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EFFECTS OF RACTOPAMINE HCL (OPTAFLEXX®) ON SENSORY PROPERTIES OF BEEF

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Introduction

Consumer demand for a consistent and acceptable eating experience has led the beef industry to invest significant resources to provide consumers with a predictable, high quality product from a sensory and palatability perspective. Considerable efforts have been made to measure and quantify changes in meat sensory properties and palatability; specifically, flavor, juiciness and tenderness. The importance of these quality and sensory attributes was confirmed by results of the 1991, 1995 and 2000 National Beef Quality Audits and the 1990 and 1999 National Beef Tenderness Surveys.

The ultimate determination of consumer satisfaction is the consumer's eating experience. Consumers consider flavor, juiciness and tenderness as they evaluate beef palatability, with tenderness as one of the most important attributes. Researchers have spent years trying to identify a reliable and objective tool to use under controlled conditions to predict and evaluate meat tenderness. To date, no mechanical process has been identified, that can be used commercially, which consistently indicates a specific degree of tenderness.

Since the measurement of consumer satisfaction and eating experience is a personal preference and a decision influenced by a complex interaction of numerous factors, the test of consumer preferences is difficult to replicate in the laboratory. Many times definitive consumer preferences are difficult to ascertain even through the use of large uncontrolled consumer panel evaluations. As an alternative, trained sensory panels and Warner-Bratzler shear force tests are typically used to provide an indication of meat palatability when the use of large uncontrolled consumer panel evaluations is impractical.

Objectives

The objective was to determine the effects of feeding various levels of ractopamine HCl, (Optaflexx®) on beef sensory properties and Warner-Bratzler shear force in boneless strip loin steaks.

Methodology

Sample Preparation and Attributes Measured

Boneless strip loin steaks were collected from carcasses from control and treated animals. Optaflexx treatments were 0.0, 9.1, 18.2 and 27.3 g/ton (100% DM), which provided approximately 0, 100, 200 and 300 mg/hd/d, respectively. For additional information on trial procedures for assessing live performance and carcass variables, refer to Elanco Animal Health Optaflexx FOI, NADA 141-221.

Trained sensory panel evaluation and Warner-Bratzler shear force measurement of beef strip loin steaks (*longissimus* muscle) were conducted at Iowa State University, Department of Food Science and Human Nutrition. Samples were obtained from a representative group of carcasses (n = 90 per treatment) from five steer and four heifer trials. Evaluations were conducted on 2.54 cm thick steaks cooked to a medium degree of doneness (71^{o}C). Additional parameters measured included raw weight, cooked weight, cooking loss, and ultimate muscle pH.

Preparation and evaluation of samples were conducted with procedures described in the *Research Guidelines for Cookery, Sensory Evaluation and Instrumental Tenderness Measurements of Fresh Meat* (American Meat Science Association, 1995). Training of sensory evaluation panelists enabled the panelists to detect incremental differences in attributes more discreetly than the average consumer. Trained panelists (n=10) used a 150 mm line scale to critically evaluate the sensory traits of juiciness, initial tenderness, sustained tenderness, beef flavor, and off flavor.

Statistics

Data from all trials were pooled and statistically analyzed using a mixed model analysis (PROC MIXED, SAS). Trial heterogeneity was tested using a residual and random component. Depending on the results of these tests, either a weighted mixed model analysis was conducted for traits showing trial heterogeneity or an un-weighted mixed model analysis was conducted for all traits without trial heterogeneity.

Results & Discussion

Cooking Loss and Ultimate pH of Fresh Muscle

Results for cooking loss and ultimate pH of fresh muscle are shown in Table 1. No differences ($P > 0.05$) were observed for cooking loss percentage and ultimate pH between control and treated steaks.

Trained Sensory Panel Traits

The effects of ractopamine (Optaflexx®) on sensory variables are shown in Table 1. Using a 150 mm line scale, panelists were trained to evaluate samples for initial tenderness, juiciness and sustained tenderness, as well as beef flavor. Values in the range of approximately 70 mm to 85 mm were considered to be only slightly juicy, slightly tender and having slight beef flavor. Samples exhibiting the characteristics of being moderately juicy, moderately tender, and having moderate beef flavor were judged to fall in the range of approximately 85 mm to 120 mm. Values above 120 mm to the maximum of 150 mm were considered to be very juicy, very tender and having intense beef flavor.

Values for all sensory traits of all treatments were within the range of 89 mm to 112 mm, considered to be moderately juicy, moderately tender and moderate in beef flavor and were judged to be in the mid range of acceptability for each trait.

Panelists were trained to evaluate off flavors and identify samples without off flavors with a zero (0 = none) and intense off flavors with values as high as 150 (intense). A minimal number of samples exhibited off flavors resulting in very low scores (<1) for off flavor.

Understanding the meaning of the results of the trained sensory panels and the relationship to the preferences of the consumer can be somewhat subjective. In the opinion of the principal investigator in this study, a shift of 10 to 15% (15 mm to 22 mm change on the line scale) would be required for the consumer to detect a difference in a sensory trait. In this study, no sensory trait was changed by more than 7 mm compared to controls. When evaluating beef steaks, highly trained sensory panelists are conditioned to distinguish between minute differences in sensory traits that may be statistically different but have no practical meaning to the consumer.

No differences ($P > 0.05$) were detected for juiciness, flavor and off flavor for any of the Optaflexx treatments. No differences ($P > 0.38$) were detected for initial and sustained tenderness at the 100 or 200 mg/hd/d Optaflexx feeding level. Initial and sustained tenderness values were lower at the 300 mg/hd/d level ($P < 0.05$) compared to controls. However, these changes (5.7 to 6.6 mm, respectively) were below what would be considered to be the threshold of consumer detection (15 to 22 mm).

Warner-Bratzler Shear Force

Warner-Bratzler shear force results for this study are presented in Table 1. For all treatments values were 3.95 kg or less, considered acceptably tender and well within the normal variation observed in today's meat industry. No differences were observed ($P > 0.45$) when comparing the controls to the 100 mg/hd/d and 200 mg/hd/d levels. The Warner-Bratzler shear force for the 300 mg/hd/d level was increased ($P < 0.05$) compared to controls.

The results of the Warner-Bratzler shear force measurements on *longissimus* muscle were well within the normal range of shear forces observed in the meat industry as reported in the scientific literature and considered acceptably tender for cooked strip loin steaks. Small increases in Warner-Bratzler shear force values may be expected in longissimus dorsi samples from cattle treated with ractopamine, since the treated cattle had a larger ribeye area, due to hypertrophy similar to pigs (Aalhus et al., 1992; Solomon et al., 1991). Therefore, size of the muscle fiber is increased most likely by increasing the number of myofibrils or diameter of myofibers. A logical conclusion is that muscles with slightly larger muscle fibers may require slightly more shear force to shear the larger myofibrils and muscle fibers. Increased myofibrils would potentially have an impact upon both subjective and objective measurements.

Star Probe Compression Force (STRPB)

Star probe compression force test results for this study are presented in Table 1. No differences ($P > 0.12$) were detected in STRPB for the 10 ppm and 20 ppm concentrations of ractopamine compared to controls. STRPB was increased ($P = 0.0007$) for the 30 ppm concentration of ractopamine compared to controls. Increased star probe values may be expected in longissimus dorsi samples from cattle treated with ractopamine since the treated cattle had a larger ribeye area, most likely due to hypertrophy similar to pigs (Aalhus et al., 1992; Solomon et al., 1991). Therefore, size of the muscle fiber is increased, containing more protein, which in turn increases the diameter of myofibrils. Muscles with slightly larger muscle fibers and denser myofibrils may inevitably have slightly higher STRPB compression force values.

Interpretation of Warner-Bratzler Shear Force Tests, Threshold Values for Shear Force, Sensory Panel Results and Classifications of Tenderness

Understanding and interpreting the meaning of the Warner-Bratzler shear force, trained sensory panels and the relationships of each method to the preferences of the consumer is not an exact science and can be somewhat subjective. To date, no mechanical process has been identified that consistently indicates degree of tenderness or exactly predicts the preferences of consumers.

While investigating the relationship between Warner-Bratzler shear force and trained sensory panels evaluation of tenderness, Bourne (1982) reported correlation coefficients (r) of –0.001 to –0.942 with many researchers reporting correlations in the range of $r = -0.5$ to -0.7. This means that about 25% to 50% of the variability in trained sensory panel tenderness ratings can be explained by the use of Warner-Bratzler shear force, with the remainder attributable to other factors.

Since the review by Bourne (1982), numerous research reports (McKeith et al., 1985; Harris and Shorthose, 1988; Shackelford et al., 1991; Miller et al., 1995; Shackelford et al., 1997; Shackelford et al., 1999; Wheeler et al. 1999; Miller et al. 2001) have concurred with the review, citing many factors that impact meat juiciness, flavor and tenderness and ultimately consumer satisfaction. Published research reports emphasize that factors such as cooking method, gender, chronological and physiological age, connective tissue, stress, meat color, feed ingredients, implant program, post mortem handling of carcasses or meat, electrical stimulation and mechanical stimulation all have considerable effects on the tenderness, flavor and juiciness of meat. Of the factors affecting meat palatability, cooking method and degree of doneness has been identified as major contributors leading to a less than desirable eating experience (Cross et al., 1976; Wheeler et al., 1999).

Efforts by researchers (Miller et al, 1995; Huffman et al, 1996, Boleman et al. 1997; Shackelford et al. 1991, 1997, 1999; Wheeler et al., 1999; Bruns et al. 2000; and Miller et al. 2001) have attempted to measure and describe definitive thresholds or breakpoints in meat tenderness as measured by Warner-Bratzler shear force tests in order to classify meat for tenderness. Instead of trying to classify meat as either tender or tough, their approach groups the tenderness assessment of cooked steaks into 3 primary categories: **1)** tender, **2)** acceptable or intermediate and **3)** unacceptable or tough.

Table 2 summarizes the various threshold values for Warner-Bratzler shear force reported by the various authors.

Use of a three category classification tends to segregate meat into the following three groupings:

1. **Tender** - with a shear force in the range of 3.6 to 4.1 kg or less. Typically the *psoas* muscle from the loin otherwise known as the tenderloin or filet mignon and the chuck muscle called the *infraspinatus*, more recently referred to as the flat iron steak.
2. **Acceptable or Intermediate –** with a shear force ranging from 3.6 to 4.1 kg up to 4.5 to 5.9 kg (differing depending on individual researchers and reports). Typically muscles such as the *longissimus* and *gluteus* of the strip loin and top sirloin, respectively.
3. **Unacceptable or Tough –** with a shear force of approximately 5.4 to 5.9 kg or greater. Typically brisket or roasts from the chuck and round requiring moist heat cooking methods.

Interpretation of the Practical Significance of Changes in Warner-Bratzler Shear Force

As one might expect, a practical or meaningful change in Warner-Bratzler shear force that might be detectable to the consumer is an area of debate. Miller et al. (1995) found that a change in shear force of about 1 kg was necessary for detection by consumers in restaurants and about 0.5 kg being noticed by the consumer when eating at home. Huffman et al. (1996) found that a shear force change of about 1 kg or more is necessary in order for the consumer to find a noticeable difference between steaks.

Practical Use of Information Obtained from Trained Sensory Panels and Warner-Bratzler Shear Force Tests Conducted under a Standard Protocol and Common Institution.

Wheeler et al. (1997) reported a high repeatability of about 85% between the results of a trained sensory panel and Warner-Bratzler shear force and considered both methods reliable as long as both are conducted at the same institution. In such cases, panelists are trained to differentiate between samples with a known shear force obtained from complimentary samples cooked by the same methods. Wheeler et al. (1997) recommended use of a standard protocol to achieve meaningful results from sensory evaluation tests.

Following recommendations of experts in the areas of meat science and sensory evaluation, steaks from cattle fed Optaflexx were evaluated for sensory traits and Warner-Bratzler shear force using a standard protocol at a single institution.

Understanding the relationships between the meat sensory evaluation results obtained from trained sensory panel and Warner-Bratzler shear force has proven to be a challenge and area of debate for researchers over many years. There are many references that demonstrate very low to very high relationships between trained sensory panel results and Warner-Bratzler shear force tests. The interpretation of the results from Warner-Bratzler shear force and trained sensory panel test results is an area filled with many differing opinions and opportunity for discussion or debate.

Conclusions

After a thorough review of the sensory data collected from strip loin steaks obtained from cattle fed ractopamine, (Optaflexx®), it was concluded by the US FDA CVM, that no differences in palatability as defined by juiciness, flavor and tenderness would be detected by the consumer.

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Tables and Figures

Table 1. Effects of Optaflexx on Sensory Variables and Warner-Bratzler Shear of Strip Loin Steaks[a]

	Optaflexx, mg/hd/d				
Variables	**0**	**100**	**200**	**300**	**SE**
No. Samples	90	90	90	90	
Cooking Loss, % [b]	21.5	21.5	21.0	21.8	0.13
Ultimate pH of Fresh Muscle	5.56	5.54	5.56	5.56	0.01
Juiciness [c]	104.6	104.5	106.0	103.3	1.6
Initial Tenderness [d]	111.7	110.7	111.5	106.0*	1.8
Sustained Tenderness [d]	101.8	100.5	100.3	95.2*	1.8
Flavor [e]	90.3	89.0	90.5	88.7	1.7
Off Flavor [e]	0.252	0.222	0.156	0.157	0.098
Warner-Bratzler shear force, kg	3.54	3.49	3.62	3.95*	0.16
Star probe compression force, kg	5.03	5.17	5.25	5.56*	0.21

[a] Least squares means

[b] Cooking Loss = (raw weight – cooked weight) / raw weight) * 100

[c] Juiciness evaluation: 0 = not juicy, 150 = very juicy

[d] Tenderness evaluation: 0 = not tender , 150 = very tender

[e] Flavor / Off Flavor evaluation: 0 = none, 150 = intense

* $P \leq .05$ compared to controls

Table 2. Independent Research Reports of Threshold Values for Warner-Bratzler Shear Force of Primarily Cooked Strip Loin Steaks and Classification of Tenderness[a]

Reference / Author	Year	Tenderness Classification		
		Tender	Acceptable or Intermediate	Unacceptable or Tough
		Threshold kg of Warner-Bratzler Shear Force		
Shackelford et al.	1991	<3.9	≤4.6	>4.6
Miller et al.[b]	1995		<4.3	
Huffman et al.	1996	<4.1	≤4.5	>4.5
Boleman et al.	1997	<3.6	<5.4	>5.9
Shackelford et al.	1997		≤6.0	>6.0
Shackelford et al.	1999		≤5.0	>5.0
Wheeler et al.	1999		≤5.0	>5.0
Bruns et al.	2000	<3.5	3.6-4.9	>5.0
Miller et al.	2001	<3.0	3.0-4.6	>4.6

[a] threshold values are from steaks cooked to a medium degree of doneness (approximately 71^0 C)

[b] a mixture of steaks from the chuck, rib, loin and round were utilized in this study