Project Summary

Flavor Volatiles, Color and Warner-Bratzler Shear Changes of Five Beef Muscles Enhanced Prior to Aging—Short and Long Term

Principal Investigator: Susan Brewer, Ph.D.
University of Illinois

Study Completed
July 2004

Funded by The Beef Checkoff

Flavor Profile and Volatiles, Color and Warner-Bratzler Shear Changes of Five Beef Muscles Enhanced Prior to Aging—Short and Long Term: Project Summary

Background

Beef flavor results from the combined perception of basic tastes (sweet, sour, bitter, salt and umami) and odor derived from a myriad of volatile compounds. While raw meat has little aroma and only a blood-like taste, it is a reservoir of compounds that serve as aroma and flavor precursors. Past research has indicated that more than 1,000 compounds have been identified in the aroma of cooked meat.

Aging alters the make-up of the aroma and flavor precursors. Compounds such as 12-methyltridecanal, an especially important flavor component of beef, may be affected by enhancement or aging. As a result, it is important to understand what roles beef aging and enhancement have on the levels of these important flavor constituents.

Previous research has also indicated that the injection of a sodium phosphate solution (commonly referred to as product enhancement in the meat industry) may have the potential to modulate flavor and aroma changes, which occur during aging.

This project was two-fold. The first experiment's objectives were 1) to profile the flavor changes and to evaluate Warner-Bratzler shear and color changes and 2) to identify and quantify the compounds that change during the aging of five beef muscles (g*luteus medius, infraspinatus, psoas major, rectus femoris and teres major*) that were enhanced.

The second project evaluated the same parameters, but for different muscles—the c*omplexus, serratus ventralis, vastus lateralis, vastus medialis and longissimus dorsi.*

Methodology

Experiment One (Short Term)

Researchers obtained 20 U.S. Select carcasses from a commercial beef processor. The five muscles being evaluated, the g*luteus medius, infraspinatus, psoas major, rectus femoris and teres major* were removed 48 hours after harvest. Muscles from one side of the carcass were used as controls and the corresponding muscles from the remaining side were enhanced to 108 percent of their initial weight with a solution of final concentrations of 0.3 percent salt and 0.4 percent sodium tripolyphosphate. Both the enhanced and control muscles were vacuum packaged and aged for either seven or 14 days depending on which experimental group they had been assigned.

Samples were removed, either raw or cooked as appropriate, for proximate analysis, purge and cook losses, instrumental color (L*, a*, b*) evaluation, Warner-Bratzler shear testing and evaluation of flavor-active compounds. A trained sensory panel also evaluated the color of the uncooked steaks using a 15-point line scale for redness, brownness and greenness.

Cooked steaks were also evaluated for aroma and flavor by a 10-member trained panel. Panelists evaluated steaks for intensity of sample attributes on a 15-point scale, where 0 equaled none, and

15 equaled intense. Cooked samples were evaluated for tenderness using Warner-Bratzler shear values.

During the second phase of Experiment One, volatile flavor components were determined using solid-phase microextraction-gas chromatography (SPME) coupled with a sulfur-selective detector. Sulfur-containing compounds and non-sulfur containing components, as well as free amino nitrogen were all evaluated. The changes in the compounds were correlated with sensory flavor profiles determined in the first phase.

Experiment Two (Long Term)
Five muscles from one side of 20 carcasses were enhanced to 108 percent of their initial weight with the same solution as was used in Experiment One. The muscles, the c*omplexus*, *serratus ventralis, vastus lateralis*, *vastus medialis* and *longissimus dorsi* were evaluated similarly as in Experiment One.

Findings
Experiment One
Aging increased tenderness slightly and decreased the rancid off-flavor score, however overall, the off-flavor scores were very low. Enhancement increased juiciness moderately, beef flavor slightly and saltiness dramatically and decreased rancid off-flavor, although the control scores were very low.

Physical Characteristics
Enhancement affected sensory characteristics of different muscles differently, while aging had similar effects on all of the muscles. Aging time did, however affect enhanced versus non-enhanced beef differently.

Flavor-Active Volatiles
The major flavor-active volatiles affected by enhancement and aging were:

- Hexanal
- 2-pentyl furan
- 3-hydroxy-butanone
- 1-octen-3-ol
- Pentanal
- Nonanal
- Butanoic acid
- 3-hydroxy-2-butanon
- Hexanoic acid

The *infraspinatus* contained the most hexanal and the *gluteus medius* and *teres major* contained the least hexanal, a typical indicator of oxidation. Aging decreased pentanal, nonanal and butanoic acid content, while enhancement increased hexanal, 3-hydroxy-2-butanon and hexanoic acid content.

General Conclusions

Enhancement generally increased pH and color quality of i*nfraspinatus*, *rectus femoris* and *teres major*. Juiciness of the *infraspinatus* and *teres major* and tenderness of the g*luteus medius* and i*nfraspinatus* were also increased through enhancement. Purge loss was decreased for the *gluteus medius*, *psoas major* and *rectus femoris*. For all muscles, enhancement increased juiciness, beef flavor, and moisture content and saltiness and decreased livery flavor, shear values and b* values.

After seven days of aging, enhanced beef had higher cook losses and lower color scores, however these differences disappeared after 14 days. There were 10 flavor-active volatile compounds which were affected by enhancement, however these volatiles varied due to muscle. The *infraspinatus* and *teres major* appeared to benefit the most from enhancement, however this may be due to inherent differences in these muscles, such as pH, compared to the other muscles that were evaluated.

The salt in the enhancement solution impacted flavor and may have masked the low levels of off-flavors originally present or after aging. There were 10 volatile compounds known to affect flavor that were identified in these samples, however these volatiles varied among muscles.

Experiment Two

General Conclusions

Enhancement increased positive sensory attributes, including tenderness, juiciness, beef flavor and saltiness, and decreased off-flavors for all of the muscles evaluated, however some benefited more than others. The *complexus*, s*erratus ventralis* and *vastus medialis* especially seemed to benefit from the enhancement solution.

Enhancement decreased instrumentally measured color values (L*, a*, b* and chroma) to varying degrees for various muscles. Aging had very small effects on beef flavor, decreasing it only in the v*astus lateralis* after 14 days. It did decrease off-flavors, however all of the scores were low. The various muscles differed in their tenderness, color, moisture and fat content to begin with, which may explain some of the varying responses. Aging had overall, if small, positive effects on flavor and shear force values, but negative effects on instrumental color values. As in Experiment One, there were 10 volatile compounds known to affect flavor that were identified in these samples, however they varied due to muscle, enhancement and aging period.

Enhancement had minimal effects on nonanal content of all muscles except the *longissimus dorsi.* It contained higher levels of nonanal before enhancement but dropped to the same level as the other muscles after enhancement. When averaged, after seven days of aging, enhanced and non-enhanced beef contained equivalent amounts of 2,3-octanedione and nonanal. After 14 days of aging, the two compounds' concentration in enhanced samples had not changed, but had doubled in the non-enhanced samples. When averaged over enhancement and aging, the *serratus ventralis* contained the most pentanal and 3-hydroxy-2-butanone.

Implications
This project identified 10 flavor volatiles known to affect flavor, however they varied among the muscles that were analyzed.

For more information contact:
National Cattlemen's Beef Association
9110 East Nichols Avenue
Centennial, Colorado 80112-3450
(303) 694-0305