Beef Flavor Attributes and Consumer Perception

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Study Completed

May 2014
Beef Flavor Attributes and Consumer Perception: Project Summary

Background

Beef flavor has been defined as an important component of beef demand. Beef flavor is not a “single” attribute, but it is composed of multiple attributes that can be dynamic. The beef industry took the first big step in addressing beef flavor by funding the development of the beef flavor lexicon that identified major and minor beef flavor components. Now that the beef lexicon has been developed, the industry is working to understand what chemical compounds are responsible for each flavor attribute in the lexicon. After understanding what chemical compounds are responsible for specific beef flavor attributes, this information can be used to control, mask, enhance or reduce specific flavor compounds to manage beef flavor. One of the important questions that is yet to be answered is “which beef flavor attributes are positive and which attributes are negative for beef consumers?” Consumer perceptions are variable, and some attributes may be positive to one consumer, but negative to another consumer. It is important to understand the effect of specific beef flavor attributes or combinations of beef flavor attributes on consumer attitudes across consumer segments.

Beef flavor attributes are derived by chemical reactions within beef during cooking. The chemical components of beef flavor are volatile compounds that are sensed by the consumer’s olfactory bulb during chewing. The major chemical reactions contributing to beef flavor occur in the lean and fat components of meat. Early flavor chemistry research has shown that lean flavors are associated with reactions between reducing sugars (mainly glucose) and amino acids during cooking, called the Maillard reaction. This is why raw beef is not beefy, but cooked beef is. The amount, fatty acid composition, oxidative state of lipid and differences in the phospholipid composition have all been associated with cooked beef flavors, both positive and negative. Myoglobin content and pH of meat can also affect flavor attributes, but their contribution has not been fully elucidated. During cooking, the rate of cooking determined by changes in cook temperature or cooking method, and the final endpoint temperature or degree of doneness affect the rate and extent of chemical reactions. Therefore, the flavor compounds present in cooked beef are not only affected by the chemical compounds present in the raw form, but also depend on cooking influences to determine which flavor volatiles may or may not develop. The project hypothesis was that beef flavor attributes can be characterized as positive or negative across consumer segments for light beef eaters or consumers who eat beef one or two times per week. If the industry can understand the positive beef flavor attributes for differing consumer segments and the volatile chemical components that are responsible for them, the beef industry can more effectively market beef to maximize positive eating experiences for consumers.

Objectives

The objectives of this study were to create varying levels of positive beef flavor attributes, measure these with an expert trained meat flavor panel, measure the volatile compounds using an Aroma-Trax system with a sniff-port to elucidate the chemicals in beef flavor, measure flavor like/dislike of light beef consumers and then understand consumer attitudes toward flavor using one-on-one consumer interviews.

Methods

USDA Choice beef Tenderloins, Strip Loins and Top Sirloin Butts, USDA Choice and Select beef Bottom Rounds, and high-pH Strip Loins were selected from 10 carcasses. Steaks, 2.54 cm thick, were cut from the Tenderloin, Strip Loins and Top Sirloin Butts and 2 lb roasts were cut from the Bottom Rounds. Steaks and roasts were assigned to cooking method and internal cooked end-point temperature. Choice Top Sirloin, Tenderloin, high-pH Top Loin and Top Loin Steaks were cooked on either a George Foreman® grill or gas serrated or flat grill at 450°F. These steaks were cooked to either 137 or 176°F to create differences in degree of doneness. Choice and Select Bottom Round Roasts were cooked to either 137 or 176°F in crock pots to create a cooking method that was high in beef identity and umami, but low in grilled flavors. This resulted in 20 treatments that were used to create differences in beef flavor attributes. Raw chemical pH, non-heme iron, myoglobin content and fatty acid levels were determined on the raw material prior to cutting into steaks or roasts. Within treatment, steaks and roasts were assigned to either trained descriptive attribute flavor analyses using the beef lexicon, or consumer sensory evaluation in College Park (PA), Portland (OR)
or Olathe (KS). Samples from steaks and roasts evaluated by consumers in Kansas City were collected for volatile aroma chemical determination and evaluated using the AromaTrax System.

The trained panel descriptive flavor attributes and the volatile compounds were analyzed using Proc Means, Proc Corr, Proc Reg stepwise procedure and Proc GLM of SAS (v9.3, SAS Institute, Cary, NC) to understand what chemical attributes drive specific beef flavor attributes. A predetermined alpha level of \( P < 0.05 \) was used in all analyses. For Analysis of Variance, least squares means were calculated and the pdiff function of SAS was used to determine differences between means. Multivariate analyses for Principal Components and Partial Least Squares Regression were conducted using XLSTAT.

**Important Results**

Treatments defined by design differed in trained beef descriptive flavor attributes as expected and as similarly found in previous work with moderate to heavy beef consumers. These treatments provided an excellent method for understanding the relationship between trained sensory flavor attributes, consumer acceptance and cooked chemical aromatic volatile compounds. Beef identity, brown/roasted, bloody/serumy, fat-like, metallic, liver and umami differed across treatments. Cooking method, cut and internal temperature impacted beef flavor attributes as defined by the beef flavor lexicon. However, it was not determined if these differences could be detected by consumers. Consumer’s ratings for various flavor attributes differed across treatments. Consumers liked Choice Tenderloin Steaks, Top Sirloin and Top Loin Steaks cooked to lower internal end-point temperatures. Consumers liked grilled Choice Tenderloin and Top Loin Steaks more than steaks cooked on the George Foreman® grill. For high-pH Top Loin Steaks, consumers liked grilled steaks cooked to 176°F more than these steaks cooked differently. Consumers had the lowest preference for Bottom Round Roasts cooked in the crockpot, regardless of quality grade. When Choice or Select Bottom Round Roasts were cooked to higher degrees of doneness, consumers liked these beef cuts the least and identified them as dry, tough and lacking flavor. Overall flavor, beef flavor and grilled flavor liking showed similar results to overall liking ratings across treatments. Juiciness and tenderness liking were rated similarly by consumers and were not as closely associated with overall liking as the flavor attributes. These results indicated that consumers can assess differences in beef flavor attributes and that differences in flavor impact overall liking.

The relationship between trained descriptive beef flavor attributes and consumer acceptance showed that overall flavor liking was related to fat-like, sweet, salty and overall sweet flavors. Grilled flavor liking was most closely related to beef identity, brown/roasted, burnt and umami descriptive flavors. Interestingly, consumer ratings for juiciness and tenderness were clustered with descriptive panel attributes for juiciness and tenderness indicating that consumers rated these attributes similarly to trained sensory panelists. Consumer juiciness and tenderness liking was also closely related to metallic and bloody/serumy flavor attributes. As higher levels of bloody/serumy and metallic would be found in beef cuts cooked to lower degree of doneness and these same cuts were rated higher for juiciness and tenderness, the relationship between these attributes was expected. Liver-like, green hay-like and sour were related to Choice top sirloin steaks cooked on a George Foreman® grill and Select Bottom Round Roasts cooked in a crockpot to 137°F indicating that these treatments induced higher levels of these negative flavor attributes. Musty/moldy, cardboardy and sour aromatics, also classified as negative flavors, were higher in Choice and Select Bottom Round Roasts cooked to 176°F. These results indicate that these roasts had higher levels of musty/moldy, cardboardy, and sour aromatics that these attributes were not liked by consumers. These results showed that there were relationships between trained and consumer sensory attributes, and that treatments impacted sensory attributes for both consumers and trained sensory attributes.

There were 248 volatile aromatic compounds defined by the GC/mass spec system, and 234 where found to have some relationship to consumer and/or trained meat flavor attributes. To understand relationships between consumer overall like and volatile aromatic compounds, stepwise regression was conducted. Forty-eight volatile aromatic chemicals accounted for 72% of the variability in consumer overall like/dislike. Compounds associated with Maillard reaction products, heat denaturation and lipid oxidation were included in the equation indicating that all three reactions are associated with consumer overall liking. Stepwise regression equations to predict descriptive sensory flavor attributes for beef identity, brown/roasted, bloody/serumy, fat-like, metallic, liver-like and umami were determined. To more closely understand relationships between consumer and trained descriptive sensory attributes,
partial least square regression was conducted. Four pyrazine compounds were somewhat closely related to burnt, umami, brown/roasted, beef identity and grilled flavor liking, and 2-ethyl-3,5-dimethyl-pyrazine was the single compound most closely clustered with overall consumer liking and fat-like descriptive flavor. These results indicate that development of pyrazine compounds are related to improved flavor in beef.

In one-on-one interviews, consumers indicated that flavor was extremely important to them when eating beef. They also did not segment tenderness, juiciness and flavor as separate attributes. Consumers, in general, indicated that they liked grilled flavor in their beef. They also indicated that the beef Bottom Round Roasts cooked in the crock pot were very bland, and they liked the sample the least. They liked beef because it was versatile, healthy and easy to prepare. The most common factor identified as to why they do not eat beef more often was the price of beef.

Figure 1. Principal component biplot of consumer liking sensory attributes (in blue) and 20 treatments (in green) where 111 = Tenderloin Steaks grilled to 137°F; 112 = Tenderloin Steaks grilled to 176°F; 121 = Tenderloin Steaks George Foreman® to 137°F; 122 = Tenderloin Steaks George Foreman® to 176°F; 211 = high-pH Top Loin Steaks grilled to 137°F; 212 = high-pH Top Loin Steaks grilled to 176°F; 221 = high-pH Top Loin Steaks George Foreman® to 137°F; 222 = high-pH Top Loin Steaks George Foreman® to 176°F; 331 = Choice Bottom Round Roasts cooked in a crockpot to 137°F; 332 = Choice Bottom Round Roasts cooked in a crockpot to 176°F; 431 = Select Bottom Round Roasts cooked in a crockpot to 137°F; 432 = Select Bottom Round Roasts cooked in a crockpot to 176°F; 511 = Choice Top Loin Steaks grilled to 137°F; 512 = Choice Top Loin Steaks grilled to 176°F; 521 = Choice Top Loin Steaks George Foreman® to 137°F; 522 = Choice Top Loin Steaks George Foreman® to 176°F; and 611 = Choice Top Sirloin Steaks grilled to 137°F; 612 = Choice Top Sirloin Steaks grilled to 176°F; 621 = Choice Top Sirloin Steaks George Foreman® to 137°F; 622 = Choice Top Sirloin Steaks George Foreman® to 176°F. 

This study was funded by the Beef Checkoff.