Beef flavor attributes and consumer perception

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Study Completed
May 2013

Funded by the Beef Checkoff.
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Project Summary

Background

Beef flavor has been defined as an important component of beef demand. Beef flavor, however, 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 (Adhikari et al., 2011) that identified major and minor beef flavor components. We cannot develop systems for identifying beef flavor if we do not know what “beef flavor” is or how the human senses perceives beef flavor. Now that the beef lexicon has been developed, we are working to understand what compounds are responsible for each 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. While this research is on-going, one of the big questions that still has not been answered is “which beef flavor attributes are positive and which attributes are negative for beef consumers?” While consumer perceptions are variable, some attributes may be positive to one consumer, but negative to another consumer, it is important to understand specific beef flavor attributes on consumer attitudes across consumer segments. Additionally, combinations of beef flavor attributes are most likely perceived by consumers as associated with positive beef flavor.

Understanding what chemical components make up positive beef flavor across consumer segments is imperative to understanding how to manipulate or create conditions so that the end beef product has positive beef flavor attributes and minimized or mask negative attributes to increase consumer satisfaction. The objectives of this research 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 consumer like/dislike, and then understand consumer attitudes using one-on-one consumer interviews.

Methodology

Choice beef strip loins and top sirloin butts, 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 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 cook temperature endpoint. Top sirloin and 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 16 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 Houston, Philadelphia, Portland (OR), or Kansas City. 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 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.

Findings

Treatments defined by design differed in trained beef descriptive flavor attributes as expected. 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 and 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. Consumers’ attributes differed across treatments. Consumers liked Choice top sirloin and Choice top loin steaks cooked to lower internal temperature endpoints. Consumers like grilled Choice 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 crock pot, regardless of internal temperature endpoint or Quality grade. Flavor like/dislike and beef flavor like/dislike showed similar results to overall like/dislike ratings across treatments. Choice and Select bottom round roasts were lowest in beef flavor intensity, grilled flavor like/dislike and grill flavor intensity. High pH top loin steaks grilled and cooked to 176°F were rated higher for beef flavor intensity grill flavor like/dislike, and grill flavor intensity. These results indicated that consumers can assess differences in beef flavor attributes and that differences in flavor impact overall like/dislike.

The relationship between trained descriptive beef flavor attributes and consumer acceptance showed that fat-like and brown/roasted were moderately related to overall consumer like/dislike. As brown roasted and fat-like increased, consumer like/dislike scores increased or consumers liked the beef more. Bloody/serumy, liver-like, and salty were also slightly and positively related to consumer overall like/dislike. These same relationships were found between the aforementioned beef flavor descriptive attributes and consumer flavor and beef flavor like/dislike, and beef flavor intensity. As brown/roasted and fat-like beef flavor attributes increased, consumers liked the grill flavor more and steaks and roasts had more grilled flavor intensity. Consumer off-flavor intensity was moderately related to increases in beef brown/roasted and fat-like flavor attributes.

Chemical attributes were determined on raw steaks and roasts prior to cooking. pH was highest in top loin steaks from high pH top loin steaks. Non-heme iron was highest in Choice top sirloin steaks and Select bottom round roasts. Myoglobin content was highest in Choice top loin and high pH top loin steaks and lowest in Choice and Select bottom round roasts. Lipid content was highest in Choice bottom round roasts and top loin steaks and cuts differed in some fatty acid levels. There were 189 aromatic volatile compounds defined across the 16 treatments.

Regression analysis to predict consumer overall like were not highly predictive using raw chemical and fatty acid variables ($R^2=27\%$). However, overall consumer like/dislike was highly predicted by overall flavor, grill flavor and beef flavor ($R^2= 90\%$). This indicated that flavor, grilled flavor and beef flavor drive overall consumer like/dislike. When examining aromatic volatile compounds to predict consumer overall like, fifteen aromatic volatile chemicals
accounted for 57% of consumer overall like/dislike. These chemicals could be used to predict consumer acceptability for moderate to heavy beef eaters.

Stepwise linear regression equations to predict trained panel beef descriptive flavor attribute for beef flavor identity, brown/roasted, bloody/serumy, fat-like, metallic, liver, and umami. These equations accounted for 77, 50, 51, 52, 77 82 and 79% of the variability in beef flavor identity, brown/roasted, bloody/serumy, fat-like, metallic, liver, and umami beef flavor descriptive attributes, respectively. These aromatic chemical attributes can be used to predict beef flavor attributes. While it is not practical to measure each of these attributes for every piece of beef cooked or served, examination of treatments or conditions that affect or increase aromatic compounds related to beef identity, browned/roasted, bloody/serumy, fat-like and umami would increase consumer acceptance.

Implications

Beef flavor is important to consumers. These results provide highly predictive regression equations that identify the compounds responsible for major beef sensory positive flavor attribute. Compounds differed for each sensory attribute and provides an opportunity to select for specific compounds if flavor changes are needed or one specific flavor needs to be enhanced. Additionally, not one single compound was highly predictive of a single beef flavor attribute, but chemical compounds from lean and fat heat denaturation were responsible for specific beef flavor components. It would have been ideal to find one or two chemical compounds that were responsible the major beef sensory flavor descriptive attributes. We have identified groups of flavor compounds that may help to narrow down what compounds can be used to drive flavor differences.

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