



A contemporary tool for a new age in brewing: bringing modern science into everyday flavor analysis

Nicole Garneau, Ph.D, Denver Museum of Nature and Science

Lindsay Guerdrum, MS, New Belgium Brewing Company

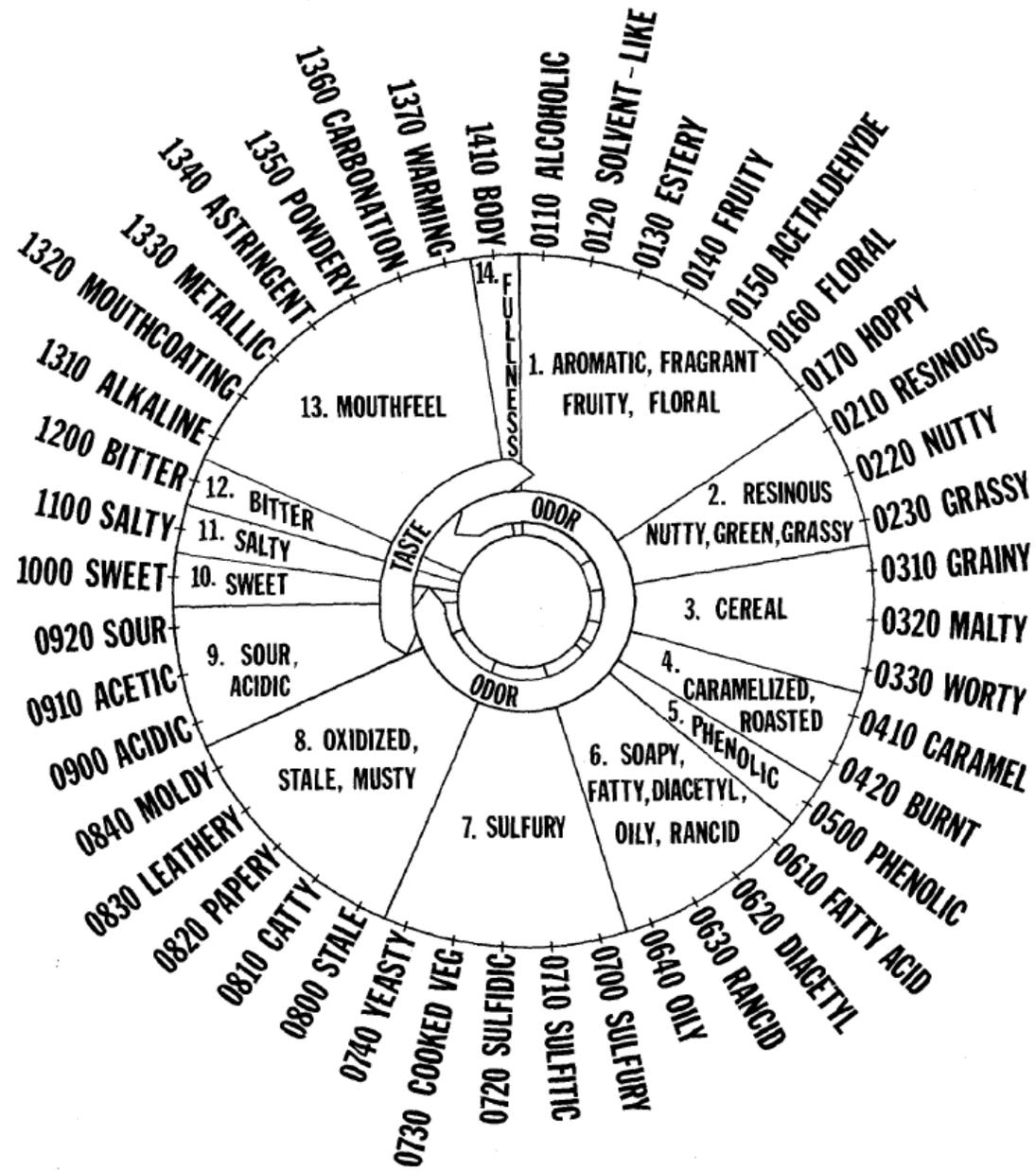


TABLE I

Recommended Descriptors

Particular Relevance: O = Odor			T = Taste	M = Mouthfeel	W = Warming	Af = Afterflavor
Class	First Term	Second Tier	Relevance	Comments, Synonyms, Definitions		Reference Standard
Class 1 — Aromatic, Fragrant, Fruity, Floral						
	0110	Alcoholic	OTW	General effect of ethanol and higher alcohols		Ethanol, 50 g/L
		0111 Spicy	OTW	Allspice, nutmeg, peppery, eugenol; see also 1003 Vanilla		Eugenol, 120 µg/L
		0112 Vinous	OTW	Bouquet, fusely, wine-like		(White wine)
	0120	Solvent-like	OT	Like chemical solvents		
		0121 Plastics	OT	Plasticizers		
		0122 Can-liner	OT	Lacquer-like		
		0123 Acetone	OT			(Acetone)
	0130	Estery	OT	Like aliphatic esters		
		0131 Isoamyl acetate	OT	Banana, peardrop		(Isoamyl acetate)
		0132 Ethyl hexanoate	OT	Apple-like with note of aniseed; see also 0142 Apple		(Ethyl hexanoate)
		0133 Ethyl acetate	OT	Light fruity, solvent-like; see also 0120 Solvent-like		(Ethyl acetate)
	0140	Fruity	OT	Of specific fruits or mixtures of fruits		
		0141 Citrus	OT	Citral, grapefruit, lemony, orange rind		
		0142 Apple	OT			
		0143 Banana	OT			
		0144 Black currant	OT	Black currant fruit; for black currant leaves use 0810 Catty		
		0145 Melony	OT			(6-Nonenal, <i>cis</i> - or <i>trans</i> -)
		0146 Pear	OT			
		0147 Raspberry	OT			
		0148 Strawberry	OT			
	0150	Acetaldehyde	OT	Green apples, raw apple skin, bruised apples		(Acetaldehyde)
	0160	Floral	OT	Like flowers, fragrant		
		0161 2-Phenylethanol	OT	Rose-like		(2-Phenylethanol)
		0162 Geraniol	OT	Rose-like, different from 0161; taster should compare pure chemicals		(Geraniol)
		0163 Perfumy	OT	Scented		(Exaltolide musk)

TABLE I
Compounds Recommended for Use as Flavor Reference Standards

Term	Compound	Supplier	Method of Purification	Difference Threshold^a	In Beer Containing	
0110	Alcoholic	Ethanol	High-quality vodka ^b	None required	17 g/L	33–42 g/L
0111	Spicy	Eugenol	Aldrich	Solvent wash + fractional distillation + adsorption	40 µg/L	...
0131	Isoamyl acetate	Isoamyl acetate	Aldrich	Adsorption + GC	0.5–1.7 mg/L	1–3 mg/L
0132	Ethyl hexanoate	Ethyl hexanoate	K & K Laboratories	Adsorption + GC	0.15–0.25 mg/L	0.2–0.4 mg/L
0133	Ethyl acetate	Ethyl acetate	Fluka	Adsorption	20–40 mg/L	10–30 mg/L
0145	Melony	Melonal ^c	Givaudan	None required	1 µg/L	...
0150	Acetaldehyde	Acetaldehyde	Merck	Adsorption + distillation + adsorption	10–20 mg/L	2–10 mg/L
0162	Geraniol	Geraniol	Merck	Use fresh supply	~150 µg/L ⁸	0–60 µg/L
0173	Hop oil	Cluster hop oil ^d	S. S. Steiner	None required	0.1 mg/L	...
0224	Almond	Benzaldehyde	Aldrich	Non required	1 mg/L	...
0611	Caprylic	Octanoic acid	Sigma	Recrystallization of calcium salt	5–10 mg/L	2–8 mg/L
0613	Isovaleric	Isovaleric acid	Sigma	None required	0.5–1.5 mg/L	0.5–1.5 mg/L
0614	Butyric	Butyric acid	Merck	2 × Fractional distillation	2–3 mg/L	0.5–1.5 mg/L
0620	Diacetyl	2,3-Butanedione	Aldrich	Fractional distillation + adsorption	0.07–0.15 mg/L	0.03–0.3 mg/L
0710	Sulfitic	Sodium meta-bisulfite	Fisher Scientific	None required	20 mg/L SO ₂	1–10 mg/L SO ₂
0721	H ₂ S	Sodium sulfide	Mallinckrodt	Select colorless crystals	4 µg/L H ₂ S	0–2 µg/L
0722	Mercaptan	Ethanethiol	Aldrich	None required	1 µg/L	0–0.5 µg/L
0732	DMS	Dimethyl sulfide	Matheson, Coleman and Bell	Adsorption	25–50 µg/L	30–100 µg/L

"...[we] urge all brewers and brewing researchers to use the present system for a period sufficiently long to identify (and report on) both advantages and defects. Then, in a few years' time, a new working group should be given the task of bringing the terminology up to date."

ASBC Methods of Analysis

Beer Flavor Database

[VIEW DATABASE as Excel File](#)
[VIEW DATABASE as PDF File](#)

Summary

This database is the culmination of countless hours of research and comprises a total of 624 molecules. The overall purpose of this project was to create a flavor database for the brewing industry to use for sensory science and sensory labs. For example, if there is a strong aroma or flavor in beer, a search can be completed to find the molecule responsible for the aroma. Sensory labs can use the database to compare panel thresholds to cited values or to create a vocabulary of commonly used flavor descriptors in beer.

The format of the database can be seen in the sample below:

Chemical Name	Synonyms	Structure	Molecular Weight (g/mol)	Flavor Descriptors	Conc. Minimum (mg/l)	Conc. Maximum (mg/l)	Conc. Mean (mg/l)	TH 1 (mg/l)	TH 2 (mg/l)	TH 3 (mg/l)	TH Water (mg/l)	Formation/Description	Compound Classification	References	CAS Number
Dimethyl sulfide	DMS	C ₂ H ₆ S	62.13	cooked-vegetable (corn, apricot, garlic, sweet corn, etc.)/black licorice, sulfury, cooked cabbage, broiled hamlets, baked beans	0.005	0.3	0.053	0.001	0.008	0.03	0.00010	Alone the precursor 3-Methylmethionine (DMSP) deriving from green malts, with lighter kilned malts containing more DMSP. Higher levels when there is insufficient degradation of DMSP (DMS) during wort boiling. Concentration dependent on the yeast strain to reduce DMSP during fermentation. Also fermentation temperature and high cell levels lower DMSP production. Reported concentration 0.04-0.3mg/l. 43-Phenylphenol and capsaicin (DMS) in the final beer may be formed by interaction during fermentation.	Sulfur compound	[31] [32] [33] [34] [35] [36] [37] [38] [39] [40] [41] [42] [43] [44]	75-08-0
Dimethyl sulfide		C ₂ H ₆ S	62.13		0.005	0.3	0.053	0.001	0.008	0.03	NP				75-08-0

This is an example of the compound dimethyl sulfide, one of the most important molecules in beer.

The database shows, in order from left to right:

Chemical Name – the most often cited in brewing literature

Synonyms – other common names or abbreviations found

Chemical Formula – e.g., C₂H₆S

Molecular Weight – in grams/mol

Flavor Descriptors – these descriptors are derived from what sensory scientists have sniffed in gas chromatography-olfactometry work and are indications of how the compounds are perceived by multiple analysts

Concentration Minimum, Maximum, and Mean – in milligrams/liter found in beer

Threshold (TH) 1, 2, 3 – in milligrams/liter found in beer – if a compound contains more than three published thresholds, a new row has been created to keep the width of the Excel file to a minimum. Most molecules will contain between one and three thresholds.

Threshold (TH) Water – in milligrams/liter

Formation/Description – this column contains additional information as to how the compound is created, where it is derived from, and/or any other relevant information

Compound Classification – the type of compound, whether it be an ester, alcohol, monoterpene, sesquiterpene, acid, phenol, sulfur compound, or other

References – one can find the sources in the other tab of the database

CAS Number – identification of the molecule by the Chemical Abstract Service, a registered trademark of the American Chemical Society

ASBC Methods of Analysis

Hop Flavor Database

[VIEW DATABASE as Excel File](#)
[VIEW DATABASE as PDF File](#)

Summary

This database is the culmination of countless hours of research and comprises a total of 594 molecules. The overall purpose of this project was to create a flavor database for the brewing industry to use for sensory science and sensory labs. For example, if there is a strong aroma or flavor in beer, a search can be completed to find the molecule responsible for the aroma. Sensory labs can use the database to compare panel thresholds to cited values or to create a vocabulary of commonly used flavor descriptors in beer.

The format of the database can be seen in the sample below:

Chemical Name	Synonyms	Chemical Formula	Molecular Weight (g/mol)	Flavor Descriptors	Conc. Minimum (mg/l)	Conc. Maximum (mg/l)	Conc. Mean (mg/l)	TH 1 (mg/l)	TH 2 (mg/l)	TH 3 (mg/l)	TH Water (mg/l)	Formation/Description	Compound Classification	References	CAS Number
Myrcene	β-Myrcene, 7-Adenyl-3-methyl-2-octadiene	C ₁₀ H ₁₆	136.23	herby, metallic, resinous, spicy, balsamic, geranium-like, green, anise-like, terpenic, balsam, plastic, sweet carrot, slight green, celery, lemon, soapy	0.0001	1	0.5	0.009	0.01	0.08	0.010-0.042	Synthetic product during hop growth, and therefore degrades to geraniol and linalool	Monoterpene alcohol	[45] [46] [47] [48] [49] [50] [51]	110-95-0
Myrcene	NP	C ₁₀ H ₁₆	136.23	NP	0.0001	1	0.5	0.2	0.5	1.0	NP	NP	Monoterpene alcohol		110-95-0

This is an example of the compound myrcene, the most abundant molecule in fresh hops.

The database shows, in order from left to right:

Chemical Name – the most often cited in brewing literature

Synonyms – other common names found

Chemical Formula – e.g., C₁₀H₁₆

Molecular Weight – grams/mol

Flavor Descriptors – these descriptors are derived from what sensory scientists have encountered in gas chromatography-olfactometry work and are indications of how the compounds are perceived by multiple analysts

Concentration Minimum, Maximum, and Mean – milligrams/liter found in beer

Threshold (TH) 1, 2, 3 – milligrams/liter found in beer – if a compound contains more than three published thresholds, a new row has been created to keep the width of the Excel file to a minimum. Most molecules will contain between one and three thresholds.

Threshold (TH) Water – milligrams/liter

Formation/Description – this column contains additional information as to how the compound is created, where it is derived from, and/or any other relevant information

Compound Classification – the type of compound, whether it be an ester, alcohol, monoterpene, sesquiterpene, acid, phenol, sulfur compound, or other

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CAS Number – identification of the molecule by the Chemical Abstract Service, a registered trademark of the American Chemical Society

Main Objectives

1. User friendly: "It aims to provide, first, a simple and easily understood terminology that will enable brewers and other interested parties to *communicate effectively* about flavor."
2. Actionable: "A more *comprehensive* system that will enable flavor researchers, brewers, and marketing professionals to describe and *define* each separately identifiable flavor note in beer."

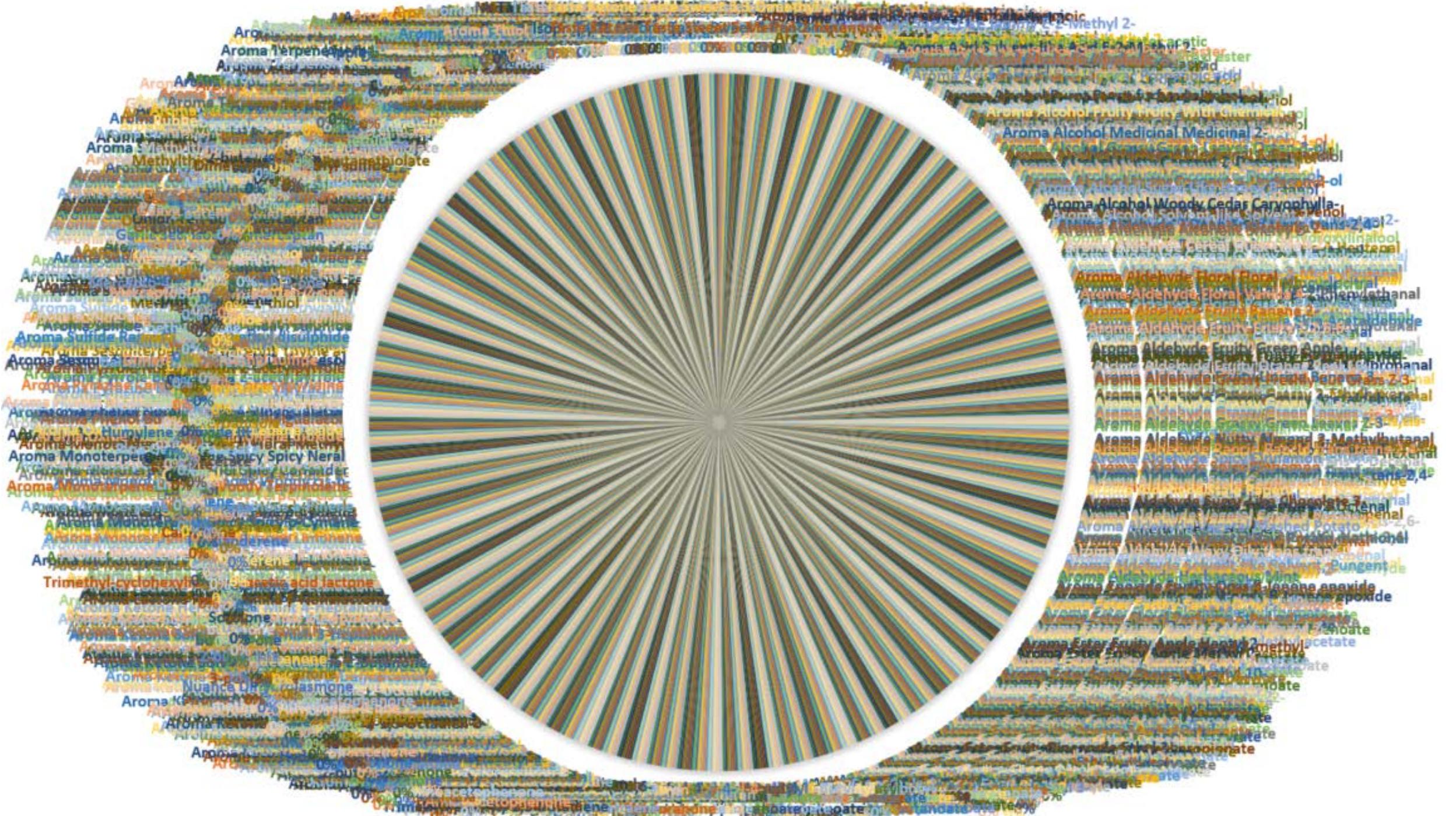
Term Review Principles

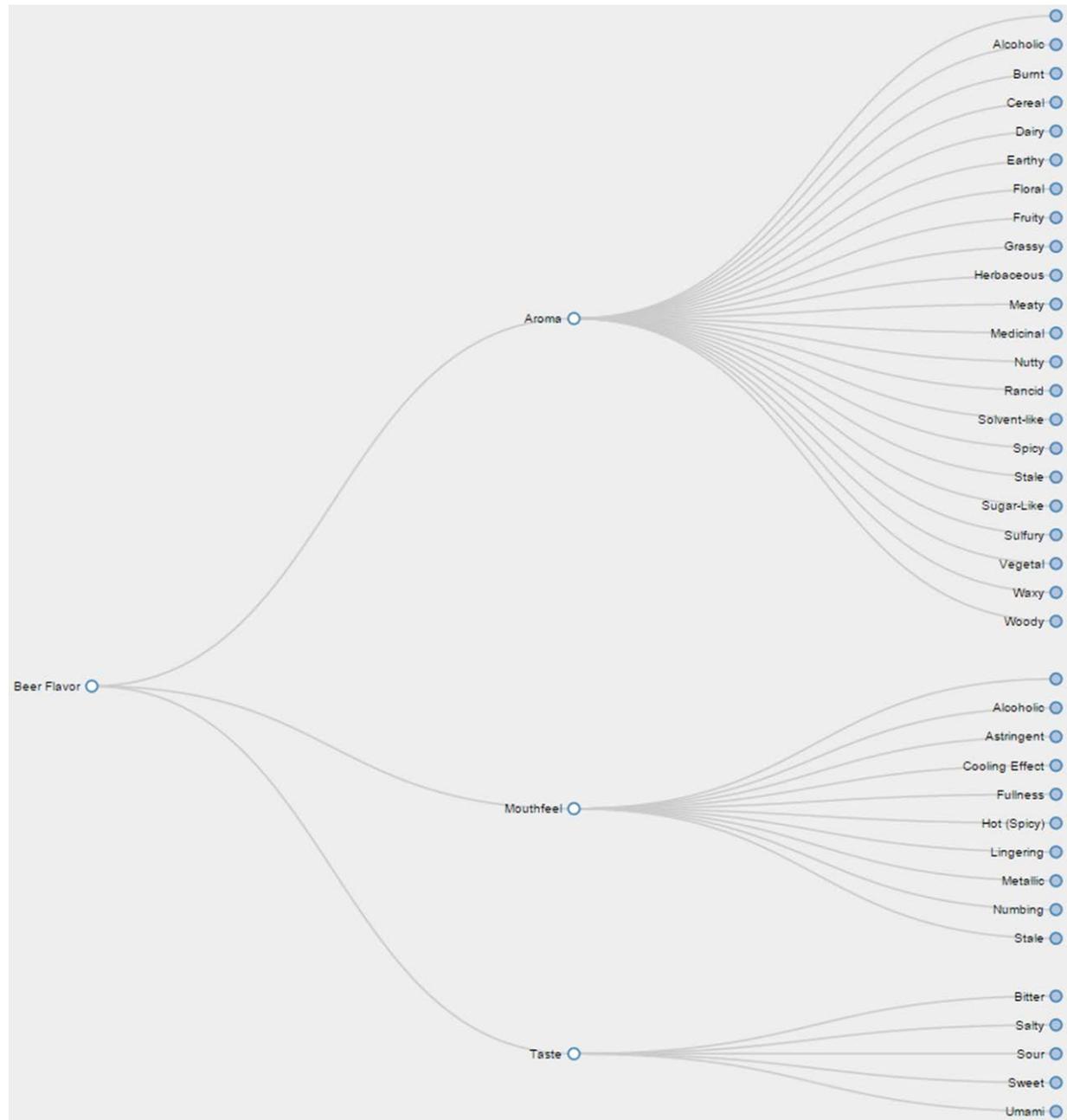
1. Singularity - Each term has only one meaning and can therefore be consistently communicated across levels of experience.
2. Capable of being referenced- The chemicals listed have been shown to be present in beer and are attached to references and CAS number when available.
3. Capable of being standardized - Every term included is tied to specific a single chemical compound.
4. Non-subjective - Hedonic terms like "pleasant" were omitted to remain in line with principle #3.
5. Consistency - Adjustments were made to the flavor terminology to remain consistent. For example, plural terms were altered to become singular (oranges changed to orange) and complex descriptions were simplified (green grass changed to grass and geranium-like to geranium)

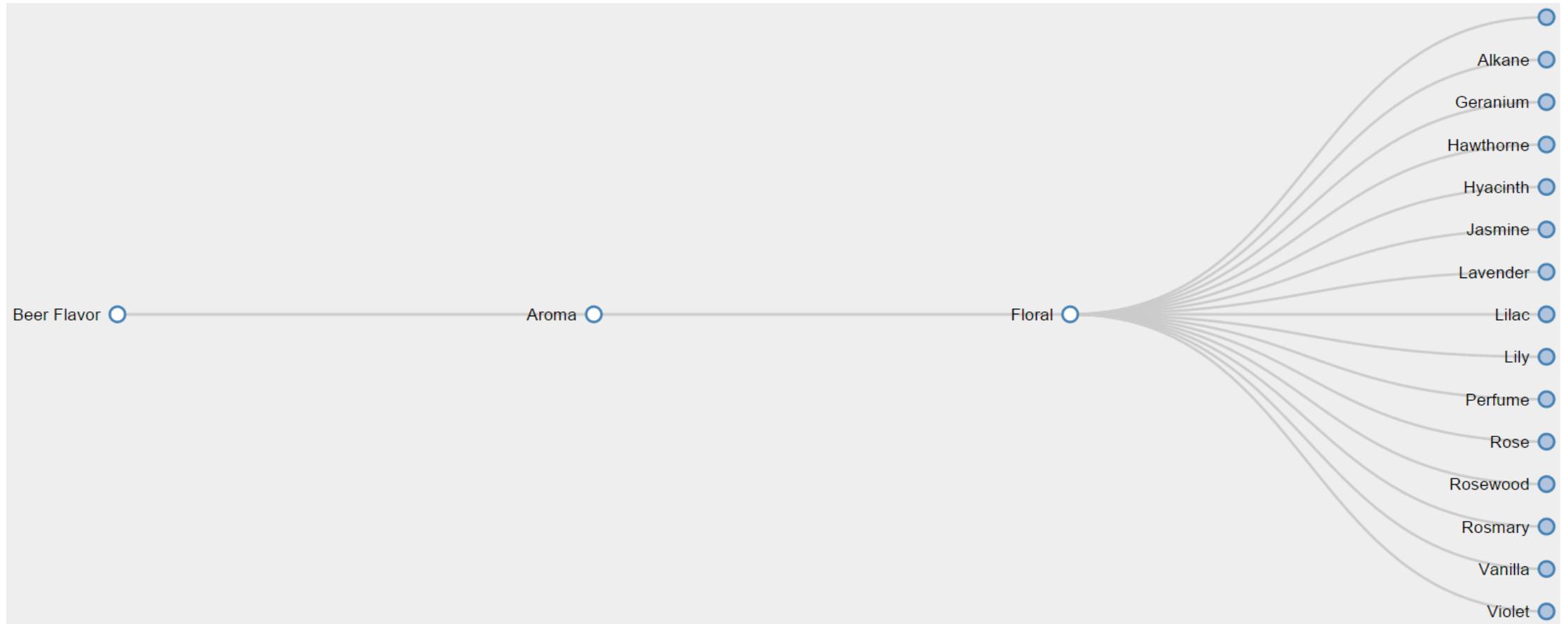
Structure

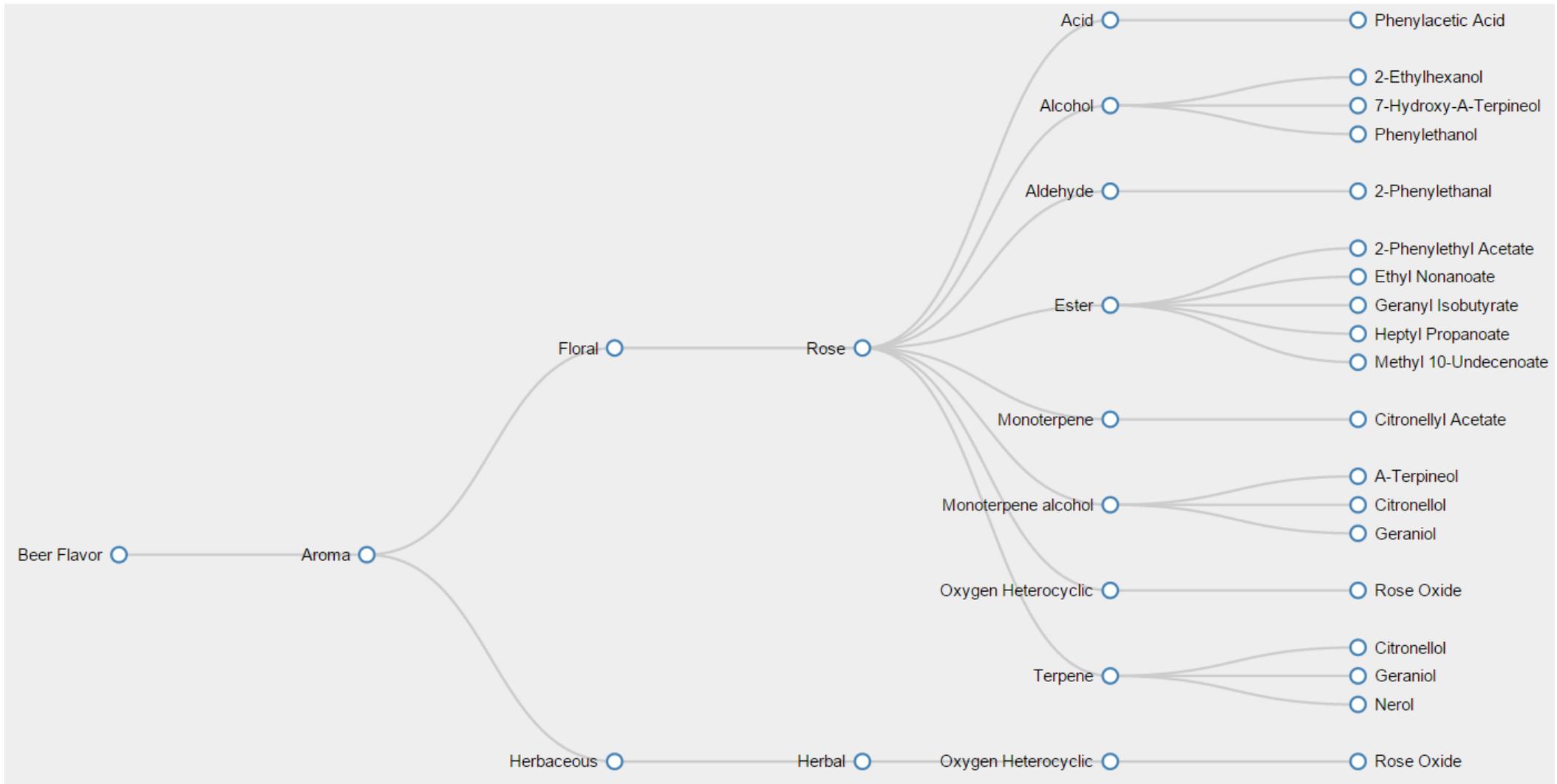
1. Sensory modality
2. General descriptor
3. Specific descriptor
4. Compound classification
5. Specific chemical compound











ASBC Flavors Database: Geraniol

Beer Flavor Compound

Chemical Name	Geraniol
Synonyms	
Structure	C ₁₀ H ₁₈ O
Molecular Weight (g/mol)	154.25
Flavor Descriptors	floral, citrus, rose-like, flowery
Conc. Minimum (mg/l)	0.001
Conc. Maximum (mg/l)	0.2
Conc. Mean (mg/l)	0.1
TH 1 (mg/l)	0.01
TH 2 (mg/l)	0.04
TH 3 (mg/l)	0.07
FU 1 (Conc. Ave./TH)	10
FU 2 (Conc. Ave./TH)	2.8
FU 3 (Conc. Ave./TH)	1.4
TH Water (mg/l)	
Formation/Description	<ul style="list-style-type: none"> •found in hops •will be partly hydrogenated to citronellol and nerol by yeast •concentration varies by time and amount of hops added and the type of hops
Compound Classification	Terpene
References	[1] , [9] , [11] , [13] , [14] , [17] , [22]
CAS Number	106-24-1

Beer Flavors References

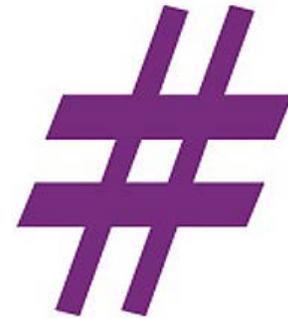
Reference Source

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ASBC Beer Flavor Model

By the numbers...

- Sensory modalities: 3
- General descriptors: >30
- Specific descriptors: ~240
- Compound classification: ~40
- Specific chemical compound: ~500





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