postmortem aging on tenderness of 17 individual beef muscles vacuum-packaged and stored at 2°C. Theres was a significant increase ($P<0.05$) in the MFI after 21 days of storage. Our results demostrated that the MFI of both muscles increased with time postmortem. During postmortem storage of muscles, myofibrillar proteins degradation depends on muscle type, differences between muscles in MFI maybe due to variations in catepsins and calpains activities (Nagaraj *et al*., 2002). Based on sarcomere data, increasing ageing time resulted in better tenderness by lengthening of sarcomere. In this research an increase ($P<0.05$) in sarcomere length of both muscles was found during aging. These results agree with those reported by Stromer and Goll (1967) and Wheeler and Koohmaraie (1994).

Table 1. Effect of ageing, production system and muscle type on shear value (WBSF), myofibrillar fragmentation and sarcomere length (mean).

	Muscle	Temp (°C)	Prod. System	Ageing time (days)			
				2	7	14	21
Fresh WBSF (Kg/cm²)	*L. thoracis*	0	A	1.99^{A}	1.42^{B}	1.54^{B}	1.28C
			B	2.06^{A}	1.66^{B}	1.96^{A}	1.68^{B}
		5	A	1.73^{A}	1.33^{B}	1.64^{A}	1.24^{B}
			B	2.41^{A}	1.83^{B}	1.97^{B}	1.59^{C}
	L. lumborum	0	A	1.99^{A}	1.38^{B}	1.51^{B}	1.26^{C}
			B	2.14^{A}	1.68^{C}	1.85^{B}	1.60^{C}
		5	A	1.69^{A}	1.22^{C}	1.49^{B}	1.26^{C}
			B	2.43^{A}	1.80^{C}	2.03^{B}	1.80^{C}
Cooked WBSF (Kg/cm²)	*L. thoracis*	0	A	8.46^{X}	8.37^{X}	7.49^{Y}	5.09^{Z}
			B	9.63^{W}	9.12^{X}	7.93^{Y}	6.02^{Z}
		5	A	8.40^{W}	7.55^{X}	6.11^{Y}	4.26^{Z}
			B	9.31^{W}	8.87^{X}	7.74^{Y}	5.41^{Z}
	L. lumborum	0	A	8.81^{W}	8.42^{X}	7.04^{Y}	5.24^{Z}
			B	9.05^{W}	8.78^{X}	7.67^{Y}	6.16^{Z}
		5	A	7.63^{X}	6.65^{Y}	6.62^{Y}	4.89^{Z}
			B	8.84^{W}	8.50^{X}	8.21^{Y}	5.98^{Z}
MFI	*L. thoracis*	0	A	31.47^{M}	36.20^{N}	43.99^{N}	50.37^{P}
			B	25.24^{M}	39.71^{N}	42.82^{N}	48.61^{P}
		5	A	30.36^{M}	40.03^{N}	50.79^{P}	54.57^{P}
			B	30.15^{N}	30.08^{N}	45.51^{P}	49.89^{P}
	L. lumborum	0	A	30.42^{M}	37.34^{N}	46.87^{P}	50.62^{P}
			B	24.90^{M}	32.85^{N}	45.03^{P}	48.27^{P}
		5	A	36.08^{M}	40.82^{N}	56.30^{P}	58.07^{P}
			B	30.55^{M}	34.26^{N}	47.10^{P}	49.38^{P}
Sarcomere length (µm)	*L. thoracis*	0	A	1.23^{a}	1.33^{b}	1.37^{b}	1.48^{d}
			B	1.17^{a}	1.30^{b}	1.31^{b}	1.46^{d}
		5	A	1.22^{a}	1.39^{b}	1.43^{c}	1.55^{d}
			B	1.25^{a}	1.39^{b}	1.46^{c}	1.54^{d}
	L. lumborum	0	A	1.30^{a}	1.40^{b}	1.40^{b}	1.54^{d}
			B	1.21^{a}	1.31^{b}	1.37^{c}	1.45^{d}
		5	A	1.25^{a}	1.40^{b}	1.42^{b}	1.50^{d}
			B	1.31^{a}	1.45^{b}	1.41^{b}	1.55^{d}

^{ABC} Means within the same row of Fresh WBSF with different superscript are significantly different (P<0.05).
^{WXYZ} Means within the same row of Cooked WBSF with different superscript are significantly different (P<0.05).
^{MNP} Means within the same row of Cooked WBSF with different superscript are significantly different (P<0.05).
^{abcd} Means within the same row of Cooked WBSF with different superscript are significantly different (P<0.05).

Conclusion

The results of this study indicate that the meat of **A** Producer was tenderer since the values of WBSF, in fresh and cooked meat, were lower than of **B** Producer, being greater the miofibrillar fragmentation index to for **A** Producer, due to a mayor activity of proteases. Most recommendable for **A** producer it is ageing at 5°C, due to the tenderness obtained; whereas for **B** Producer any temperature is viable because meat tenderness does not increase significantly. Ageing process was better for LL because it showed more tenderness.

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