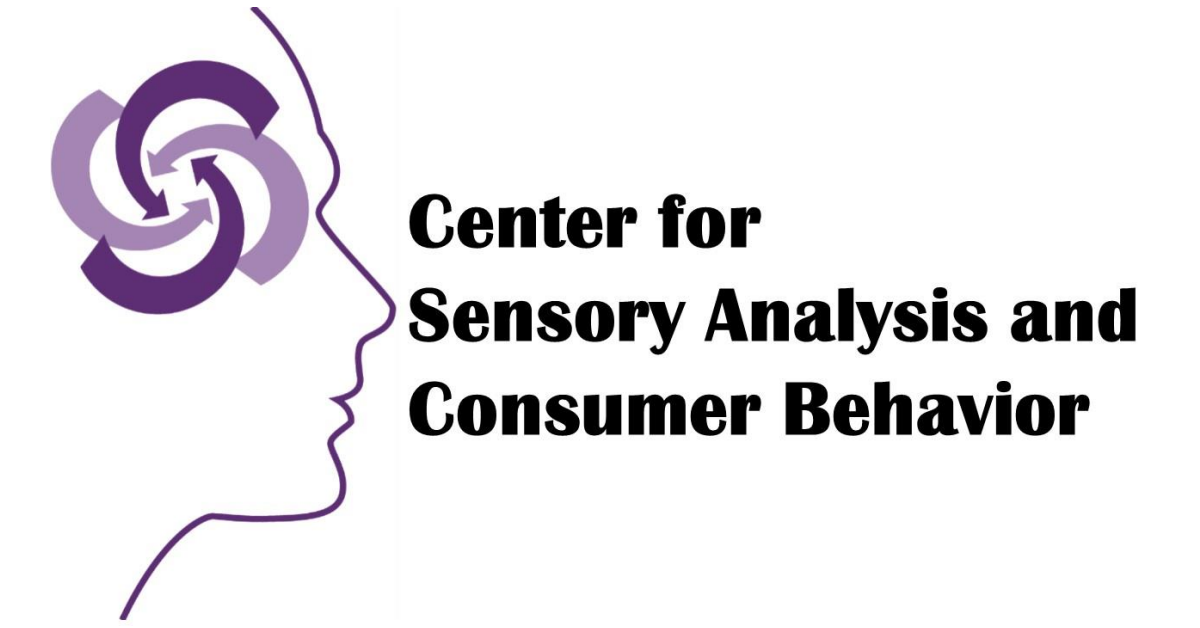# DEVELOPMENT AND APPLICATION OF A LEXICON TO DESCRIBE THE FLAVOR OF SORGHUM VARIETIES

Thao Tran (thaotran@ksu.edu), Edgar Chambers IV (eciv@ksu.edu)

KANSAS STATE UNIVERSITY

Center for Sensory Analysis and Consumer Behavior, Department of Food, Nutrition, Dietetics, and Health, College of Human Ecology

Center for Sensory Analysis and Consumer Behavior

Introduction

- Sorghum (Sorghum bicolor [L] Moench), is an ancient grain that possesses many health and economic values.
- Sorghum is gluten-free, non-GMO, one of the most environmentally friendly crops and considered as a major staple food in many countries.
- There are more than 40,000 cultivars of sorghum resulting in variations in physical and nutritional characteristics as well as sensory profiles.
- Understanding the differences in the flavor profiles among cultivars is essential to increase the use of sorghum for food application purposes. Different products require different flavor profiles.

Objectives

- Develop a sensory lexicon to describe the flavor characteristic of sorghum varieties.
- Validate the lexicon by characterizing the flavor of 20 sorghum varieties under 2 applications - cooked grain and cookies – to determine if the lexicon differentiates varieties.

Cooked Sorghum Grain

Sorghum Cookies

Materials and Methods

Samples

- 57 sorghum samples varied in their physical characteristic and nutritional content were used in the studies including:
  - Stage I (initial terminology development): 9 commercially available sorghum samples
  - Stage II (final lexicon development): 48 samples from the USDA sorghum associate collection that contains a collection of the world'sgenetically diverse sorghum varieties.
  - Stage III (validation): 20 samples chosen from the previous 48 sample set

Samples preparation

- Stage I - samples were prepared and presented to panelists in 5 applications: cooked grains, porridge, cookies, muffins and extruded puffs
- Stage II and III – samples were prepared and present as cooked grain and cookies
- All samples served blinded with 3-digits codes

Evaluation procedure

- 6 highly trained panelists participated in the studies
- The panel used the Consensus Profile method.
- Samples were evaluated using a 15-point scale with 0.5 increments

1. <u>Initial Lexicon development</u>: Generation of flavor attributes, determination of attributes' definitions and descriptive references
2. <u>Expanding of the lexicon</u>: Adding more terms, refining and modifying the initially developed lexicon.
3. <u>Validation of the lexicon</u>: Applying the lexicon to characterize the flavor profile of sorghum samples under multiple applications.

Results

Attributes	Definition	References and Intensity
Starchy	The flat flavor note associated with raw or processed starch based grain products such as wheat, rice, oats, and other grains.	Mix of 2g corn Starch in 200 mL water = 3.5 Microwaved potato meat = 7.0 Cooked American Beauty Elbow Macaroni = 12.0
Beany	A slightly brown, musty, nutty, and starchy flavor associated with cooked beans.	Kroger Great Northern Beans= 6.0 Bush's Best Pinto Beans = 12.0
Cardboard	A flat flavor note associated with cardboard or paper packaging that may be associated with a stale characteristic.	Mission Flour Tortilla = 6.0 Baked Mama Mary's Pizza Crust for 4 minutes= 12
Brown	A part of the grain complex that presents a flavor impression associated with characteristics such as toasted, nutty, caramelized and sweet.	Kretschmer Wheat Germ = 5.0 (f) Wheat Chex Cereal = 12.0 (f)
Spice brown	A blend of sweet, slightly pungent, brown, spicy aromatics.	McCormick Spice blend in water (1/8 tsp in 16c water) = 7.0 McCormick Spice blend in water (1/8 tsp in 8c water) = 13.0
Sweet Aromatics	Aromatics associated with the impression of sweet substances.	Kellogg's Special K = 8.0 Lorna Doone Cookies = 12.0
Brown-Sweet	A rich, full-bodied, light brown, sweet aromatic, which may include the character notes of vanilla and caramelized.	Nabisco Graham Original = 13.0
Leavening	The flat, metallic, somewhat sour, bitter and salty aromatics associated with baking soda and/or baking powder in baked flour products.	Pancake = 7.0 Prep: ½ cup Pancake Mix+1 1/2-tspBaking Powder+ ½ cup water. Pillsbury Original Biscuit Dough (raw) = 15.0 (f)
Oil-Heated	The aromatics/flavors associated with heated cooking oils that may include olive oil, vegetable oils such as corn or soybean, and other common cooking oils. Characteristics include a lack of freshness, accompanied by slight brown and musty notes.	Heated Spectrum Safflower Oil = 6.0 (f) Heated Wesson Vegetable Oil = 12.0 (f) Prep: Heat 1/3 cup oil for 2 minutes on high power in the microwave oven.
Buttery	Dairy aromatics/flavors associated with sweet cream. May also include a slightly salty note and occur in both natural and non-natural products.	2 drops of Kroger Imitation Butter Flavor in 200 ml water = 6.0 3 drops of Kroger Imitation Butter Flavor in 200 ml water =12.0
Petroleum	Specific chemical aromatics/flavors associated with crude oil and its refined products that have heavy oil characteristics.	2 drops of Briggs & Stratton SAE 30 Small Engine Oil = 7.0 4 drops of Briggs & Stratton SAE 30 Small Engine Oil = Prep: drop oil on a cotton ball in a large 24 oz. snifter, covered.
Eggy	Aromatics/flavors associated with cooked whole chicken eggs, with savory, earthy, salty, buttery, and sulfur overtones. May also include sweet, metallic, and cardboard notes.	Sara Lee Pound Cake = 6.0 (f) Chopped Egg White = 13.0 (f)
Umami	Savory, salty, and somewhat flat, brothy aromatics/flavors associated with juices from cooked seafood, meat, and/or vegetables.	2 Button Mushrooms + 2 Shrimps Broth = 6.0 4 Button Mushrooms + 4 Shrimps Broth = 12.0
Overall Green	Sharp, pungent aromatics/flavors associated with fresh green/plant/vegetable matter such as parsley, spinach, pea pod, fresh cut grass.	Diluted Fresh Parsley water (1:6 dilution) = 6.0 Diluted Fresh Parsley water (1:3 dilution) = 12.0 Parsley water: chop 50 g of fresh parsley, add 600 ml of water. Let sit for 15 min.
Nutty	A combination of slightly sweet, brown, woody, oily, musty, bitter and astringent aromatics commonly associated with nuts, seeds, beans, and grains.	Quaker Quick Oats (uncooked) = 6.0 Kretschmer Wheat Germ= 12.0
Woody	The sweet, brown, musty, dark aromatics/flavor associated with dry, freshly cut wood.	Dry Hickory Smoker Wood Chips = 8.0 Wet Apple Wood Smoker Chips = 15.0
Musty Dusty	Dusty, musty paper.	Diluted Brewed Lipton decaffeinated tea = 6.0 Prep: Diluted with ½ c of hot water, let cool and serve. Brewed Lipton decaffeinated tea according to package instruction = 13.0
Cocoa	A brown, sweet, dusty, musty, often bitter aromatic associated with cocoa bean, powdered cocoa and chocolate bars.	Hershey's Cocoa Powder in water (1/16 tsp in 200 ml water) = 6.0 Hershey's Cocoa Powder in water (1/8 tsp in 200 ml water) = 12.0
Leather	Warm, sweet, aromatics associated with tanned animal hides. Characteristics may include musky perfumery, honey, woody, tobacco, resinous, and smoky notes.	Brewed Harney & Sons PU-ERH Tea diluted = 4.0 Prep: Brew 1tsp tea in 1c boiling water for 5 min, dilute with 1 c hot water. Brewed Harney & Sons PU-ERH Tea (1tsp +1 water for 5 minutes) = 14.0
Bran	Light dusty brown grain-like aromatic/flavor impression that may include characteristics such as slightly raw, sweet, or bitter.	Bob's Oat Bran=4.0 Kretschmer Wheat Germ= 7.0 Bob's Wheat Bran = 12.0
Corn-Like	Sweet, musty, light brown, and slightly sour aromatics/flavors, accompanied by earthy and starchy characteristics.	Quaker Yellow Corn Meal =7.0 Corn Chex=13.0
Wheat Like	Dusty brown, nutty aromatics/flavors that may include light raw or caramelized notes, as well as a slight metallic note.	Wheat Chex = 4.0 Baked Whole Wheat Flour (350 F for 5 minutes= 8.0
Sweet	A fundamental taste factor of which sucrose is typical.	0.25% Sucrose Solution = 3.0 0.50% Sucrose Solution = 7.0 1.0% Sucrose Solution = 12.0
Sour	The fundamental taste factor associated with a citric acid solution.	0.015% Citric Acid Solution = 8.0 0.025% Citric Acid Solution = 15.0
Bitter	The fundamental taste factor associated with a caffeine solution.	0.01% Caffeine Solution = 6.0 0.02% Caffeine Solution = 12.0
Salty	The fundamental taste factor of which sodium chloride is typical.	0.15% NaCl Solution = 8.0 0.20% NaCl Solution = 14.0
Metallic	The impression of slightly oxidized metal such as iron, copper, and silver spoons.	0.10% Potassium Chloride Solution = 8.0 0.15% Potassium Chloride Solution = 14.0

Validating the lexicon

- Based on the results of Principal Component Analysis, there are differences in flavor among sorghum cultivars and the lexicon attributes successfully separate the sorghum samples in various applications.
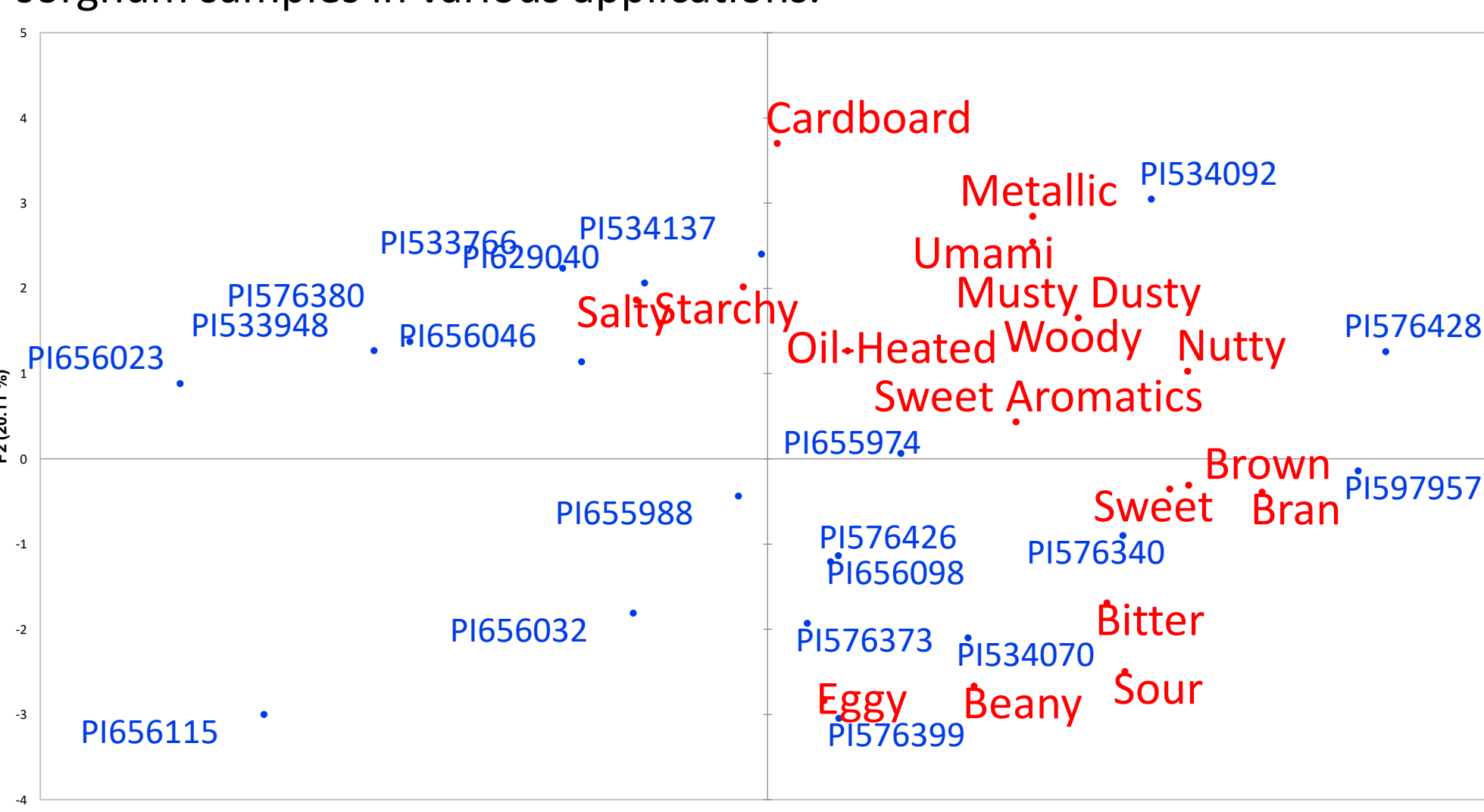

Figure 4. Principal Component Analysis (PCA) of the trained panel evaluations for flavor attributes of multiple cooked grains sorghum samples.

- F1 is defined by nutty, brown, and bran attributes while F2 separate cardboard with eggy, beany and sour.
- Samples PI576428 and PI597957 are highly correlated with F1 and are different compared to sample PI656023
- Samples PI576399, PI576373 and PI534070 are more pronounced in eggy, sour and beany compared to other samples
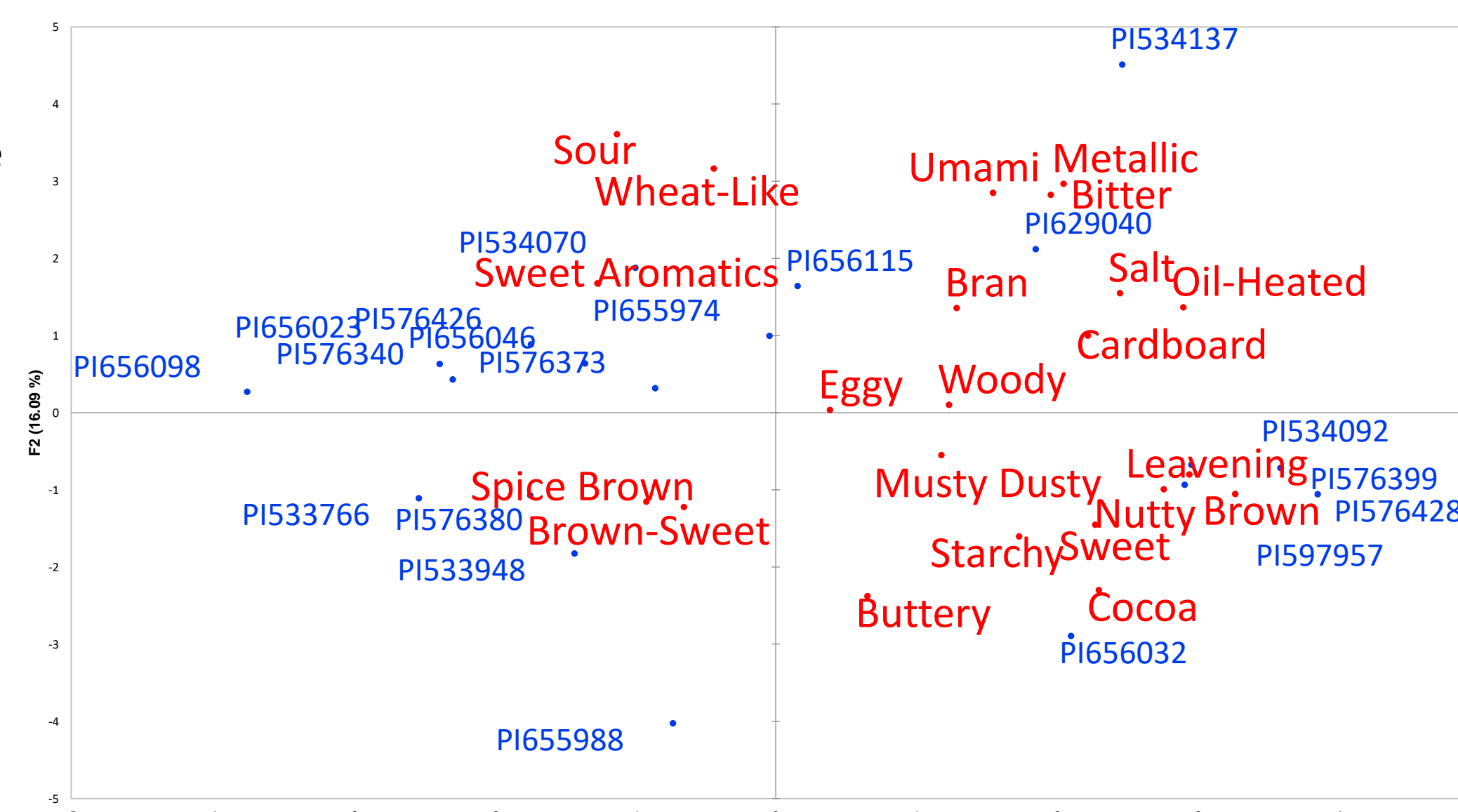

Figure 5. Principal Component Analysis (PCA) of the trained panel evaluations for flavor attributes of multiple sorghum cookies samples.

- Sorghum cookie samples were greatly differentiated from each other
- Samples PI5324137 and PI629040 were more pronounced in umami, metallic and bitter
- Samples PI534092, PI576399, PI576428, and PI597957 were grouped close together with attributes that are highly correlated with factor 1 such as brown, leavening and nutty
- samples PI533766, PI576380 and PI533948 are more pronounced in spice-brown and brown-sweet while samples PI655988 and PI656032 were recognized to be more unique in their flavor profile.

Conclusions

- A sensory lexicon with 27 attributes was identified, defined and referenced by the trained panel to facilitate characterization of sorghum flavor both as grains and in finished products
- The lexicon was applied to differentiate the flavor profiles among many sorghum cultivars under different applications.
- Such understanding allows researchers to better understand differences in sorghum flavor that can be used to select varieties for certain applications & to select advantageous characteristics for selective breeding purposes.

References

- All About Sorghum. (n.d.). Retrieved March 13, 2018, from http://www.sorghumcheckoff.com/all-about-sorghum
- Casa, A. M., Pressoir, G., Brown, P. J., Mitchell, S. E., Rooney, W. L., Tuinstra, M. R., . . . Kresovich, S. (2008). Community resources and strategies for association mapping in sorghum.(RESEARCH)(report). Crop Science, 48(1), 30. doi:10.2135/cropsci2007.02.0080
- Dicko, M. H., Gruppen, H., Traore, A. S., Voragen, A. G. J., & Berkel, v., W.J.H. (2006). Sorghum grain as human food in africa: Relevance of content of starch and amylase activities. African Journal of Biotechnology, 5(5), 384-395. Retrieved from
- Hongsoongnern, P., & Chambers Iv, E. (2008). A lexicon for green odor or flavor and characteristics of chemicals associated with green. Journal of Sensory Studies, 23(2), 205-221. doi:10.1111/j.1745-459X.2007.00150.x
- Ratnavathi CV, P. J. (2014). Sorghum utilization as food. Journal of Nutrition & Food Sciences, 4(1) doi:10.4172/2155-9600.1000247