Project Title: Differentiation of Beef Flavor across Muscles and Quality Grades Phase I

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Background

Currently, the beef industry does not have a complete library of terms that describe flavor attributes in beef. Beef flavor was generally evaluated as overall flavor intensity. If off-flavors were detected, sensory panels would rate them on a subjective, non-anchored way, producing a result that could not be replicated by another panel since the flavor attributes were not defined or referenced. As more value-added cuts of beef and new beef products are developed, it is imperative that the industry has a standardized flavor lexicon to characterize and evaluate the flavor attributes among different beef products.

Methodology

Trained Panel: Six highly trained panelists from the Sensory Analysis Center at Kansas State University (Manhattan, KS) participated in the lexicon development. Each panelist had completed at least 120 hours of general descriptive analysis training and had a minimum of 1,200 hours of descriptive sensory testing, including food products with descriptors similar to those that might be found in beef.

Samples: The beef samples were supplied by Texas A&M University to represent variation in animal age (young versus mature), cut (strip loin, top butt, top round, tenderloin), USDA quality grade (prime, top choice, choice, select, standard), live animal feeding regimen (wagyu, grass-fed), storage type (dry-aged, wet-aged, frozen), aging time (long frozen, wet-aged 24 days, wet-aged 70 days), packaging type (vacuum-packaged, modified atmosphere, PVC overwrap) and gender (cow, bull).

Sample Preparation: The beef samples were cooked to five levels of doneness (57.2, 62.8, 68.3, 73.9, and 79.4°C) by oven-roasting, oven-broiling, grilling using electric grill or countertop electric charbroiler and stewing. Outside grill was used for selected strip loin samples to capture characteristics that resulted from the grilling process using charcoal and/or woodchips. For inducing warmed-over-flavor (WOF), a selection of beef samples cooked by different methods were kept overnight in the refrigerator and reheated in a conventional or microwave oven prior to evaluation to simulate the common techniques used by consumers to warm up left-over food. Some spoilage samples were also evaluated for any aromatic characters associated with spoiled beef cooked by oven-roasting, oven-broiling, stewing and grilling with both grill types.

Findings

A total of 36 aroma attributes, 31 flavor attributes and 5 fundamental tastes (sweet, sour, salty, bitter and umami) were identified and referenced (Table 1). All of the attributes were grouped into two categories: major attributes and other notes. Beef ID, brown/roasted, bloody/serumy, fat-like, metallic, liver-like, green (hay-like), overall sweet and all 5 fundamental tastes were present in most samples and were therefore grouped into the

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"major attributes" category. The remaining attributes, such as animal hair, barnyard, chemical, old leather, cocoa and cooked milk were grouped as "other notes" and only present in certain samples.

Table 1. List of the attributes with definitions

Attribute	Definition
Beef ID	Amount of beef flavor identity in the sample
Brown/Roasted	A round, full aromatic generally associated with beef suet that has been broiled
Bloody/Serumy	The aromatics associated with blood on cooked meat products. Closely related to metallic aromatic
Fat-liked	The aromatics associated with cooked animal fat
Metallic	The impression of slightly oxidized metal, such as iron, copper, and silver spoons
Liver-like	The aromatics associated with cooked organ meat/liver
Green (hay-like)	Brown/green dusty aromatics associated with dry grasses, hay, dry parsley and tea leaves
Umami	Flat, salty, somewhat brothy. The taste of glutamate, salts of amino acids and other molecules called nucleotides.
Overall sweet	A combination of sweet taste and sweet aromatics. The aromatics associated with the impression of sweet
Sweet	The fundamental taste factor associated with a sucrose solution.
Sour aromatics	The Aromatics associated with sour substances.
Sour	The fundamental taste factor associated with a citric acid solution
Salty	The fundamental taste factor of which sodium chloride is typical
Bitter	The fundamental taste factor associated with a caffeine solution
Animal hair	The aromatics perceived when raw wool is saturated with water.
Barnyard	A combination of pungent, slightly sour, hay-like aromatics associated with farm animals and the inside of a horne.
Burnt	The sharp/acrid flavor note associate with over-roasted beef muscle, something over-baked or excessively browned in oil
Rancid	The aromatics commonly associated with oxidized fat and oils. These aromatics may include cardboard, painty, varnish, and fishy.
Heated oil	The aromatics associated with oil heated to a high temperature.
Chemical	The aromatics associated with garden hose, hot Teflon pan , plastic packaging and petroleum based product such as charcoal liter fluid.
Leather (old)	Musty, old leather (like old book bindings)
Apricot	Fruity aromatics that can be described as apricot.
Green	Sharp, slightly pungent aromatics associated with green/plant/vegetable matters such as parsley, spinach, pea pod, fresh cut grass, etc.
Asparagus	The slightly brown, slightly earthy green aromatics associated with cooked green asparagus
Musty/Earthy/ Hummus	Musty, sweet, decaying vegetation
Cumin	The aromatics commonly associated with cumin and characterized as dry, pungent, woody, and slightly floral
Floral	Sweet, light, slightly perfume impression associated with flowers
Beet	A dark damp, musty, earthy note associated with canned red beets
Chocolate/Cocoa	The aromatics associated with cocoa beans and powdered cocoa and chocolate bars. Brown, sweet, dusty, often bitter aromatics
Medicinal	A clean sterile aromatic characteristic of antiseptic-like products such as Band-Aids, alcohol and iodine.
Petroleum-like	A specific chemical aromatic associated with crude oil and its refined products that have heavy oil characteristics.
Smokey (Charcoal)	An aromatic associated with meat juice and fat dripping on hot coals which can be acrid, sour, burnt, etc.
Smoky (Wood)	Dry, dusty aromatic reminiscent of burning wood.
Spoiled/Putrid	The presence of inappropriate aromatics and flavors that is commonly associated with the products. It is a foul taste and/or smell that indicates the product is starting to decay and putrefy.
Dairy	The aromatics associated with products made from cow's milk, such as cream, milk, sour cream or butter milk.
Buttery	Sweet, dairy-like aromatic associated with natural butter
Cooked milk	A combination of sweet, brown flavor notes and aromatics associated with heated milk
Sour milk/ Sour dairy	Sour, fermented aromatics associated with dairy products such as buttermilk and sour cream
Refrigerator - stale	The aromatics associated with products left in a refrigerator for an extended period of time and absorbed a combination of odors (lack of freshness, flat)
Soapy	An aromatic commonly found in unscented hand soap
Warmed-over	Perception of a product that has been previously cooked and reheated

Implications

The focus of the beef industry has been mainly to assess beef tenderness and juiciness and ways to improve beef texture. Both the industry and academia uses the AMSA (1995) guidelines to assess the flavor of beef, which is a good starting point but it is not comprehensive. As of now, the beef industry does not have a standardized flavor lexicon that can be used and it is vital that the industry be able to systematically identify flavor attributes present in different beef products and quantify attribute intensity to determine which attributes drive consumer satisfaction or dislike.

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