



Development of a beef flavor lexicon and its application to compare the flavor profile and consumer acceptance of rib steaks from grass- or grain-fed cattle

Curtis Maughan, Rossarin Tansawat, Daren Cornforth, Robert Ward, Silvana Martini*

Department of Nutrition, Dietetics, and Food Sciences, Utah State University, 8700 Old Main Hill, 750 North 1200 East, Logan, 84322-8700, UT, United States

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ABSTRACT

Ten panelists were selected from the local community to develop a meat lexicon composed of 18 terms that describe flavor attributes found in red meats. This flavor lexicon was used to compare the flavor profile of meat from beef cattle finished on grass or grain. Steaks from grass-fed animals were significantly ($P < 0.05$) higher in barny, bitter, gamey, and grassy flavor, and lower in juicy and umami notes. Gamey, barny, bitter and grassy were some of the attributes inversely correlated to the degree of liking of the meat and therefore can be classified as “negative” attributes. Brothy, umami, roast beef, juicy, browned, fatty and salty are some of the attributes positively correlated to the degree of liking of beef and therefore can be identified as attributes that drive consumers’ acceptance. Steaks from grass-fed cattle were rated by consumers as slightly liked (6.08 on a 9-point scale), while steaks from grain-fed animals were rated as moderately liked (7.05 on a 9-point scale).

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1. Introduction

Flavor is a combination of taste and aroma, and is one of the main factors that drive consumer acceptance of foods. Sensory evaluation is a powerful tool to evaluate the quality of a food product. In particular, sensory evaluation has been used during the last 20 years to identify meat flavors, both desirable and undesirable (Allen, Cornforth, Whittier, Vasavada, & Nummer, 2007; James & Calkins, 2008; Wadhvani, Murdia, & Cornforth, 2010). However, sensory studies usually differ in terminology, type of scale used, and type of panel (consumer vs. descriptive), and are usually focused on the negative attributes of beef. Variation among sensory panel methods hampers meaningful comparisons among studies.

A standardized lexicon of terms applicable among sensory studies on fresh meats is strongly needed. Flavor lexicons have been used for decades in several high value products such as cheese, wine, whisky, coffee, and chocolate (Drake & Cville, 2003) where small changes in specific attributes can tremendously affect the acceptance of the product by the consumer. Johnson and Cville (1986) developed a flavor lexicon for warmed-over flavors (WOF) in meats. Their lexicon included terms such as: cooked beef lean, cooked beef fat, browned, serum/bloody, grainy/cow, cardboard, oxidized/rancid/painty, and fishy. They also included sweet, salty, bitter and sour in their lexicon. Their research

showed that WOF from reheated samples were associated with an increase of negative notes, such as cardboard and oxidized, and a decrease in positive notes, such as cooked beef lean and cooked beef fat. Even though their research provided a lexicon for identifying and quantifying WOF, it did not provide a tool to evaluate the sensory profile of fresh cooked meats. Sensory evaluation techniques have also been used by Berry et al. (1980) to evaluate the flavor profile of loin steaks with different levels of maturity. These authors reported that beef from E maturity had higher aroma and flavor amplitudes and a greater predominance of “grassy” flavors. Stetzer, Cadwaller, Singh, McKeith, and Brewer (2008) also reported the effect of enhancement and ageing on flavor and volatile compounds in beef. They reported that several flavor-active compounds such as nonanal were increased by the enhancement and ageing of the beef, while pentanal, hexanal and hexanoic acid were decreased by these treatments. There are myriad studies using sensory evaluation to determine the flavor profile of the meat (Stelzleni & Johnson, 2008; Hamling, Jenschke, & Calkins, 2008; James & Calkins, 2008; Stetzer, Cadwaller, et al., 2008; Sitz, Calkins, Feuz, Umberger, & Eskridge, 2005; Stetzer, Tucker, McKeith, & Brewer, 2007; Stetzer, Tucker, McKeith, & Brewer, 2008; Rojas & Brewer, 2007); however, it is very difficult to compare results among these studies due to the lack of standardized terms. A standardized meat flavor lexicon will have immediate application to identify the effects of diet (grass or grain), maturity, and marbling on beef flavor profile. Other applications will include the identification of processing procedures (ageing, marinating) to minimize off-flavors (sour, grassy, gamey) and maintain desirable flavors (savory, umami, salty, brothy).

The objectives of this research were: 1) to develop a standardized flavor lexicon for beef, 2) to use the new lexicon to identify and

* Corresponding author. Tel.: +1 435 797 8136; fax: +1 435 797 2379.

E-mail addresses: curtis.maughan@usu.edu (C. Maughan), ross.t@aggiemail.usu.edu (R. Tansawat), daren.cornforth@usu.edu (D. Cornforth), Robert.ward@usu.edu (R. Ward), silvana.martini@usu.edu (S. Martini).

URL: <http://www.MartiniResearch.com> (S. Martini).

quantify differences between the flavor profile of beef from cattle fed different diets, and 3) to correlate these flavor differences with consumer acceptance. These objectives allow the identification of flavor notes that drive consumer acceptance in red meats.

2. Materials and methods

2.1. Meat samples

Primal rib sections of three grass-fed steers were purchased from James Ranch, CO; while rib sections of two grain-fed steers and one heifer were obtained from USU's Animal Science Farm.

The grain-fed animals were Black Angus bred, while the grass-fed animals were Red Angus sired with a mix of Hereford and Angus dams. The grass-fed animals were 24–27 months old and had a hanging weight between 318 and 360 kg. Their diets were supplemented with alfalfa during the winter, and they were finished for 120 days exclusively on grass. The grain-fed animals were 19–20 months old, had a finish diet of 120 days consisting of 60% corn silage, 30% flaked barley, and 10% alfalfa, and were also 320–345 kg in hanging weight. The left and right rib sections were used from each animal. The characteristics of the beef samples used in this study are detailed in Table 1. The fat content of the samples was determined in uncooked rib steaks using the Soxhlet method using petroleum ether as the solvent (AOAC, 1990). Raw steak pH was measured on 10 g of sample that were finely chopped, diluted to 100 ml in distilled water, allowed to equilibrate at room temperature for 30 min and then filtered. Filtrate pH was measured, using a Fisher Accumet pH meter model 610 A (Fisher Scientific Inc, Salt Lake City, UT), equipped with a combination pH electrode calibrated immediately before use to pH 4.0 and 7.0.

Primal ribs from each animal were vacuum packed after harvest, shipped to the Department of Nutrition, Dietetics, and Food Sciences at USU and immediately frozen at -20°C until use. The *Longissimus dorsi* muscles for each animal were used for the sensory tests.

2.2. Sample preparation for sensory tests

Frozen ribeye steaks were cut to a thickness of 2.54 cm and thawed for 24 h before cooking. The ribeye steaks were then trimmed to leave only the *Longissimus dorsi* muscles for cooking, to avoid any variation in flavors between muscle types.

Samples were prepared following the guidelines from the American Meat Science Association (1995). Steaks were cooked on electric griddles at 163°C until reaching an internal temperature of 70°C . Internal temperature was measured at the center of the steak using an AquaTuff 35200 digital thermometer (Atkins Technical Inc, Gainesville, FL USA) equipped with a fast-responding microneedle probe. The probe was inserted horizontally from the side along the center line of the steaks during cooking. At least two readings were taken per steak to verify that steaks had reached the target internal temperature of 70°C . They were then cut into 2.54 cm cubes and placed in covered aluminum dishes, and served to the panelists hot. Panelists tasted the samples in random order with 3-digit blinding codes under red colored lights to minimize bias.

Table 2

Taste concentrations used to achieve a specific taste intensity in aqueous phase during panel training.

Attribute	Taste definition	Treatment	Levels (%)	Scale value
Bitter	Taste elicited by caffeine	Caffeine	0.05	2
			0.08	5
			0.15	10
Salty	Taste elicited by salts	Sodium chloride	0.20	2.5
			0.35	5
			0.50	8.5
Sour	Taste elicited by acids	Citric acid	0.05	2
			0.08	5
			0.15	10
Sweet	Taste elicited by sugar	Sucrose	2	2
			5	5
			10	10
			10	10
Umami	Taste elicited by monosodium glutamate	Monosodium glutamate	0.7	5
			1.4	9
			2.8	13

2.3. Descriptive sensory evaluation

A sensory descriptive panel ($n=10$) was recruited and selected from the local community to develop a flavor lexicon for meats. Potential panelists were recruited using local newspapers and flyers in the community, and were screened for the panel based on their ability to differentiate between basic tastes in both identification and intensity rankings, according to established guidelines (American Society for Testing and Materials, 1981). Panelists who passed basic screening were recruited for the panel and monitored over time for ability to identify and quantify meat attributes in order to be included in the final evaluation. Panelists ranged in age from 18 to 60, with 7 males and 3 females, though demographics are not expected to influence the ratings in a trained descriptive panel. Panelists were trained for a minimum of 50 h on beef flavors using the 15-point Spectrum intensity scale (Muñoz & Civille, 1998). A 15-point intensity scale was used in the development of this standardized lexicon to allow the use of this tool in different types of meats, from plain beef to more flavorful products such as jerky and salami. This scale is commonly used in the development of other flavor lexicons such as cheese (Drake & Civille, 2003). Panelists were first trained on the identification and rating of the five basic tastes: sweet, sour, bitter, salty and umami. Solutions of sucrose, citric acid, caffeine, sodium chloride, and monosodium glutamate were used, respectively. The concentrations used to achieve specific taste intensity are included in Tables 2 and 3. After training with the five basic tastes, panelists were introduced to different pieces of meat to develop the meat flavor lexicon. Meat references were created to train the panelists in the identification and quantification of the flavor intensity of the terms included in the flavor lexicon. These references were based on previous studies (Berry et al., 1980; Johnson & Civille, 1986; Stelzleni & Johnson, 2008; Stetzer, Cadwallar, et al., 2008), and supplemented with flavors identified by the panelists during the lexicon development. Each reference was presented at different levels of intensity to standardize the use of the 15-point intensity scale. The lexicon

Table 1

Carcass characteristics of grain and grass-fed animals. HW: hanging weight; REA: rib eye area; BFT: back fat thickness; MS: Marbling score; MA: moderately abundant; M: moderate; S: small; SI: Slight.

Samples	HW (kg)	REA (cm ²)	BFT (mm)	MS	Quality grade	pH	Fat (%)
Grain #1	320	81.3	1.3	MA	Prime (heifer)	5.13 ± 0.02	13.86 ± 1.99
Grain #2	330	80.6	0.5	M	high Choice (steer)	5.15 ± 0.01	12.38 ± 1.45
Grain #3	345	87.7	1.3	S	low Choice (steer)	5.06 ± 0.02	11.05 ± 1.40
Grass #1	318	80.0	0.3	SI	Select (steer)	5.28 ± 0.02	3.03 ± 0.20
Grass #2	330	78.7	0.8	SI	Select (steer)	5.27 ± 0.01	3.51 ± 0.40
Grass #3	360	85.8	0.5	SI	Select (steer)	5.27 ± 0.01	3.54 ± 0.23

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