5-2011

Sensory Evaluations of USDA Select Strip Loin Steaks Enhanced with Sodium and Potassium Phosphates and USDA Choice Strip Loin Steaks for Comparable Palatability Factors

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SENSORY EVALUATIONS OF USDA SELECT STRIP LOIN STEAKS ENHANCED WITH SODIUM AND POTASSIUM PHOSPHATES AND USDA CHOICE STRIP LOIN STEAKS FOR COMPARABLE PALATABILITY FACTORS

A Thesis
Presented to
The Faculty of the Department of Agriculture
Western Kentucky University
Bowling Green, Kentucky

In Partial Fulfillment
Of the Requirements for the Degree
Master of Science

By
Lindsey Berry Reynolds

May 2011

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Date Recommended May 2, 2011

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Dr. Nevil Speer

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Richard H. Baker May 16, 2011

Dean, Graduate Studies and Research Date

ACKNOWLEDGEMENTS

I would like to express my appreciation and gratitude to the following people who assisted me in completing this paper:

Thank you, Dr. Elmer Gray for your critical reading of this text and your continuous motivation for improvement.

Thank you to the following students who participated in this study: Adam Thomas, Ashley Quiggins, Brian Reynolds, Olivia Payne, Justin Vaughn, John Baston, Matthew Turner, Wes Korthaus, Dustin Ogburn, Alan Bush, Ed Hendrick, Adam Hendrickson, Amanda Swift, Chris Davis, and Tom Nichols.

Thank you to the following members of the 2010 WKU Livestock Judging Team: Ashley Quiggins, Brian Reynolds, Nathan DeKemper, and Jacob Sharpe. Your hard work and dedication was greatly appreciated and experiences shared with you will always be remembered.

Thank you, Department of Agriculture Faculty, for the assistance and opportunities I have encountered here at Western.

Finally, thank you to my husband, Daniel, for giving me the love, support, and encouragement to complete graduate school. Without your help and understanding I could not have accomplished my goals.

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The cyclic nature of the beef industry is dependent on the supply and demand transaction initiated by consumers' acceptability of quality meat products. When purchasing beef at the grocery store, consumers are dependent on USDA grades and visual appraisal; consumers expect consistency in products. Upon this appraisal, quality is determined by the color, marbling content, and texture of a particular retail cut, as well as cooked characteristics of tenderness, flavor, and juiciness. Variability in meat tenderness is a major quality defect of beef (Morgan et al., 1991b; Smith et al., 1992). A common practice used by beef processors to extend the shelf life and improve tenderness of beef products is "enhancing". Even though enhancing products is effective for water and color retention and improved tenderness, these additives can negatively impact flavor by giving a bitter, salty or metallic taste. This experiment was conducted to determine the effect of enhancement on the eating quality of USDA Select strip loin steaks. After a training session, six students in the agriculture department at Western Kentucky University were selected to serve on a sensory panel. The panel members evaluated tenderness, juiciness, flavor, off-flavor, overall acceptability, and saltiness. The USDA Select strip loin steaks were enhanced with a 12% solution of sodium and potassium phosphate and USDA Choice strip loin steaks were non-enhanced. Results indicated the enhanced product was inferior for all palatability measures ($P<.05$). Enhanced

USDA Select strip loin steaks were rated as being lower for tenderness, juiciness, flavor, overall acceptability, and more salty. Also, the enhanced strip loin steaks received significantly higher evaluations for off-flavor ($P<.01$). These data suggested that a 12% solution of sodium and potassium phosphates administered to USDA Select strip loin steaks lowered consumer satisfaction.

Chapter I

INTRODUCTION

All industries of business are pushed by one ever present factor that is the ultimate success or demise of an enterprise. Consumer perception and acceptance is the driving force for any form of profitability. Many times in the beef industry the "back seat driver" position of the consumer is forgotten in the everyday focus of animal production. However, the acceptability of beef by the consumer triggers lasting sensory experiences that influence the repeatability of purchases.

Flavor, juiciness, and tenderness determine the palatability and overall eating satisfaction or dissatisfaction, with the coupling of these characteristics (Aberle et al., 2001). Tenderness variability is a major concern of the beef industry because of the increased demand for a leaner, more consistent product (Miller et al., 1995) and according to Morgan et al. (1991a) tenderness is the most influential trait affecting consumer acceptance and is unacceptably inconsistent. Boleman et al. (1997) have also noted that consumers are willing to pay a premium for beef that is guaranteed tender.

Traditional characteristics for selection of raw meat for palatability have not changed over time. Consumer identification of marbling, color, and texture are prudent for choosing a meat cut that will give the end result of satisfaction. An added feature for beef is also the USDA quality grade stamping on the packaging of the product. Branded beef is another way to ensure quality to consumers and the largest organization of its kind is Certified Angus Beef (CAB) founded in 1978 (Certified Angus Beef Partners). Branded beef takes factors such as marbling score, fat thickness, ribeye area, maturity, and meat texture into an evaluation for a product that will be more satisfying to

consumers. This may help in determining a product to purchase. However, with every consumer driven industry one factor is very often the front runner in determining a selection, namely price. For competition in retail the lowest price beef cuts are among the most favorable for purchase to the majority of the public. The USDA quality grade of these low cost cuts is also sacrificed. An example of this is the quantity of Choice versus Select beef that is sold in groceries. The bulk of beef that is sold in retailers drawing in crowds with "low pricing" is USDA Select. Only a small section of USDA Choice is offered, thus raising the question "with Select beef having an upper hand in pricing, how are the palatability factor perceived by consumers?"

The answer to this question is through enhancing. In the simplest form of the word, enhancing is the addition of a solution to a piece of meat. Marinating is the most obvious form of enhancing to consumers because of the packaging of the meat with liquid, herbs, and spices. Enhancement of USDA Select beef is not often noticed by consumers due to marketing brand names and the solution added to the beef has been injected mechanically.

According to Hamling et al. (2008) enhancement systems have traditionally been composed of water, salt, and phosphates. Injection of solutions containing salt and phosphate has been shown to increase water holding capacity and tenderness (Vote et al., 2000; Lawrence et al., 2004; Baublits et al., 2006). Conversely Morgan et al. (1991) and Miller et al. (1995) both encountered off flavors experienced by sensory panels described as bitter, metallic, soapy, and sour. This off flavor would result in a disappointing eating experience and the consumer could think that their cooking method and/or seasoning would be at fault. The objective of this study was to evaluate whether enhanced USDA

Select strip loin steaks are comparable to USDA Choice strip loin steaks, as judged by a sensory panel.

Chapter II

LITERATURE REVIEW

Establishment of Grading Systems

In 1916, the United States Department of Agriculture, responded to demand for a uniform livestock reporting service, by initiating studies that led to the development of standards for grades of beef (Dyer et al., 1972). By 1925, purebred breeders, with the support of the USDA and National Livestock and Meat Board, initiated the "better beef" campaign (Rhodes et al., 1960). The main objective of the beef campaign was to promote the carcass quality of purebred cattle. Cole et al. (1975) stated that by 1955 about half of beef slaughtered was graded and the full benefit of a grading system was becoming prevalent. It allowed new packers to compete with established firms and for smaller packers to compete with larger ones in selling retail beef of known standard. In 1960-65 growing consumer aversion to fat, stimulated by press stories stating the risks of eating high levels of saturated fat, caused a re-evaluation of grading standards (Cole et al., 1975). This was the development of yield grading which predicted the yield of boneless trimmed retail cuts from the round, loin, rib and chuck. This is also confirmed by Gerrard et al. (2003) who compares the composition of market livestock from the 1950's-1960's to present day. Since 1950-1960 the market weight of animals has increased, the average daily gain increased, pounds of feed per pound of gain decreased, fat thickness decreased, loin muscle area increased and days to market weight has decreased.

Quality Grade

Beef carcass quality grading is determinate on the following two factors: degree of marbling and degree of maturity. Marbling is defined as fat that is deposited intramuscularly and is the single most widely used indicator of beef quality (Dyer et al., 1972). This intramuscular fat in the lean muscle tissue is evaluated by graders in the ribeye muscle after the carcass has been ribbed between the twelfth and thirteenth rib (Hale et al., 2010). Subsequent quality grades in the descending order of marbling content can be found at the restaurant and retail level in the form of retail cuts: USDA Prime, USDA Choice, USDA Select, and USDA Standard. Machine grading has resulted in less variation than that of USDA graders and has increased consistency among USDA quality grades (Peck, 2006).

Degree of maturity is evaluated through the ossification of the skeleton and the color and texture of the ribeye muscle to determine physiological age since chronological age is not always known (Hale et al., 2010). Swatland et al. (1984) stated that beef carcasses have to be graded according to age because the amount and strength of collagen binding increases with age. Since collagen is the most abundant protein in the animal body it has an important influence on meat toughness. Even though retail cuts from one particular carcass can vary in degrees of tenderness based on position of the muscle, the tightness of the collagen binding with hydrogen in areas that receive more exercise is regulated by maturity. Collagen in younger animals is more easily ruptured by pH changes, heat or denaturing agents; collagen changes with age to a much more thermostable form (Bailey et al., 1972).

Enhancement

Enhanced or value added meat and poultry products are raw products that contain flavor solutions added through marinating, needle injecting, or soaking (Cerruto-Nova et al., 2009). There are many advantages to using meat enhancers such as improved tenderness, moisture, extended shelf life, improved appearance, development of new products, consumer convenience, reduced rancidity, and increased profitability (Foote et al., 2004). According to a consumer survey conducted by Moeller and Courington, (1998), the three primary factors that would motivate consumers to purchase more beef at retail markets are "lower retail beef prices," "improved product quality and consistency at the same price," and "improvements in eating experience." Consumer acceptance of enhanced products has become more widespread with color, visible fat, price, and cut being the most important factors considered when purchasing meat (Robbins et al., 2003). Adding solutions to improve tastiness of beef, especially tenderness and water retention, has become more standardized in recent years, though this trend is well established in the poultry and pork industries. The poultry industry evaluated injecting water and polyphosphates into chicken meat more than 30 years ago (Grey et al., 1978; Griffiths et al., 1978). Similarly, the pork industry has used enhancers to increase qualities in "case ready" meats while studying sensory attributes under various conditions (Sheard et al., 1999; Brewer et al., 2002; Prestat et al., 2002).

While calcium and sodium chloride, ammonium hydroxide, salt, sodium lactate, and sodium phosphate are common additives in enhancement solutions, studies focusing on mixtures of sodium and potassium phosphates have been lacking. Published in the Biofuels Journal (2004) ingredients such as sodium phosphate, salt, potassium lactate,

and sodium diacetate can alternatively produce metallic, bitter, and astringent off flavors. Additionally, Cerruto-Nova et al. (2009) stated two concerns for extensive use of phosphates in enhancing solutions: 1. Phosphates contributing a high level of sodium to the diet which concerns people suffering from hypertension, which is a risk factor for cardiovascular diseases and 2. People suffering from kidney disease, impaired renal function or perfusion, dehydration or uncorrected electrolyte abnormalities must avoid foods that contain high levels of phosphates (Block et al., 1998; Tonelli et al., 2005). The enhancement mixture of potassium and sodium phosphate is prevalent in the markets regionally surrounding Bowling Green, KY and thus establishes a real time consumer purchasing option environment.

Studies have reflected the improvement of tenderness and juiciness through the use of enhancement solutions. Vote et al. (2000) divided forty six USDA Choice and forty nine Select strip loins, each steak into two sections, and one section was used as the control and was injected with distilled water at 110% of raw weight and the other injected with a solution of sodium tripolyphosphate, sodium lactate and sodium chloride at concentrations of .25%, 2.5% and .5%, respectively, at 107.5, 110, 112.5 or 115% of raw weight. Furthermore, Vote et al. (2000) injected ten USDA Select strip loins to 110% raw weight with a phosphate only solution of .25% sodium tripolyphosphate. Steaks from the control and treated loin sections were then cooked to two final internal temperatures of either 66^{o}C or 77^{o}C (Vote et al., 2000). Two final degree of doneness temperatures were evaluated because cooking to a high final internal temperature reduces juiciness and tenderness of beef steaks (Parrish et al., 1973; Wulf et al., 1996; Hilton et al., 1998; Wheeler et al., 1999). Vote et al. (2000) found that the strip loin steaks injected

with the phosphate/lactate/chloride solutions had improved tenderness (P<.05), juiciness (P<.05), and cooked beef flavor (P<.10) and was especially effective for maintaining tenderness and juiciness of steaks cooked to higher internal temperature. Conversely, USDA Select strip loins injected with the phosphate only solution were not effective for improving beef tenderness or juiciness and tended to impart off-flavors characterized by sensory panelists as soapy and sour (Vote et al., 2000).

Likewise, Milligan et al. (1997) discovered similar findings in regards to improved tenderness and juiciness for calcium chloride injected round roasts (P<.004). Milligan et al. (1997) however, recorded the following retail display results: thaw and purge losses were higher (P<.001) in enhanced roasts, cooking losses were lower (P<.01) than for controls. Although calcium chloride did not affect color, color uniformity, discoloration or browning of the surface through 1 day of retail case display (P<.05), day 2 and after the control roasts were superior in all traits (P<.05).

Wicklund et al. (2005) used an enhancement solution of salt, alkaline phosphate, and natural flavoring on beef strip steaks either before or after aging times of 7, 14, 21, or 28 days. Results indicated that enhanced steaks were more tender and juicy, but regardless when enhancement occurred enhanced steaks were saltier and darkening of color was prevalent. Purge loss in this experiment is contradictory to findings of other researchers. Wicklund et al. (2005) found no differences in purge loss between enhanced and control steaks. Kerth et al. (1995) found that beef strip loins enhanced with calcium chloride and aged for 7 or 14 days had increased purge over non enhanced steaks. Sutton et al. (1997) found that pork loins enhanced with sodium tripolyphosphate had less purge

than controls. These differences could be attributed to differences in the types of salts and phosphates, enhancement solution pH, and enhancement levels (Wicklund et al., 2005).

Chapter III

MATERIALS AND METHODS

Undeniably tenderness and juiciness factors are improved through enhancement, but is this done at the expense of the consumer? The wide array of solutions that are used, singly and in combinations, for enhancing show variable sensory reports for off-flavor, saltiness, purge, and color retention in a display setting. Do consumers believe that the risk for the above mentioned factors is acceptable? The investigation of this study is to infer on these questions to see if consumers are content with palatability factors or if enhancement (particularly potassium and sodium phosphate in this instance) compromises satisfactory eating experience.

This study was conducted at Western Kentucky University during October and November 2010. Six students in the Agriculture Department at Western Kentucky University were selected from a preliminary field of thirteen for sensory panel members after an initial taste testing session. The initial taste trial held on October 5, 2010 at the Environmental Science and Technology building at Western Kentucky University was a basic evaluation of sensory characteristics. Evaluators scored tenderness, juiciness, flavor, overall acceptability, off-flavor and saltiness for samples of USDA Choice strip loin steaks and USDA Standard strip loin steaks. Extreme differences in raw meat color, texture, and marbling were used for the basis of the selection of these steaks to ensure that panel members could detect distinct differences. Salting was also used on the steak samples for the selection of palates that could distinguish this factor.

During the initial sensory panel session for the selection of a six member panel a discussion of palatability factors of cooked meats occurred. Evaluators were to score

each palatability component independently for each sample. Directions pertaining to the evaluation were also explained (Figure 1). For the categories of flavor, tenderness, juiciness and overall acceptability a scale of one to ten was used, where one was the lowest in each classification and ten was the highest. In the off-flavor category a yes or no answer scored and measured the instance of a taste other than a natural beef flavor being experienced. The saltiness category was also scored on a scale from one to ten, however; one indicated no salty taste and ten indicated extreme saltiness.

The initial sensory panel session was held to ensure that panel members could detect very distinct differences among samples. Extreme differences in samples were selected for and then additional salting added. If panel members could not taste these differences then they certainly could not detect differences in all palatability factors measured.

Strip loin steaks were one inch in thickness and were grilled over charcoal heat. Each steak was turned only once and was allowed to cook for five minutes per side. USDA Select and Choice strip loin steaks were then taken off the grill and placed in separate containers to keep warm. Steaks were immediately cut into 6 sections and placed on plates to serve panel members.

All evaluators were seated individually and given water to cleanse their palate during the sampling session. They were then served either a sample of USDA Select strip loin steak enhanced with potassium and sodium phosphate or USDA Choice strip loin steak. The two types of samples were randomly assigned either to be sample A or sample B. One evaluation sheet was completed per trial consisting of one sample A and one sample B. Sensory panel test dates occurred on October 12, 2010 and November 2,

2010 in the Environmental Science Technology building on the main campus at Western Kentucky University. Overall twelve trials were conducted, each including a sample A and a sample B strip loin steak piece that was enhanced and non-enhanced.

A completely randomized design was used in this experiment with a t-test analysis to distinguish differences in evaluators for the categories of flavor, tenderness, juiciness, overall acceptability and saltiness. The t-test was used to test paired differences in each panel member's evaluation of sample A and sample B. Therefore, only the differences among an individual's ratings were analyzed. In the evaluation of off-flavor, Chi – square test of independence was used to test the relationship between flavor and enhancement.

Chapter IV

RESULTS AND DISCUSSION

The objective of this study was to determine whether an enhancement solution of up to 12% sodium and potassium phosphate injected into USDA Select strip loin steaks, offered on a retail level, resulted in lower ratings for characteristics of flavor, tenderness, juiciness, overall acceptability, saltiness, and off-flavor when compared to USDA Choice strip loin steaks. Sensory panel evaluations determined that ratings for all categories appraised ranked numerically lower for USDA enhanced Select strip loin steaks ($P<.05$), as encountered by Vote et al. (2000); except in the saltiness column where significantly higher values were observed ($P<.05$), which is consistent with the findings of Wicklund et al. (2005).

Off-flavor evaluations, which were ranked with a yes or no answer, also indicated that there were significant differences among samples ($P<0.01$). Although adjectives describing the off flavor were not recorded, any taste other than a natural beef flavor was considered to be an off flavor. Vote et al. (2000) encountered the same findings with strip loin steaks enhanced with sodium tripolyphosphate. These strip loin steaks showed no improvement in tenderness and juiciness, and imparted off-flavors. Comparatively, findings in this study are comparable to the findings of Vote et al. (2000).

In regards to the individual panel member's evaluations, overall scoring of samples were not expected to be identical. Certainly, taste distinction and palate sensibility is customized over an individual's lifetime. Consequently, the use of the paired t-test for this analysis enabled only the difference between each panel member's

evaluations of enhanced and non-enhanced samples to be determined and not between panel members.

To measure scoring between panel members a confidence interval was calculated and results are represented in Table 1. For overall acceptability, evaluator 2 was an outlier and scored both the enhanced and non-enhanced samples higher than other evaluators or the overall mean. Evaluators 5 and 6 had the largest spread in scores between enhanced and non-enhanced samples.

For flavor, evaluator 2 again scored both enhanced and non-enhanced samples higher. Evaluators 1 and 4 showed small differences in scoring between enhanced and non-enhanced samples, while evaluators 3, 5, and 6 showed larger scoring differences. Even though the overall average scores for enhanced versus non-enhanced samples for flavor are 4.5 and 5.1, this difference is attributed to three panel members.

In the tenderness category, evaluator 1 only showed a slight difference in scoring of samples. Evaluator 2 scores were much higher than other panel members and there was no difference indicated between the enhanced and non-enhanced samples. Evaluators 3, 4, 5, and 6 showed a larger spread in tenderness scoring; selecting the USDA non-enhanced Choice strip loin steaks to be more tender than USDA Select strip loin steaks. Even though enhancements have a tenderizing effect on meat (Baublits et al., 2006; Lawrence et al., 2004; Milligan et al., 1997; Vote et al., 2000; Wicklund et al., 2005), in this study, the non-enhanced product was more tender. This difference in tenderness in favor of the non-enhanced product may have been due to the superior marbling of the USDA Choice product.

For juiciness evaluators 1 and 4 showed the smallest spread in scores between samples. Even though evaluator 2 again ranked samples on a higher scale, a larger spread of scoring occurred between enhanced and non-enhanced samples. Evaluators 2, 3, 5, and 6 all recorded larger differences in scoring than evaluator 1 and 4. Evaluators 5 and 6 had the largest differences scored between samples. Previous studies have found improvement of juiciness for enhanced products (Baublits et al., 2006; Lawrence et al., 2004; Milligan et al., 1997; Vote et al., 2000; Wicklund et al., 2005). The higher ratings for juiciness for the non-enhanced strip loin steaks could again be attributed to the marbling content found in the USDA Choice product, which lead to more moisture retention.

All evaluators scored saltiness higher in the enhanced samples. Evaluator 3 had the smallest scoring difference among samples. Scores between evaluators did not differ except for the enhanced samples for evaluator 6, which recorded the highest saltiness scores.

Table 2 indicates the off-flavor evaluated between enhanced and non-enhanced samples. More off-flavor instances occurred in the evaluation of enhanced samples than that of non-enhanced ($P<0.01$). More observations of off-flavor should have been expected for enhanced samples because of the differences in flavor and saltiness between samples.

To encompass the true off-flavor imparted by enhancement solutions, in hindsight an adjective category would have been desirable to describe off-flavor, as used by Vote et al., (2005). Descriptive words such as bitter, metallic, soapy, and sour could generate particular flavors that are distinct to certain enhancement solutions.

Table 1

Consistency of Sensory Evaluations of Enhanced USDA Select Strip Loin Steaks (E) and Non-Enhanced USDA Choice Strip Loin Steaks (NE) by Six Evaluators[1]

Criteria[2]	Evaluators						
	1	2	3	4	5	6	Overall Average
1. Overall Acceptability							
Enhanced	3.4*$_a$	7.6$_b$	3.1$_a$	3.9*$_a$	4.1*$_a$	4.0*$_a$	4.3
Non-Enhanced	3.6$_a$	7.8$_b$	4.5*$_a$	4.3$_a$	6.2*$_b$	6.1*$_b$	5.4
2. Flavor							
Enhanced	3.3$_a$	7.6$_b$	2.8$_a$	3.8*$_a$	4.2*$_a$	4.2*$_a$	4.5
Non-Enhanced	3.4$_a$	7.3$_b$	4.3*$_a$	3.9$_a$	5.8*$_a$	5.9*$_b$	5.1
3. Tenderness							
Enhanced	3.3$_a$	7.7$_b$	3.6$_a$	3.3*$_a$	4.5*$_a$	3.8*$_a$	4.3
Non-Enhanced	3.4$_a$	7.7$_b$	4.2$_a$	3.9$_a$	6.7$_b$	6.2*$_a$	5.3
4. Juiciness							
Enhanced	3.3$_a$	7.4$_b$	3.1$_a$	3.8*$_a$	4.0*$_a$	4.3*$_a$	4.3
Non-Enhanced	3.7$_a$	8.0$_b$	4.3$_a$	4.1$_a$	6.0*$_{ab}$	6.1*$_{bc}$	5.4
5. Saltiness							
Enhanced	3.3*$_a$	3.3*$_a$	2.2$_a$	2.7*$_a$	3.6*$_a$	5.6$_b$	3.4
Non-Enhanced	1.6*$_a$	1.7*$_a$	1.2$_a$	1.0$_a$	1.2*$_a$	2.3*$_a$	1.5

[1]Each evaluator score is an average of 12 trials. A confidence interval (CI= score $\pm$ t(.05) x S_X) was calculated for each average score. Within a row, averages followed by the same letter have overlapping CI's and are not considered different at the 0.05 level; an average with an asterisk * includes the overall average within its CI.

[2]All criteria rated on a scale of 1-10, where 1 was the lowest and 10 was the highest for all criteria except Saltiness, where 1 was no salty taste and 10 was extremely salty.

Table 2

Off-Flavor Chi-Squared Contingency of Sensory Evaluations of Enhanced USDA Select Strip Loin Steaks (E) and Non-Enhanced USDA Choice Strip Loin Steaks (NE) by Six Evaluators

		Yes	No	Total
Enhanced	Observed	33	39	72
	Expected	25	47	
	Deviation	8	-8	
		2.56	1.36	
Non-Enhanced	Observed	17	55	72
	Expected	25	47	
	Deviation	-8	8	
Total		50	94	144

$\chi^2 = 7.84$ ($P<0.01$)

χ^2 values for 1 degree of freedom $P<.05 = 3.84$ $P<.01 = 6.63$ $P<.005 = 7.88$

Chapter V

SUMMARY AND IMPLICATIONS

Variability in consistency of beef products offered on the retail level is certainly a valid concern of consumers. When consumers purchase meat they do so in confidence that they are receiving a quality product. Though the practice of enhancing has improved the tenderness and juiciness of lower quality cuts of beef, the accumulation of risk associated with saltiness and off-flavors can be unfavorable. Even though the FDA requires enhancement solutions to be listed on the packaging label, often times it is in a discrete place and not even noticed by the consumer. Additionally, the supplement of spices and rubs on meat can intensify the effects of enhancement saltiness and off-flavor.

Through this study, a sensory panel evaluated for flavor, tenderness, juiciness, overall acceptability, and saltiness palatability attributes ($P<.05$) and off-flavor ($P<.001$) that a more satisfying eating experience was achieved with the USDA Choice strip loin steaks.

Differences in this study between panel members contain differences that would be expected in a consumer environment. Some evaluator's consistently scored both enhanced and non-enhanced strip loin steaks on a higher scale, while others showed small differences in numerical scoring for enhanced and non-enhanced samples. Other panel members indicated larger numerical scoring differences among the samples.

Past eating experiences could determine numerical scoring for panel members. The same holds true for consumers. Based on past eating experiences, one consumer may rate a steak a 3 out of 10, while that same steak rated by another consumer could be a 7 out of 10. This difference is likely due to relating the palatability of that steak to a

past experience. Some consumers may not detect any inferiority of enhanced steaks, while after one eating experience others will not repeat purchase of an enhanced product.

Another growing concern with enhancement of meat products is the health risks. Certainly consumers that are on a restricted sodium diet need to be cautious of enhanced meat products, as salt is a common additive. The labeling of enhanced meat products can often be confusing for consumers because the front of the package may say "improved tenderness"; however in the small print on the back of the package under ingredients is where the contents of the enhancement solutions are added.

The beef industry needs a strong consumer base that will have trust in purchasing quality products. Ensuring consistency and quality of beef products is the only way to build a reliable consumer base. The variability of enhancement solutions could depreciate the loyalty of consumers by the side effects attributed to these solutions.

APPENDIX

Figure 1

Evaluation Sheet for Taste Panel Members

	Sample A	Sample B
Flavor		
Tenderness		
Juiciness		
Overall Acceptability		

Rate the samples in each category on a scale of 1-10, where 1 is the lowest and 10 is the highest

	Sample A	Sample B
Off-Flavor (yes or no)		

	Sample A	Sample B
Saltiness		

Rate the samples on a scale of 1-10, where 1 is no salty taste and 10 is extremely salty

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