Study examines the compounds affecting beef flavor

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Summary

Beef flavor results from a 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 that are activated during cooking. Aging, as well as product enhancement, have the potential to alter the make-up of the aroma and flavor precursors, therefore affecting a consumer’s beef eating experience.

Background

Previous research has indicated that injecting a sodium phosphate solution (commonly referred to as product enhancement in the meat industry) may be able to modulate the flavor and aroma changes that occur during aging. A recent checkoff-funded research project profiled flavor changes, evaluated Warner-Bratzler shear (tenderness) results, assessed color changes and also identified/quantified the compounds that changed during the aging of 10 beef muscles:

- Gluteus medius (top sirloin)
- Infraspinatus (flat iron)
- Psoas major (tenderloin)
- Rectus femoris (round tip center)
- Teres major (petite tender)
- Complexus (chuck eye roll)
- Serratus ventralis (boneless rib)
- Vastus lateralis (round tip side)
- Vastus medialis (part of the round knuckle)
- Longissimus dorsi (top loin steak, strip steak)

Researchers obtained the muscles from 20 U.S. Select carcasses. Muscles from one side of the carcass were used as controls, while the others 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.

Few off-flavors detected

Samples were removed, either raw or cooked as appropriate, for proximate analysis, purge and cook losses, instrumental color evaluation, Warner-Bratzler shear force and evaluation of flavor-active compounds. Cooked steaks were also evaluated for aroma and flavor by a 10-member trained tasting panel. Panelists evaluated steaks for intensity of sample attributes on a 15-point scale, where zero equaled none, and 15 equaled intense. Overall, the off-flavor scores were very low in this experiment although aging did decrease rancid off-flavors.

Ten flavor compounds identified

During the second phase of the project, volatile flavor components were determined, and the changes correlated with sensory flavor profiles determined in the first phase. Warmed-over flavor, or WOF, is an example of how flavor compounds can change the taste of meat. WOF is a phenomenon occurring when cooked meat products are re-heated. Some consumers are more sensitive to WOF than others. There are specific compounds that cause WOF (thiobarbituric acid) similar to how the flavor compounds in this study could be causing off-flavors.

In this study, the major flavor-active volatiles or compounds affected by enhancement were:

- Hexanal (which can produce a grass, tallow or fat flavor)
- 2-pentyl furan
- 3-hydroxy-butanone
- 1-octen-3-ol
- Pentanal (responsible for almond, malt or pungent flavors)
- Nonanal
- Butanoic acid
- 3-hydroxy-2-butanone
- Hexanoic acid
- 2,3-octanedione

Research to date has not identified a direct relationship between the quantity of a compound and the severity of the off-flavor produced and there are numerous possible interactions between the compounds. This study found that the infraspinatus or flat iron contained the most hexanal and the gluteus medius (top sirloin) and teres major (petite tender) contained the least hexanal, a typical indicator of oxidation (in beef, oxidation is the degradation of compounds which can cause color, odor and taste changes). Other results included the fact that aging decreased pentanal, nonanal and butanoic acid content, while enhancement increased hexanal, 3-hydroxy-2-butanone and hexanoic acid content.
**Effects of enhancement vary**

The salt in the enhancement solution affected flavor and may have masked the low levels of off-flavors originally present. Ten compounds known to affect flavor were identified in these samples, however these flavor-active volatiles varied among muscles. Some muscles benefited more than others from the enhancement and its effect on flavor profiles. The **complexus** (chuck eye roll), **serratus ventralis** (boneless rib) and **vastus medialis** (part of the round knuckle) especially seemed to benefit from the enhancement solution.

Enhancement had minimal effects on the nonanal content of all muscles except the **longissimus dorsi** (top loin steak, strip steak). 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** (boneless rib) contained the most pentanal and 3-hydroxy-2-butanone.

Research shows that warmed-over flavor in cooked beef is primarily due to the oxidation of lipids, particularly phospholipids located in the lean tissue membranes and can be prevented by using antioxidants, such as rosemary and some acids such as ascorbic (vitamin C). Knowledge like this is the goal of ongoing checkoff-funded flavor research. Future projects will not only seek to connect the off-flavors detected by the taste panel with corresponding flavor compounds but also understand how to mediate the flavor effects through aging, product enhancement or other technology.

**Key Points**

- Checkoff-funded research examined flavor volatiles of beef that were affected by enhancement and aging.
- Ten volatiles known to affect flavor were identified, however they varied among muscles. Overall, the off-flavor scores were low in this experiment; however, the research did help identify flavor volatiles that were affected by enhancement and aging.
- The findings from this study will support future research projects that ultimately will help ensure a more consistent eating experience for consumers.