The eye (and tongue) of the beholder:

There may be more value in non-Grade A syrup than producers think

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Common off-flavors in maple syrup can arise from late season harvest, processing defects and microbiological contaminants, resulting in non-Grade A designations, and much reduced value. Twelve maple syrup samples, representing Grade A syrup and the common flavor defects "buddy", "sour," and "dark/acrid" (syrups associated with a burnt/bitter flavor), were produced in two NY State locations, Van Etten, NY and Lake Placid, NY, across the 2023 maple sap collection seasons, by Cornell Maple Program, where the samples were assigned appropriate grades and off-flavors by a maple syrup producer following industry standard guidelines. Samples were then evaluated at Cornell Food Science by a group of 26 maple syrup consumers in a multi-session qualitative study to establish a flavor profile for the maple syrups.

The participants generated a total of 75 different descriptor categories across maple syrup appearance (14 descriptors), flavor (42), texture (17) and aftertaste (2) (Figure 1). In contrast to Grade A samples with their signature caramelized sugar maple flavors, those classified as buddy, sour, and dark/acrid were described as including more diverse flavor notes such as fruity, floral, green, and sharper pungency. Participants described the texture of Grade A samples as thinner in consistency, whereas other grades were viewed as more viscous, with sour and buddy samples also described as slimy, gummy and filmy.

Figure 1. Summary of QMA participant descriptors for Grade A, Very Dark/Acrid, Buddy, Buddy and Sour, and Sour test samples. An expanded version of this figure is available in the Appendix (Figures A1-A5).

Following this, consumers took part in a Kano Analysis to determine the relative importance of sensory and other non-sensory product attributes, identifying which properties of the samples they found essential, and which were of less importance. This technique is frequently used by product developers to determine which attributes are required for a product to fulfill its function (MUST HAVE), separate its performance from others (DRIVER), provide premium product experience to consumers (DELIGHTER) and which are not important to product performance and identity (NOT IMPORTANT). After having tasted the products and discussed them as a group, participants sorted product attributes into these four categories (Table 1). The MUST HAVE attributes included primarily maple, sweet, no other flavors, and thin easy to pour consistency. Participants also required food safety aspects, maintaining thin consistency across shelf life, 100% pure no additives maple syrup claim, and non-aluminum package material. Maple flavor is the main differentiator of a maple syrup product from any other pancake syrup on the market. Having more intense maple flavor with some additional notes, such as floral, smoky, sour, bitter, and even thinner consistency were DRIVER attributes. Small/family farm produced, local production, glass packaging, specific brand and price (the lower the better) were also on the DRIVERS of satisfaction list. Lingering maple and sweet aftertaste, upscale packaging material and design, Grade information, flavor descriptions, along with recommended uses, origin information and price (looking for a good deal) were DELIGHTERS. Interestingly, the presence of sugar crystals was delightful to some participants, indicating higher sugar content and premium quality, while for others that was NOT IMPORTANT.

Finally, participants analyzed in more depth the various sensory profiles of maple syrup samples, some emblematic of processing issues or a warming maple forest, voting for their most and least favorite sample, and building a value diagram for maple syrup. Of the samples evaluated, about half (12/26) of the participants found both dark/acrid samples as the best quality because both had *"depth of flavor"*, *"good balance between the maple and sweetness"*, *"right consistency"* and generally met their expectations. Another group (8/26) voted for the two Grade A samples due to their *"clean"*, *"more sweet than maple"* flavor and *"good consistency."* Both also *"met expectations of maple syrup"* product identity for this group. Five of 26 chose a buddy and 1 of 26 a sour sample as having the best quality due to *"strong maple"* but also a more *"complex"* sensory profile. Conversely, some samples were universally disliked. The sour/buddy sample from the end of season was deemed as so *"spoiled"* and *"fermented"* tasting that participants were *"concerned about food safety"* when tasting it. A sour end of season and buddy late-mid season sample had *"no maple"* flavor and tasted *"rancid"* and *"bitter"* instead. In addition, their *"too stringy, like melted mozzarella,"* *"too thick consistency"* and *"cloudy"* appearance were other reasons for dislike. Despite these facts, consumers thought that even for these

three, they could *"find uses for,"* for example in a meat marinade or salad dressing. On the other hand, the buddy end of season sample was one that all participants wanted to *"never taste again"* because of its *"bad smell,"* and *"fermented, vinegary, sour apple fruity"* flavor of *"thinned out molasses."*

Table 1. Maple Syrup Qualitative KANO Satisfaction Summary.

	Sensory Modality				
Attribute type	**Appearance**	**Aroma**	**Flavor**	**Consistency**	**Other Non-Sensory Considerations**
MUST HAVE (required)	- A range of color (from warm light golden to medium/darker brown) - Clear/Not cloudy - No particles/debris visible	- Maple - No plasticky - Smoky (slight)	- Maple - Sweet but without lingering artificial sweetness (like aspartame) - Not Sour - Not Bitter - Not Fruity (citrus or dry fruit like resins) - Not Fermented - Not Medicinal - Not Smoky or some Smoky (slight) - Not Plasticky - Not Metallic - Not Rancid	- Syrupy - Lighter/thinner consistency but not watery - Easy to pour - Absorbs quickly [into a pancake] - Does not gel - Not slimy - Not sticky in mouth - No sugar crystals (not gritty or grainy)	- Food Safe/no mold/not making anybody sick - Retains consistency over shelf-life/no sugar crystals forming around the container/bottle over shelf-life - No aluminum can package - 100% pure maple syrup/No additives
DRIVER (more better)	- Color (the darker the better) - Translucent	Maple	- Maple - Floral - Smoky - Sour (slight) - Bitter (slight)	- Lighter/thinner consistency - Easy to pour	- Price (the lower the better) - Locally produced - Small/family farm produced rather than coming from large industrial operation - Specific brand - Glass packaging (not metal or plastic)
DELIGHTER (pleasantly unexpected)	- No specs or particles of any kind visible /very clear, translucent		- Lingering maple aftertaste - Sweet aftertaste (but not too lingering like artificial sweeteners would do)	- Presence of sugar crystals - Not sticky	- Price (looking for a deal) - Packaging material & design (see thru, glass, upscale designs) - Grade info (e.g. Grade A or another grade) - Tasting Notes/Flavor Descriptions that are beyond grade description and recommended Best Uses - Origin information: a. Artisan/small scale production b. Exact location of production (up to a tree) c. Exact timing of production
NOT IMPORTANT				- Presence of sugar crystals	

n=26

Based on USDA guidelines, Grade A distinction is awarded to four types of maple syrup based on product color and maple flavor intensity. Participants were aware but not very familiar with these descriptions ("golden color and delicate taste," "amber color and rich taste," "dark color and robust taste," and "very dark color and strong taste"). They noted that the *"grading was confusing. Grade A doesn't really mean the best, just that it came from a particular point in the season."* Another thing they felt was missing from the subcategory descriptions was the descriptors of flavors other than maple that may also be appealing. Participants felt that they may prefer maple syrup products that include flavors outside of the Grade A system, but calling these not Grade A *"may sound unappealing"* to consumers such as themselves.

In conclusion, the samples tested exhibited a surprisingly broad range of sensory profiles, and while certain off-flavors did have strong negative effects on liking, there were a broad range of flavor profiles beyond the Grade A "gold standard" that were well received by consumers, and could be a source of further value than is currently understood. Our results may bring good news to maple producers who would like to market maple syrup products outside of the currently defined "gold standard" sensory profile.

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Appendix

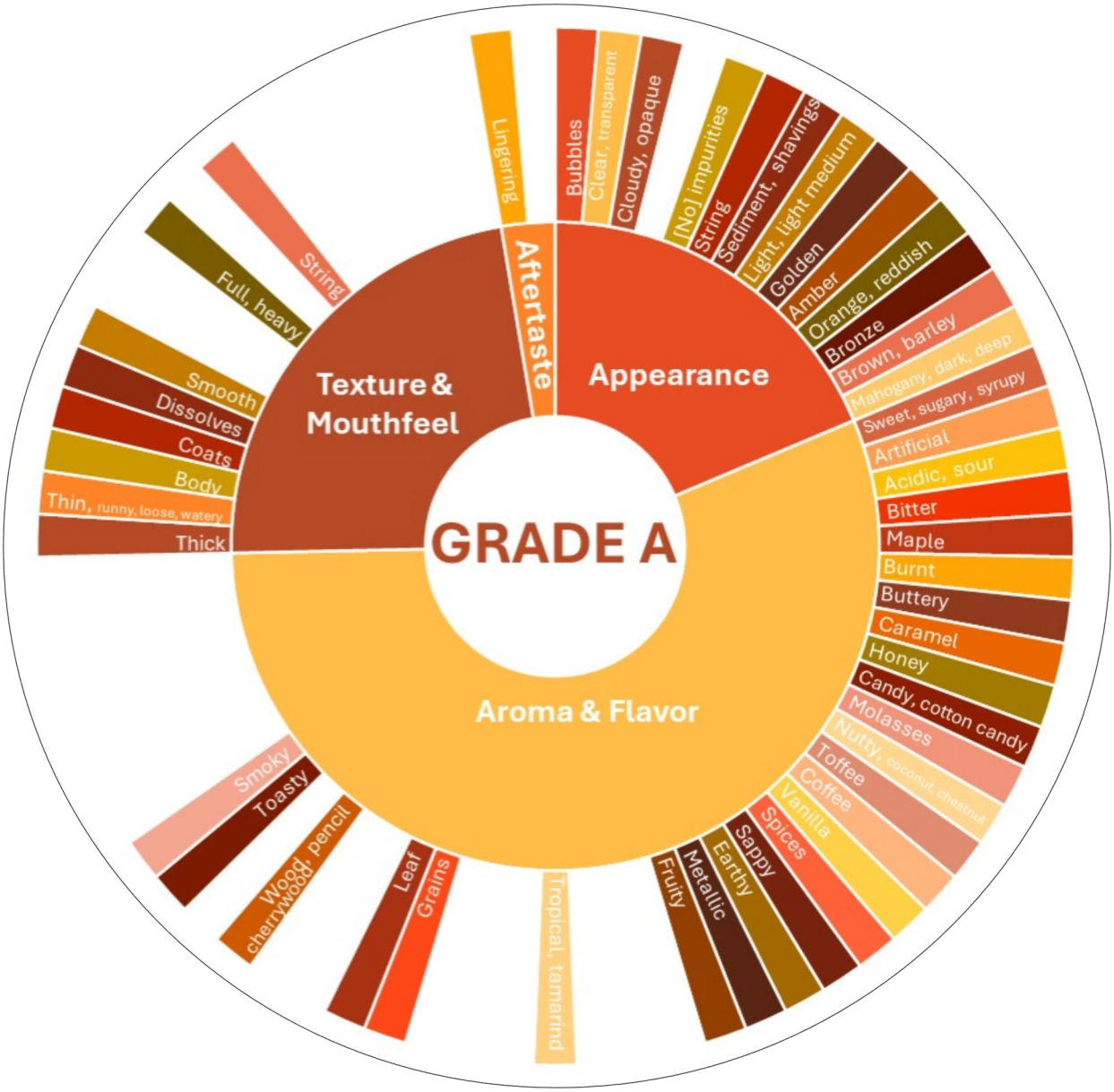

Figure A1. Expanded view of the Grade A maple syrup test sample descriptors summary provided by QMA participants.

Figure A2. Expanded view of the very dark/acrid maple syrup test sample descriptors summary provided by QMA participants.

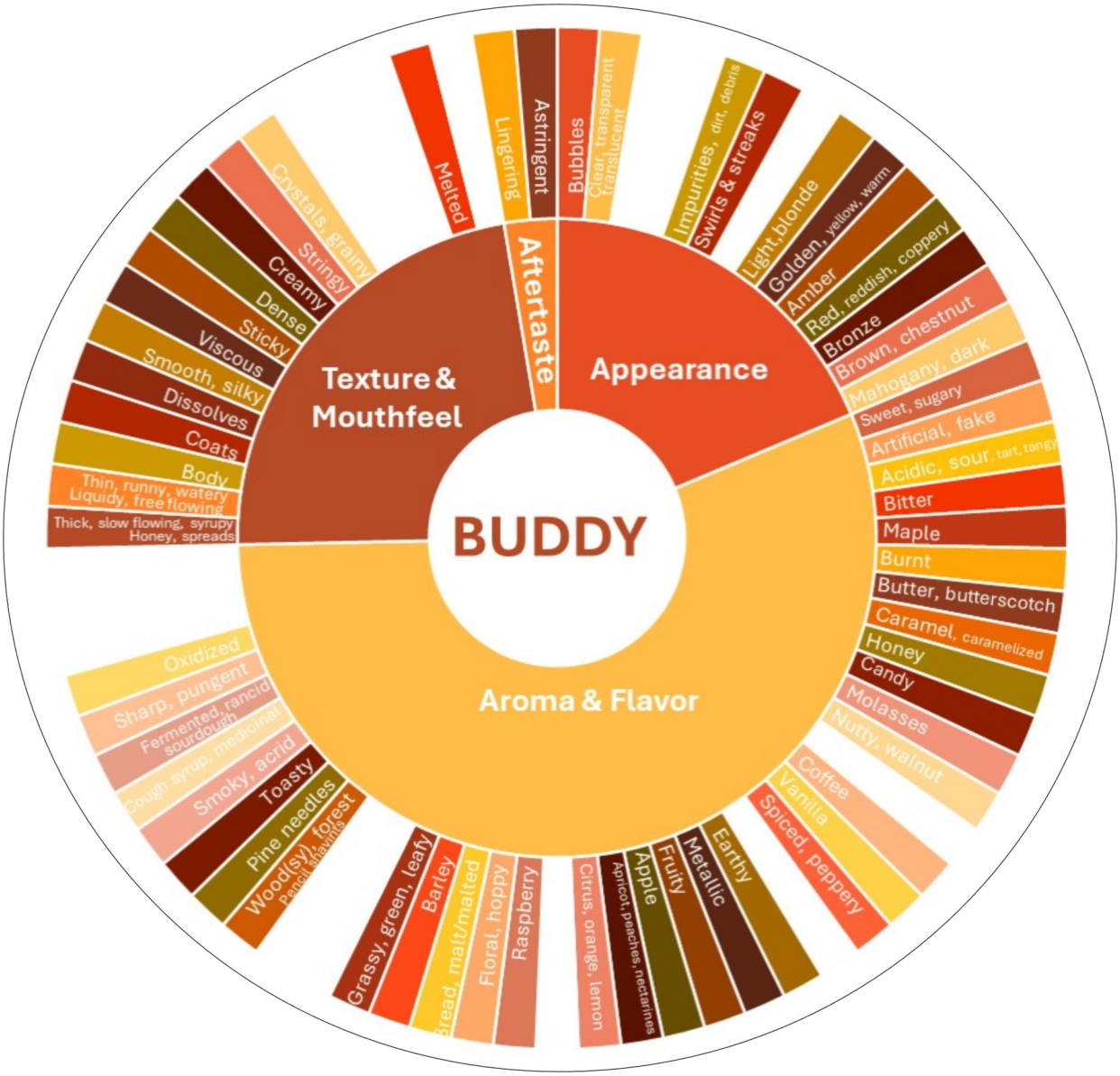

Figure A3. Expanded view of the buddy maple syrup test sample descriptors summary provided by QMA participants.

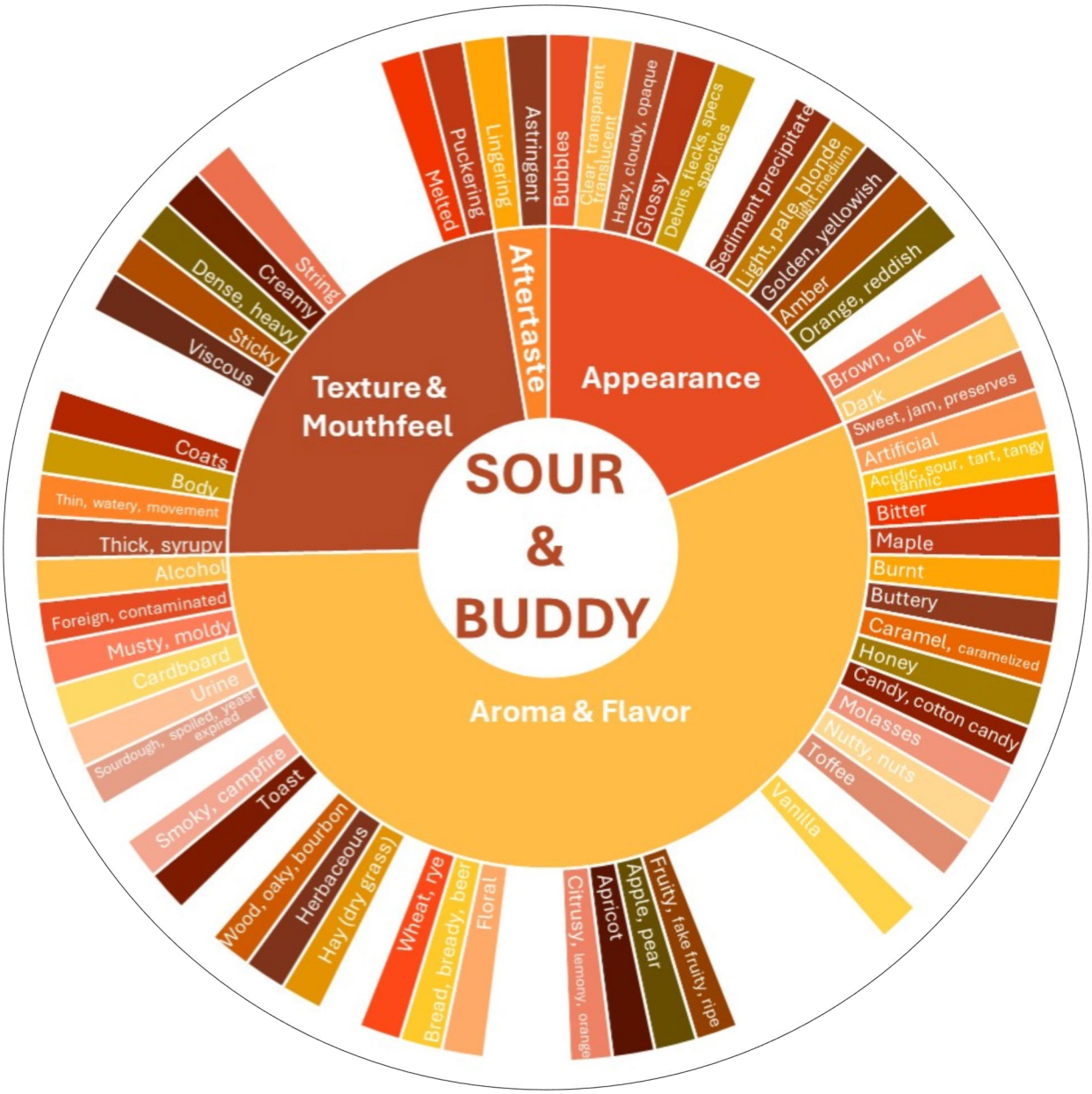

Figure A4. Expanded view of the sour and buddy maple syrup test sample descriptors summary provided by QMA participants.

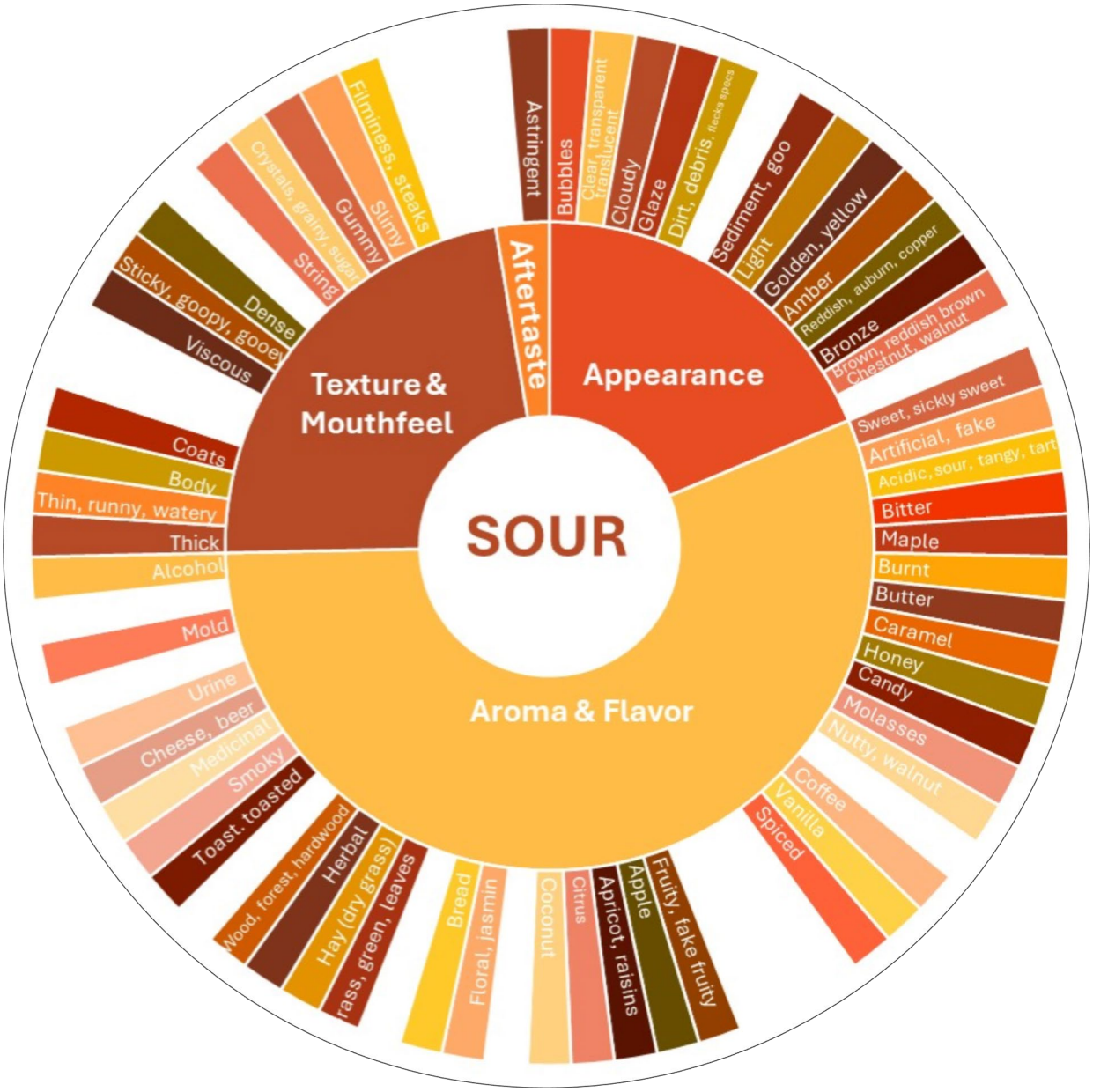

Figure A5. Expanded view of the sour maple syrup test sample descriptors summary provided by QMA participants.