ECOSISTEMAS Y RECURSOS AGROPECUARIOS

TENDERNESS AND TASTE QUALIFICATION OF RED BRANGUS BEEF IN MEXICO

Suavidad y aceptabilidad de la carne de bovinos brangus rojo en México

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ABSTRACT. Beef tenderness is an important trait in consumer satisfaction and has been considered as the main trait for palatability, for which reason it is important to evaluate its variability in different cattle breeds. An experiment was designed to evaluate the Warner Bratzler Shear Force (WBSF) of Red Brangus cattle rib eye steaks and consumer acceptance. The tenderness of beef rib eye steaks was evaluated by the WBSF. A consumer preference evaluation test was carried out to quantitatively estimate tenderness, juiciness, flavor, doneness and general acceptance of the evaluated steaks. Mean WBSF was 5.03 kg ± 0.93 kg, theoretically indicating a tough beef. The distribution of the samples showed 21 % and 11 % of moderately tender and tender beef cuts, respectively. Cattle condition (bulls and steers) was not significant for the WBSF ($p > 0.5$). All the traits evaluated in the hedonic evaluation had approximately 6 points of a total of 8 (8 was best). Tenderness, juiciness and flavor presented a high and significant correlation ($p < 0.5$). None of the subjective traits was correlated with total acceptance. Under theoretical criteria, tender Red Brangus beef cuts are infrequent; however the beef has a good acceptance. Characterization studies may be necessary and useful to create marketing niches specific for this and other cattle breeds.
Key words: Beef acceptance, beef quality, WBSF.

RESUMEN. La suavidad de la carne bovina es un rasgo importante para la satisfacción del consumidor y es la principal característica asociada a su palatabilidad, por lo que es importante evaluar su variabilidad en diferentes razas bovinas. Un experimento fue diseñado para evaluar la Fuerza de Corte de Warner-Bratzler (FCWB) de carne del ojo de la costilla de bovinos Brangus rojos y su aceptabilidad. La suavidad de la carne fue evaluada mediante la FCWB; además, se realizó una evaluación de preferencia de consumo para estimar cuantitativamente la suavidad, jugosidad, sabor, término y aceptación general de los cortes evaluados. La media de la FCWB fue 5.03 kg ± 0.93 kg, lo que teóricamente representa una carne dura. En la distribución de las muestras se registraron 21 % y 11 % de cortes, respectivamente, de carne moderadamente suave y suave. La condición de los animales (toros o novillos) no fue significativa para la FCWB ($p > 0.5$). Todas las características evaluadas en la evaluación hedónica tuvieron alrededor de 6 puntos de un total de 8 (8 era mejor). La suavidad, jugosidad y sabor mostraron una correlación alta y significativa ($p < 0.5$). Ninguna de las características subjetivas tuvo correlación con la aceptabilidad total. Bajo criterios teóricos, la frecuencia de carne suave en Brangus rojo es baja, aun así mostró buena aceptabilidad. Estudios de caracterización podrían ser necesarios y útiles para la creación de nichos de comercialización específicos para esta y otras razas bovinas.
Palabras clave: Aceptabilidad, calidad de la carne, FCWB.

INTRODUCTION

Tenderness is one of the most important traits related to beef consumer satisfaction and has been considered to be the main trait for palatability. Cataloguing tenderness is thus an important criterion regarding product quality (Marshall 1999, Mintert *et al*. 2000).

Searching for techniques and methods to evaluate and ensure tender beef production is an important and common theme of research. Some methods are the high and low voltage stimulation of meat, blade tenderization, manipulation of feed by adding high energy grains during the last 75 d before slaughter, and calcium chloride marination through the activated calcium tenderization process, among others (Jaturasitha *et al*. 2004, Koohmaraie *et al*. 2005, White *et al*. 2006, Pietrasik *et al*. 2011, Bunmee *et al*. 2014, Strydom & Frylinck 2014). However, the simplest and cheapest form of tenderization is assuring a minimum time of aging to promote the proteolysis effect by Calpain and other enzymatic systems (Koohmaraie 1996, Koohmaraie *et al*. 2005, Veiseth y Koohmaraie 2005, Huang *et al*. 2014, Lomiwes *et al*. 2014).

Although beef tenderness is a highly valued trait, and currently almost all of its biochemical processes are known, a large variability in this trait has continued because of breed differences. There are important differences between Bos taurus cattle (tender meat) and Bos indicus cattle (tough meat) (Shackelford *et al*. 1991), differences that are related to the rate of protein degradation (myofibrillar proteins) in the tougher beef breeds (Koohmaraie *et al*. 2005).

In Mexico, a large proportion of consumed meat comes from Zebu derivate cattle breeds (Bos indicus), mainly because the tropical and subtropical production systems, where a high proportion of this cattle is reared, require a genetic source of adaptability, and Zebu breeds perform excellently under harsh conditions, both as purebreeds and crossbreeds (Riley *et al*. 2003, Zorrilla-Ríos *et al*. 2013). Brangus cattle is the result of the reciprocal crossbreeding of Brahman (Bos indicus) and Red Angus (Bos taurus) cattle in approximate final proportions of 3/8 and 5/8, respectively. This breed has spread throughout most of Mexico due to its performance under limited conditions of extensive handling and its growing valued traits (Thomas *et al*. 2007).

It is estimated that beef consumption habits in Mexico have changed over the last years (Schroeder *et al*. 2007). Currently, a large percentage of consumers, particularly in urban markets, prefer meat of young animals that have grown under intensive or semi-intensive high-grain feeding systems (Peel 2002). Although consumer opinion has emphasized the growing importance of quality traits, there is little documented evidence of the consumer habits and organoleptic perception of the quality of a specific origin from the local, regional and national perspectives.

Hence, the objective of this study was to estimate the tenderness of Red Brangus cattle meat following the Warner Bratzler Shear Force method, using theoretical criteria and the hedonic preference level of the evaluated beef in a survey carried out in northern Mexico.

MATERIALS Y METHODS

Twenty-six specimens of Red Brangus derivate crossbred cattle (20 bulls, 6 steers) were obtained for this study from different cattle breeding ranches in Nuevo León, Mexico. The animals were handled in a productive performance test after weaning under the same feeding conditions, and were classified according to age in order to be placed in pens with their age group. The handling of the cattle included the use of ractopamine as a growth promoter (normally used in the region). After 120 days, the animals were transported to a supervised federal slaughterhouse (TIF), as established in the official norm.

Meat samples were obtained one day after slaughtering and consisted of a one-inch portion of longissimus dorsi muscle from between the 11^{th} and 12^{th} ribs, also known as rib eye. The samples were maintained in a vacuum at 5 °C for seven days to ensure some degree of aging, after which they were kept at -20 °C until the day of the test,

allowing a gradual lowering of the temperature. The test consisted of cooking the meat cuts in an open-hearth electric broiler (Faberware Company, Kidde, Inc. Bronx, NY) until the internal temperature was 41 °C, after which the meat was turned over and cooked to a final internal temperature of 70 °C. The temperature was monitored with a thermocouple (Model 8000024, Sper Scientific, Scottsdale, AZ). The cooked beef was covered with a plastic film to avoid dehydration and refrigerated until sampling. Six to eight cylindrical samples (1.27 cm), parallel to the muscle strings, were then cut from the rib eye nucleus as specified by AMSA (1995).

Once the samples were prepared, the beef cuts were analyzed for WBSF using a TAXT2i texturometer (Texture Analyzer, Stable Micro Systems, Vienna Court, UK) equipped with a Warner Bratzler blade, which simulates the mastication process. The average of the shear force values was recorded and processed with a variance analysis in order to examine animal type differences.

The WBSF average was classified following the criterion of Belew *et al.* (2003) and the frequency of tender (< 3.2 kg WBSF < 3.9 kg), moderately tender (< 3.9 kg WBSF < 4.5 kg) or tough (WBSF > 4.6 kg) beef cuts was recorded.

A beef tasting test was carried out at the same time using randomly selected beef cuts from the carcasses of the sampled animals. Rib eye cuts were obtained and cooked following a char-broiled traditional method, and were seasoned with salty water. A panel of 53 people (with no previous training) was grouped to carry out the survey, evaluating small beef samples as proposed by Lorenzen *et al.* (2003). The size of the samples was closer to that estimated theoretically (i.e. 48) from the procedure suggested by Hough *et al.* (2006), considering a root mean square error divided by scale = 0.23, Alpha = 5 %, Beta = 10 % and a difference in the means = 0.5, since no comparison groupings were included in the test. The evaluation criteria were tenderness, flavor, juiciness and overall perception of the quality. Each trait had an 8 to 1 point testing scale, where 8 was the best and 1 was the worst. The traits were analyzed for normality with the Shapiro Wilks modified method using the statistical software InfoStat/Professional Ver. 2.0, and a Pearson correlation test was performed among all the traits using the same statistical software.

RESULTS

The overall mean of the Red Brangus WBSF was 5.03 ± 0.93 kg, with a minimum of 3.23 kg and a maximum of 8.93 kg. The animal type (bull vs steer) produced no significant difference with respect to the WBSF mean (P > 0.05), with a difference of 0.130 kg between the means of each animal type (Table 1). With respect to the theoretical classification of the WBSF, 11 % of the beef was classified as tender, 21 % as moderately tender and 68 % as tough with more than 4.6 kg of shear force, as is theoretically suggested.

The tasting tests mean grades given for tenderness, flavor and juiciness were similar and slightly lower than the overall perception of quality (Table 2). The significant (p < 0.001) and moderately high correlation (r 0.60) obtained for the three traits evaluated (tenderness, juiciness and flavor), and the high correlation between flavor and juiciness (r = 0.83) (Table 3), are remarkable. Nonetheless, the overall grade and the other evaluated traits presented low correlations (p > 0.05).

Table 1. Least square means ± SE of WBSF per animal type in Red Brangus beef.
Tabla 1. Medias de mínimos cuadrados ± EE de la FCWB por tipo de animal en carne de ganado Brangus rojo.

	n	WBSF	p > f
Bull	20	5.39 ± 0.33	0.8400
Steer	6	5.24 ± 0.53	

n: sample number. SE: standard error.

DISCUSSIÓN

The observed mean recorded in this study was similar to that reported for Brangus longissimus dorsi beef cuts, without aging, from Colombia (Vásquez *et al.* 2007). The same authors estimated the tenderness mean for Brahman beef and reported significantly lower shear force values for beef cuts from Brown Swiss x Zebu crosses (3.051

Table 2. Arithmetic indicators of the traits evaluated in the taste test of Red Brangus beef.
Tabla 2. Indicadores aritméticos de las características evaluadas en la prueba de aceptación de carne de ganado Brangus rojo.

	n	Mean	SE	Median	Minimum	Maximum
Tenderness	53	5.283	0.211	6.0	2	8
Flavor	53	5.830	0.234	6.0	1	8
Juiciness	52	5.192	0.256	5.5	1	8
Doneness	50	5.740	1.562	6.0	1	8
Overall	52	6.000	0.214	6.0	2	8

n: sample number. SE: standard error.

Table 3. Pearson correlation coefficients among the traits of the taste test of Red Brangus beef.
Tabla 3. Coeficientes de correlación de Pearson entre las características de la prueba de aceptación de carne de ganado Brangus rojo.

	Flavor	Juiciness	Doneness	Overall
Tenderness	0.62***	0.65***	0.41**	0.17
Flavor		0.83***	0.20	0.09
Juiciness			0.06	0.11
Doneness				0.05

n: sample number. SE: standard error.

kg). Bonilla (2010) reported a mean WBSF of 4.3 kg for commercial beef without aging. Smith *et al.* (2009) estimated the difference in Brahman meat after 7 to 14 days of aging and found that a longer aging time favored a lower WBSF (4.57 kg vs 3.85 kg, respectively).

Although the WBSF is generally variable, Zebu or composite breeds consistently have higher values for this trait. This is important mainly because a large proportion of the cattle raised in tropical and subtropical regions needs the advantage of adaptability of Bos indicus-derived breeds, with the resulting increase in meat toughness, as is estimated for crossbred cattle with a 50 % or greater Zebu inheritance (Koohmaraie 1996). Similarly, Delgado *et al.* (2005) reported higher values of WBSF in the central and southern regions of Mexico, where climatic conditions require Zebu-type animals. Rubemsam *et al.* (1998) indicated that when the proportion of Bos indicus inheritance increases to more than 25 %, the tenderness trait is significantly and sustainably affected. This later observation generates a price reduction at the moment of commercialization (Riley *et al.* 2003). As presented here, the large range of WBSF values suggests that the proportion of Zebu composition in the Brangus breed may influence this important trait in different degrees, since all the animals were handled equally.

Beef tenderness is well known as being one of the most important traits in beef consumer satisfaction (Smith *et al.* 2009). The evaluation of tenderness is mainly based on the measurement of the WBSF as a metric and objective criterion homologous to mastication. Different studies differ in the level of classification and the maximum level of tenderness catalogued (Shackelford *et al.* 1997). Huffman *et al.* (1996) estimated the level at which beef is considered tender and fixed it at 4.1 kg or lower, suggesting that a 98 % consumer satisfaction rating may be observed at this level.

A complete study by Belew *et al.* (2003) classified the tenderness of 40 different bovine muscles based on the WBSF. A wide variation was reported, and the data were suggested to be highly important for marketing purposes. The classification of muscle tenderness included the criteria used in the present evaluation. However, only approximately 30 % of the samples were included in the tender group. The present results indicate there is an im-

portant variability in the sample group that could be attributed to the crossbreeding process of breed creation up to when there is a 3/8 proportion of Bos taurus. As a consequence, a fundamental issue would be the formation of homogeneous groups of cattle to guarantee the same quality at the moment of slaughter.

Since an important range of values for the evaluated traits (i.e. 5 kg) was identified, with a very positive extreme for tender beef under a theoretical classification, the timely generation of indicators to describe the quality of the traits, such as tenderness, may facilitate the creation of beef classification standards (Méndez *et al*. 2009) which may eventually promote market niches to allocate Mexican beef to a better status (Parra-Bracamonte *et al*. 2009).

As it was available, the animal type was evaluated but did not affect the WBSF mean. Similarly, Vásquez *et al*. (2007) reported a more similar WBSF mean and no difference in shear force between bulls and steers. Additionally, these authors found no difference in the beef of animals supplemented with the ractopamine growth promoter. Ractopamine is a β-agonist, an alternative to the prohibited clenbuterol, cimaterol or zilpaterol, that alters the metabolism, increases the efficiency of metabolizable protein use and positively affects muscle increase, growth, weight gain and carcass yield without affecting other quality traits such as marbling (Walker *et al*. 2006). Recent findings have indicated that ractopamine slightly and negatively affects the tenderness of beef of different breeds, including Brahman-derived beef (Gruber *et al*. 2008). However, this study was not designed to detect the effect of the ractopamine promoter on the beef tenderness of Red Brangus animals, so this may be an important research subject for further investigation.

Regarding the tasting test, the judgment levels related to the previous experience with respect to beef consumption may be observed with a significantly moderate correlation between the beef doneness grades and the tenderness, indicating an experience associated with the cooking time of the meat. Goodson *et al*. (2002) determined that a high percentage of consumers prefer a doneness higher than medium.

Consumer acceptance and reaction to palatability are very difficult to determine, despite which this study recorded important findings for a specific beef cut from the longissimus dorsi muscle of the Red Brangus breed. Regardless of the boximpossibility of consumer panel classification, their socioeconomic level and gender distribution were likely homogeneous. Frequently, perceptions may be biased or affected by many factors (Lorenzen *et al*. 2003, Delgado *et al*. 2006). Among others, the beef cut type, production and handling practices, meat pre-classification, cooking time, consumer gender, age, education level and income (Delgado *et al*. 2006, Shackelford *et al*. 2001) are of greater importance. In general, these factors may influence the grade given by a consumer because of previous experience with a particular beef cut. For example, Delgado *et al*. (2006) suggested that the habit of a previous consumption of tough beef from Bos indicus cattle may affect the evaluation of tenderness, making flavor the most preferred trait.

The trait grades suggested a good acceptance of the beef that was tasted, and the grade rank showed a similar mean and median. The highly significant correlation ($p < 0.05$) recorded between flavor and juiciness is supported by the deposition of fat, which is related to an intensification of flavor during cooking and is provided basically by the marbling or intramuscular fat deposition (Wheeler *et al*. 1994). Several studies have related the positive effect of marbling and beef tenderness (Koch *et al*. 1988; Wheeler *et al*. 1994). Although this response is beyond the objective of this study, the correlation of the assigned grades by the subjective appreciation of a consumer panel supports that tendency.

In conclusion, following a theoretical classification system, the WBSF mean indicated that Red Brangus beef is tough. The bull vs steer condition did not affect the WBSF. The distribution of the analyzed samples showed that 11 % were tender and 68 % were tough. The grades obtained in the taste test indicated a positive consumer perception of Red Brangus beef. A positive moderate to high correlation was observed among the traits of tenderness, juiciness and flavor in the subjectively

evaluated beef.

The creation of indicators for an objective quantitative characterization of quality traits in local breeds could promote commercialization niches, and an understanding of consumer perception could allow a better national and international positioning of these beef products.

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