



Hopping into the Sunset

Charlie Bamforth

33rd Annual American Homebrewers Association®
National Homebrewers Conference

SOME *like it* **HOPPY**

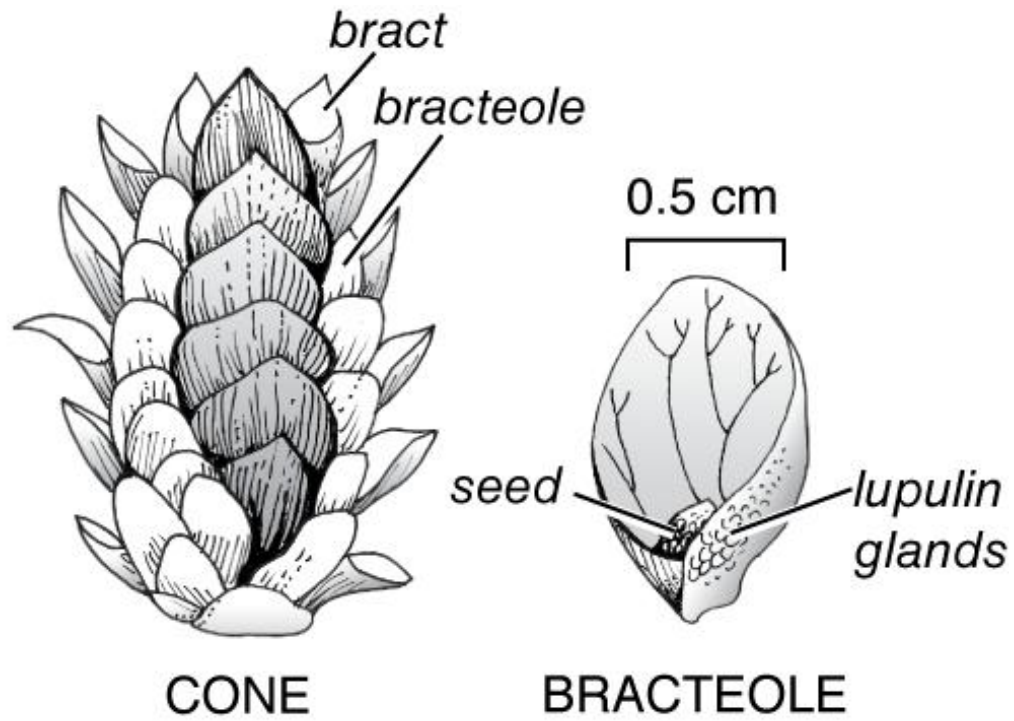
in **SAN DIEGO** **JUNE 16-18, 2011**

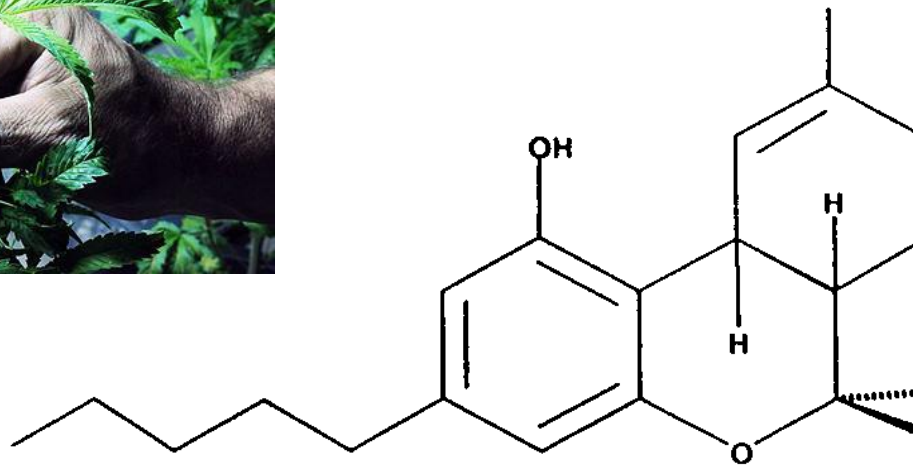
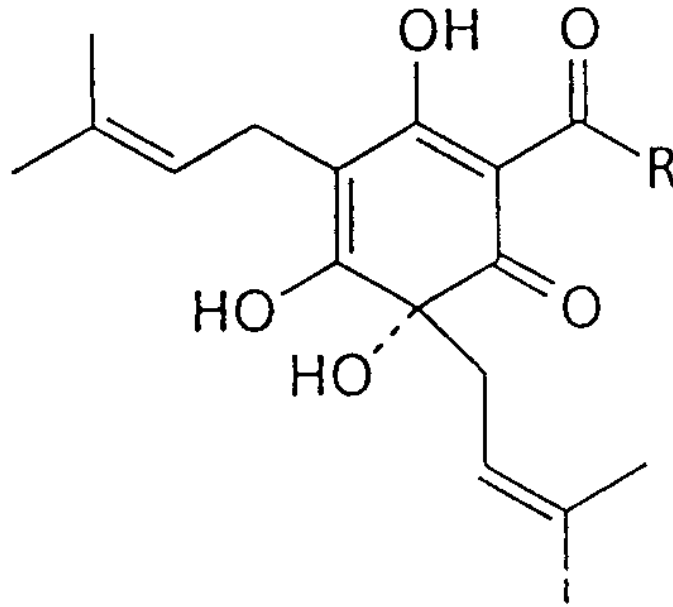
TOWN & COUNTRY RESORT **AHA.CONFERENCE.ORG**

Hops and beer quality

- Bitterness
- Aroma
- (Skunking)
- (Staling)
- Antioxidants
- Foam stability and lacing
- (Gushing)
- Anti-microbial
- Health

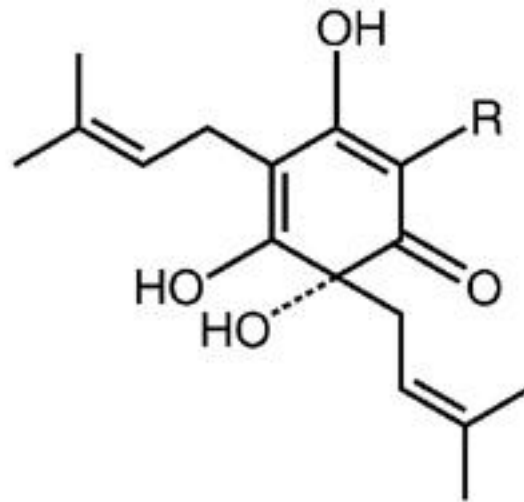






Hops and Bitterness

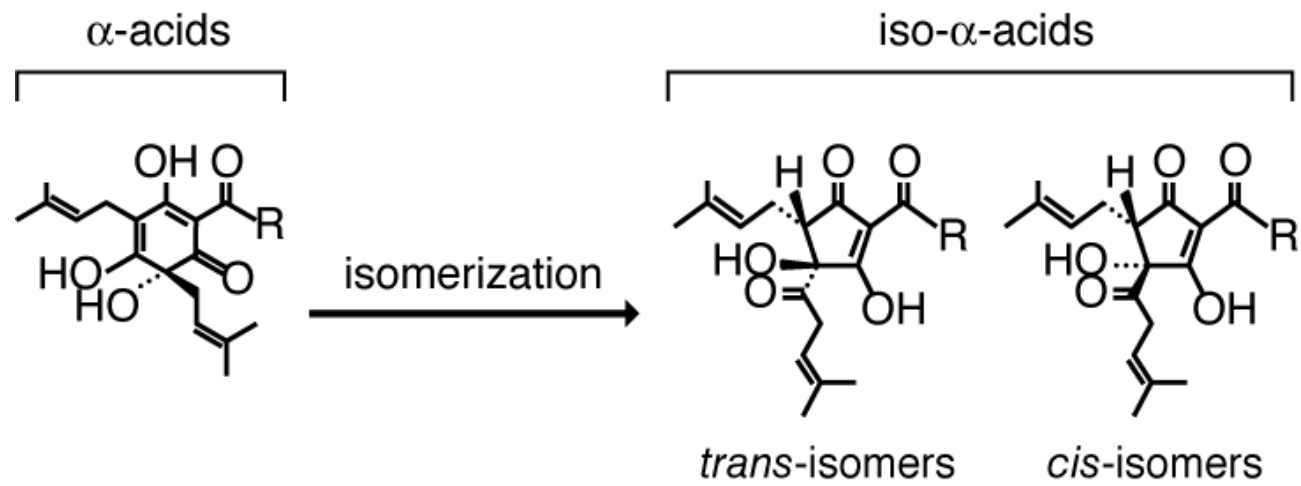




Name	Side Chain (R)
Humulone	—CO·CH ₂ ·CH(CH ₃) ₂ isovaleryl
Cohumulone	—CO·CH(CH ₃) ₂ isobutyryl
Adhumulone	—CO·CH(CH ₃)·CH ₂ ·CH ₃ 2-methylbutyryl

Typical α -acid composition (%) of selected hop varieties

Variety	cohumulone	humulone	adhumulone
Galena	36	51	13
Nugget	22	64	14
Wye Target	34	51	15



R = CH₂CH(CH₃)₂

humulone

isohumulone

R = CH(CH₃)₂

cohumulone

isocohumulone

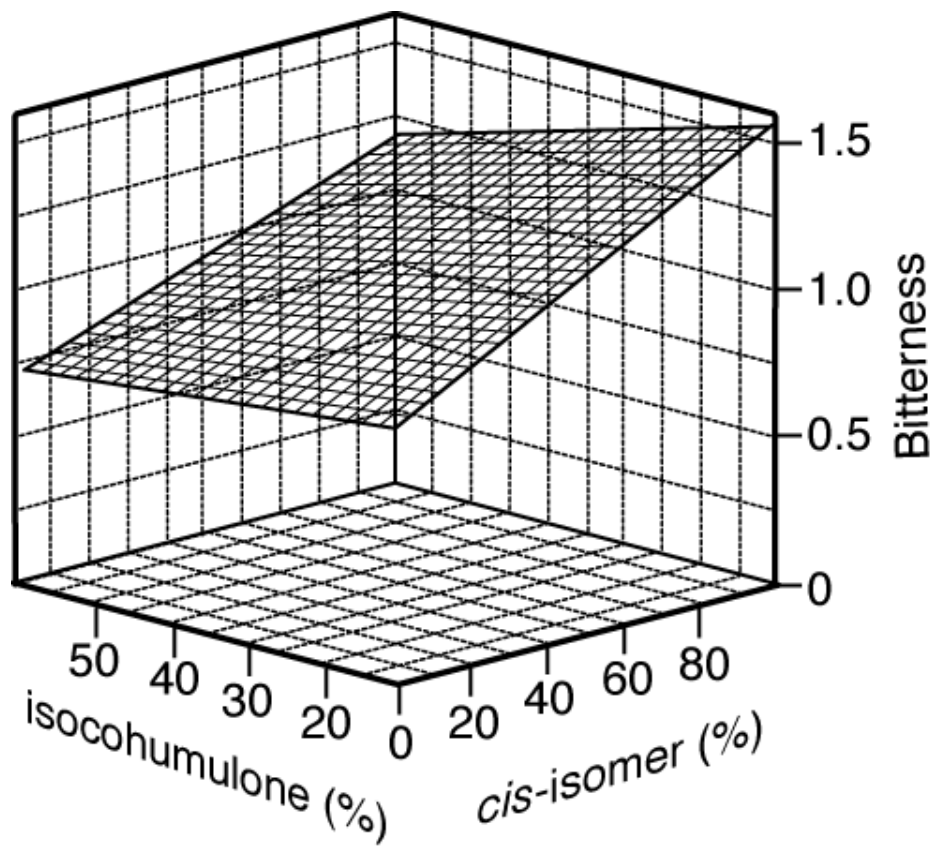
R = CH(CH₃)CH₂CH₃

adhumulone

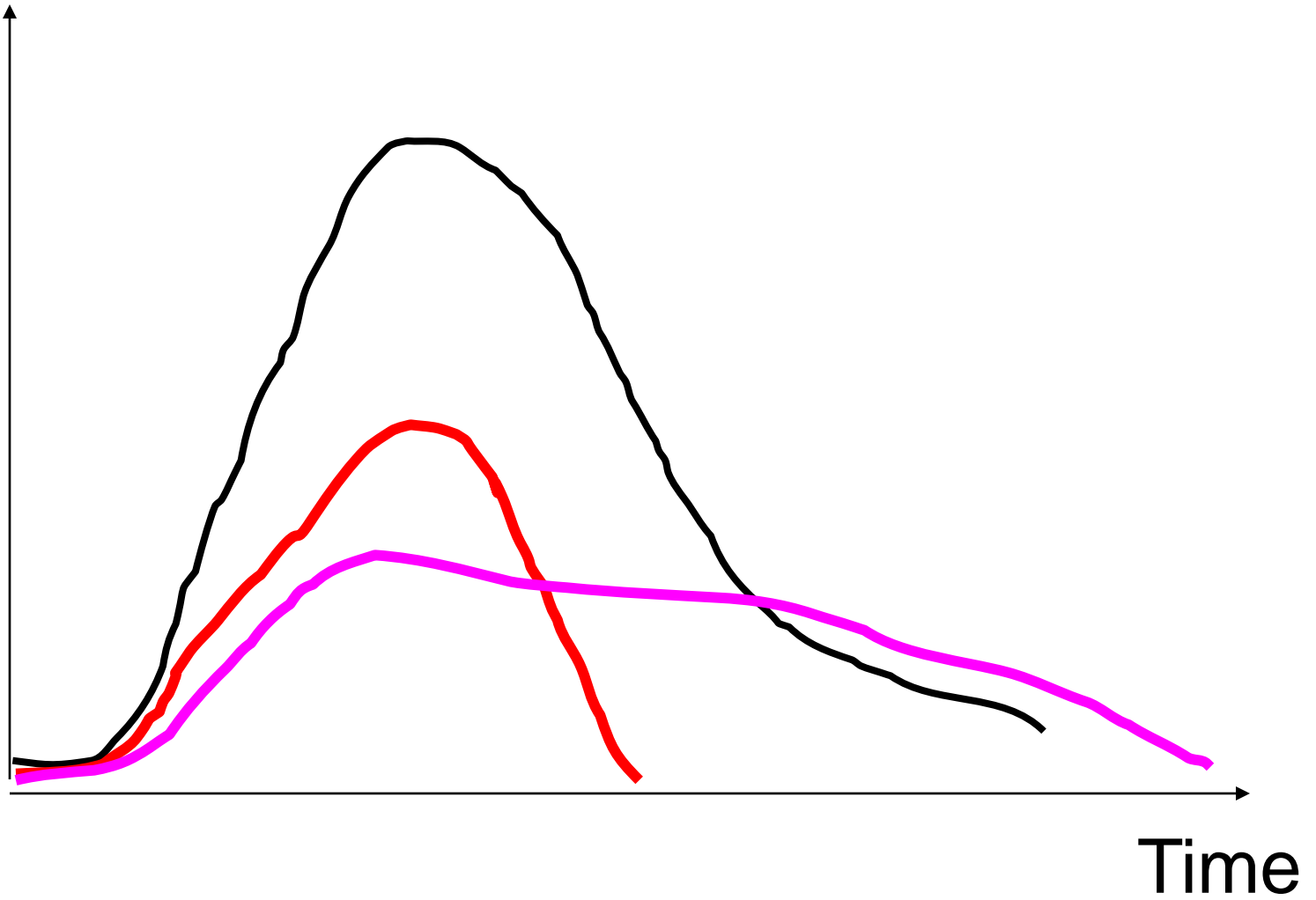
isoadhumulone

Effect of mode of isomerization on yields (%) of cis and trans isomers

Means of isomerization	cis	trans
wort boiling	68	32
aqueous alkali	55	45
MgO	80	20



Intensity of flavor



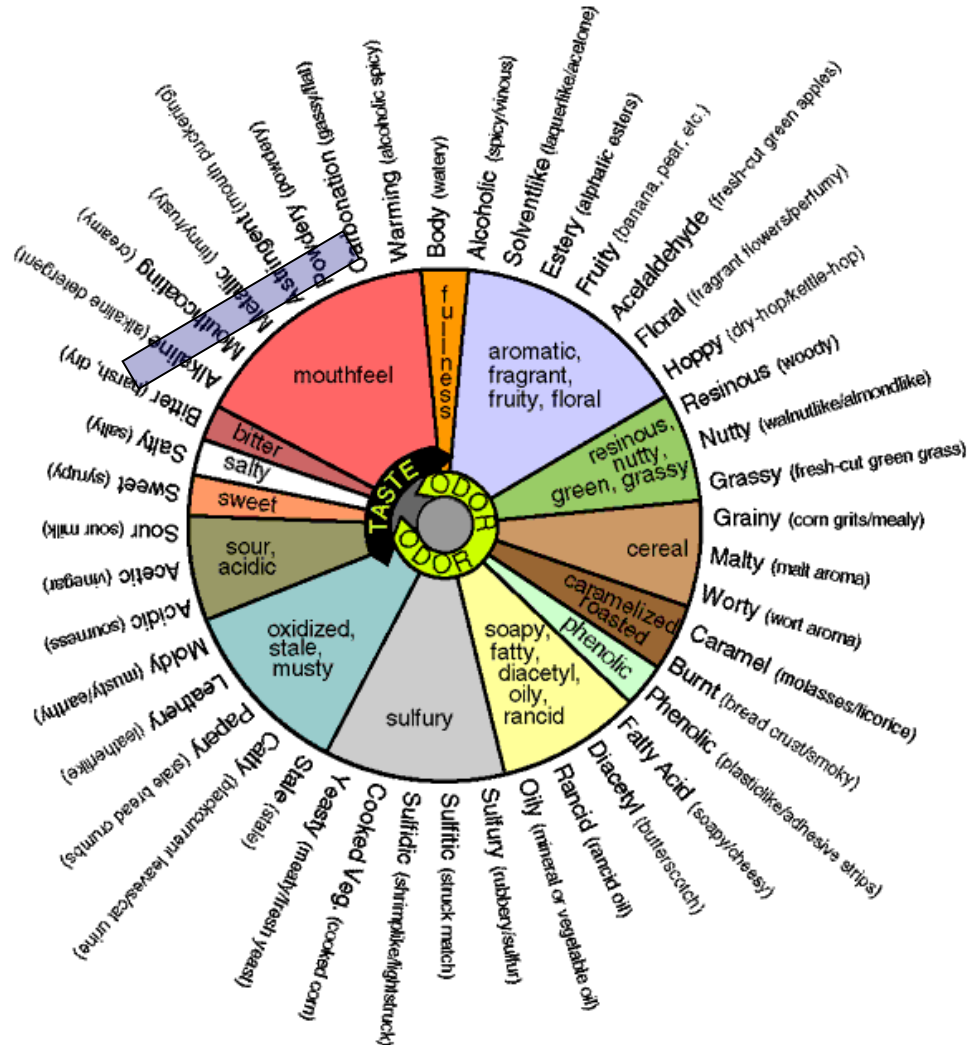
Cheesiness



Hop aroma

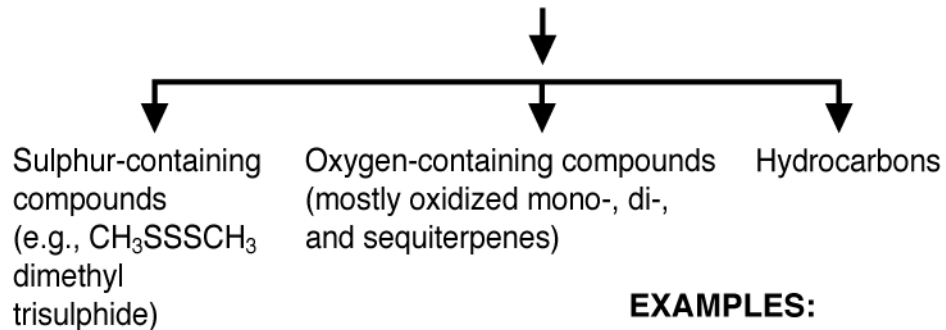


Aroma/Flavor Wheels

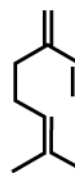
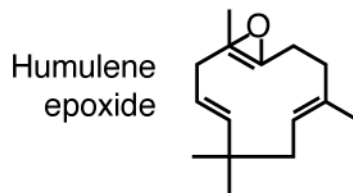


Beer Flavor wheel developed in 1970's (right), followed by the Beer Aroma wheel in 2008.

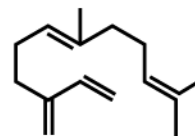
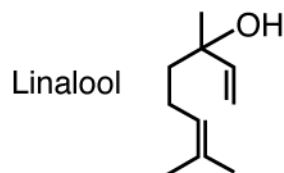
HOP OILS



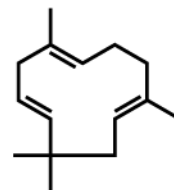
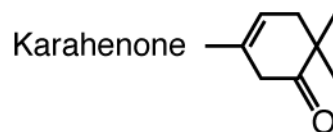
EXAMPLES:



Monoterpenes and diterpenes
(e.g., myrcene)



Sesquiterpenes
(e.g., β-farnesene)



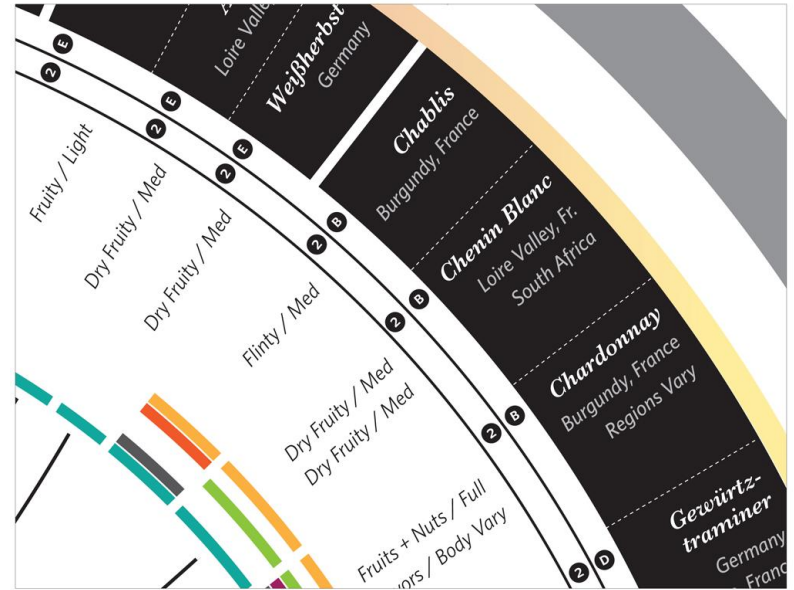
Humulene

Varietal	Characteristic of the grape
(a) white grapes	
Chardonnay	apple, pear, peach, apricot, lemon, lime, orange, tangerine, pineapple, banana, mango, guava, kiwi, acacia, hawthorn
Muscat	Terpine, coriander, peach, orange
Riesling	woodruff, rose petal, violet, apple, pear, peach, apricot,
Sauvignon Blanc	grass, weeds, lemon-grass, gooseberry, bell pepper, green olive, asparagus, capsicum, grapefruit, lime, melon, mineral, "catbox"
(b) black grapes	
Cabernet Sauvignon	black currant, blackberry, black cherry, bell pepper, asparagus (methoxy-pyrazine), green olive, ginger, green peppercorn, pimento
Merlot	currant, black cherry, plum, violet, rose, caramel, clove, bay leaf, green peppercorn, bell pepper, green olive
Pinot Noir	cherry, strawberry, raspberry, ripe tomato, violet, rose petal, saffron, rosemary, cinnamon, caraway, peppermint, rhubarb, beet, oregano, green tomato, green tea, black olive
Syrah	black currant, blackberry, grass, black pepper, licorice, clove, thyme, bay leaf, sandalwood, cedar
Zinfandel	Jammy (raspberry, blackberry, boysenberry, cranberry, black cherry), briar, licorice, nettle, cinnamon, black pepper

Hop	Aroma
Bramling Cross	Distinctive strong spicy/blackcurrant
Brewers Gold	Blackcurrant, fruity, spicy
Cascade	Flowery, citrus, grapefruit
Chinook	Spicy, piney, grapefruit
Fuggle	Delicate, minty, grassy slightly floral
Hallertau	Mild and pleasant
Hersbrucker	Mild to semi-strong, pleasant and hoppy
Millenium	Mild, herbal
Saaz	Very mild with pleasant earthy hoppy notes
Styrian Golding	Delicate, slightly spicy
Tettnang	Mild and pleasant, slightly spicy
Willamette	Mild and pleasant, slightly spicy; Delicate estery/blackcurrant/herbal

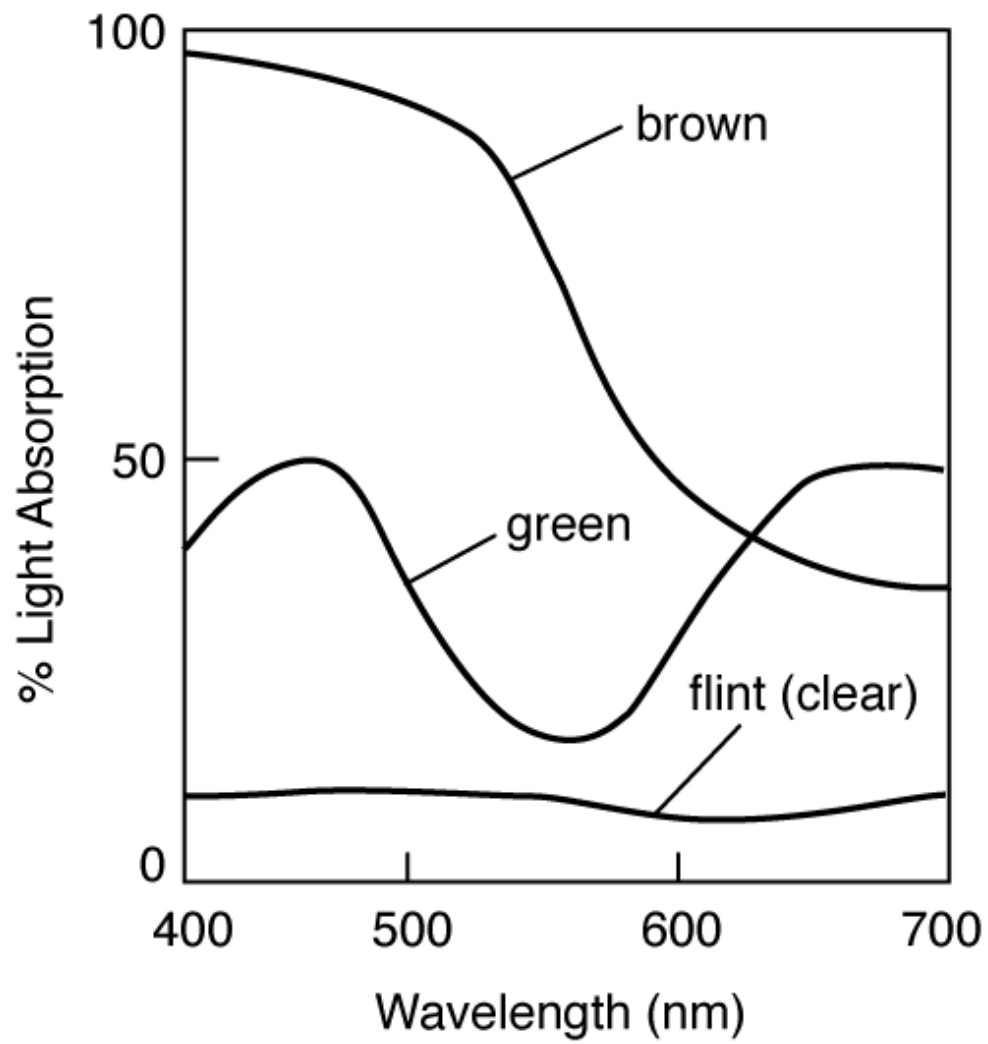
Lexicon

Fruit																	
Citrus				Tropical					Domestic								
Orange	Grapefruit	Lemon	Lime	Banana	Durian	Mango	Passion Fruit	Pineapple	Berry	Apple	Fig	Grape	Apricot	Cantaloupe			
Peel		Balm	Peel						Mild	Green		Juice	Fresh				
Juice		Zest							Tart				Dried				
									Blackberry								
Vegetable																	
Grain	Mint	Tomato	Cabbage	Pickled	Green	Carrot	Corn	Maca	Legumes	Chlorophyle	Cooked Veggies						
Barley	Wintermint	Juice	Green	Capers	Bell Pepper	Fresh		Turnip	Green Beans								
Wheat			Brussel Sprout			Cooked			Peas								
Chemical																	
Household Cleaning				Aerosol		Soap	Oil/Fuel		Medicinal			Rubber	Plastic	Play-doh	Sulphur	Metal	Splenda
Ammonia	Bleach	Chlorine	Pine-sol	Hairspray	Bug spray	Dishwashing Hand	Petroleum	Natural	Menthol	Eucalyptus	Phenol	Fresh					
							Deisel	Fish				Burnt					
							Kerosine										
							Gasoline										
Herbs and Spices																	
Mint Family		Laurel Family	Parsley Family	Cabbage Family		Myrtle Family		Orchid Family		Ginger Family		Pepper Family		Onion Family			
Basil		Bay Leaf	Cumin	Mustard		Allspice		Vanilla		Ginger		Black Pepper		Onion			
Oregano		Cinnamon	Dill			Clove				Cardamom		Red Pepper Flake		Garlic			
Rosemary			Coriander														
Sage																	
Thyme																	
Herb Families found at: http://aidanbrooksspices.blogspot.com/2007/10/botanical-families-of-spice.html																	
Outdoors																	
Wood			Floral		Earth		Plants										
Cedar	Pine	Wood	Flowers	Scents	Ground	Earthy	Clover	Grass	Hay	Leaf							
	Resin	Dry Wood	Lavendar	Linalool	Clay	Mold		Cut	Dry	Dry							
	Needles	Wet Wood	Rose	Spring Flower	Compost	Must		Dry	Wet	Wet							
			Violet	Dry Flower	Dirt	Wet Mineral		Wet									
				Old Flower	Dust	Musk											
				Pollen	Wet Soil	ceramic											
Other Aromas																	
Tea	Cheese	Smoke	Off-Aromas	Salty	Baked goods	Animal	Sweet/Spicy										
Black Tea	Blue Cheese	Ash	Cardboard	Soy Sauce	Cereal Bar	Dry Cat Food	Honey										
Camellia Tea	Funky Cheese	Burnt Cookies	Oxidized Wine	Miso Soup	Fresh Bread	Leathery	Licorice										
Chamomile	Parmesan Chees	Old Cigars	Rancid Butter	Thai Noodle Soup	Stale Bread	Meaty	Vermouth										
Green Tea	Sour Milk	Roast	Sweaty Socks	Baccala (salt cod)	Candy Sugar												
Mate			Urine		Butter												
Sweet Tea			Skunky														
			Sharp/Vinegar														
			Cat Urine														
			Lactic														

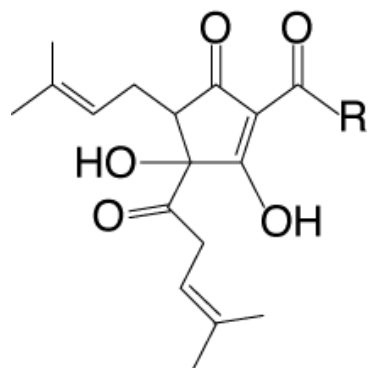


Skunking

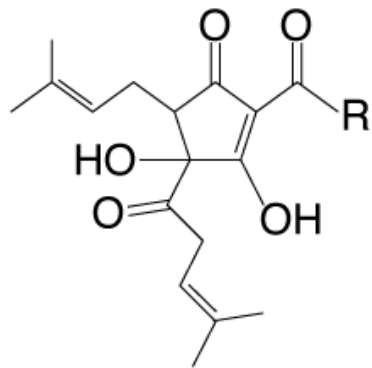




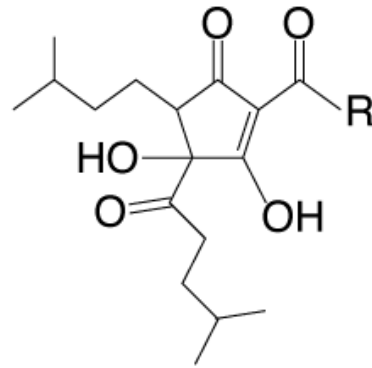
A



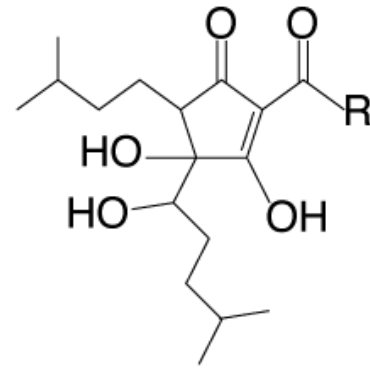
B



C



D

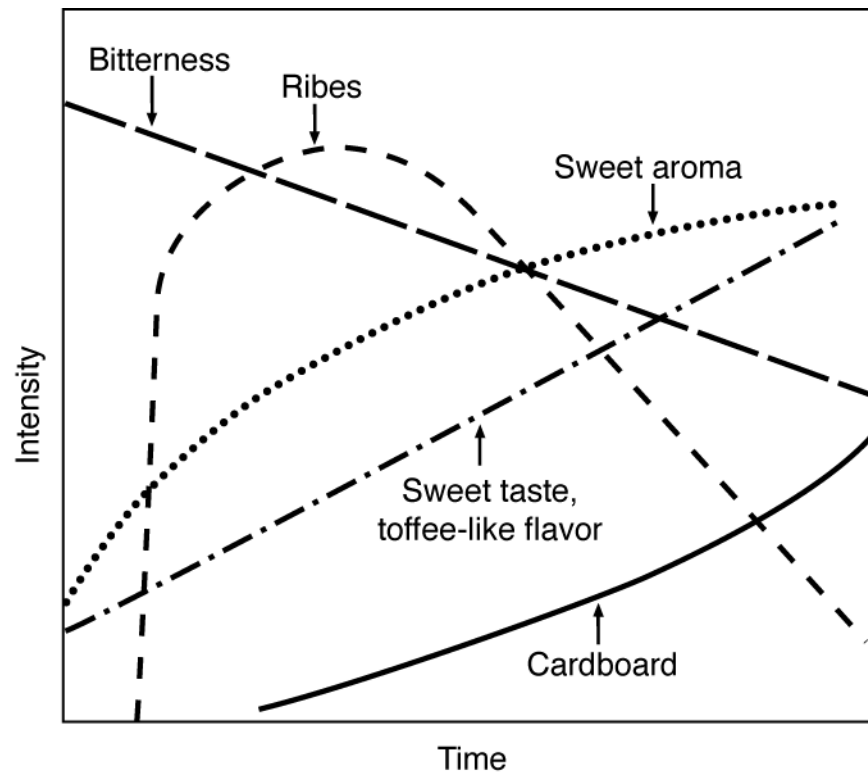


rho

tetra

hexa

Hops and staling

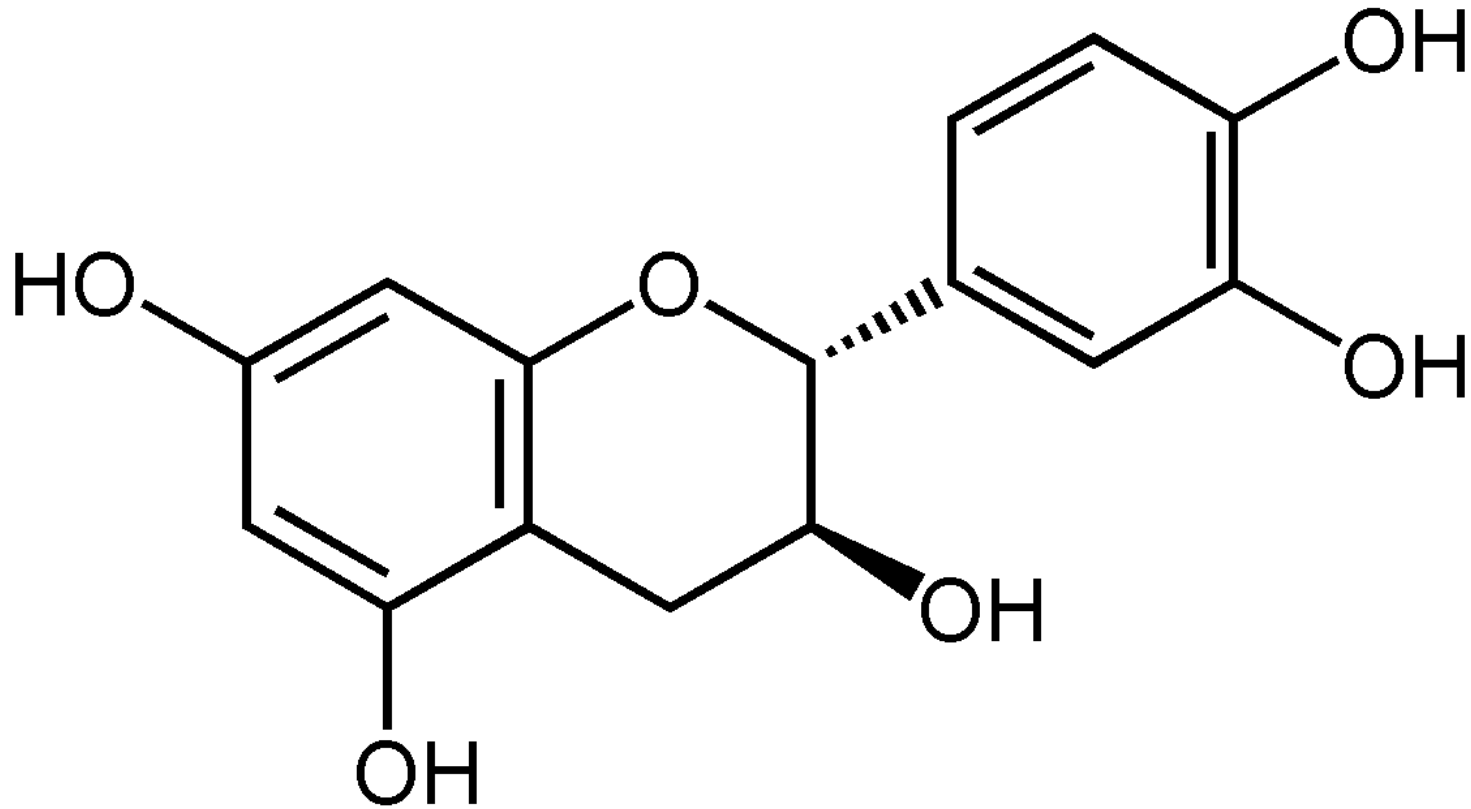




The *trans* isomers are more prone to degradation than are the *cis* isomers

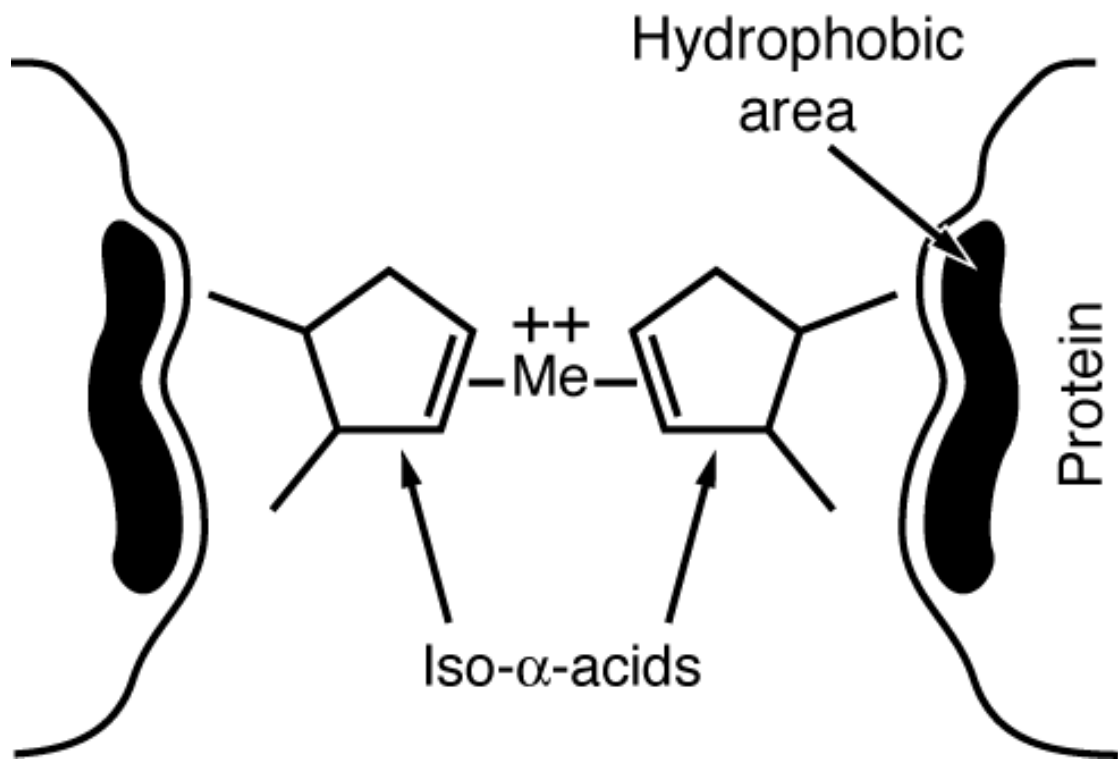
Reduced side-chain iso- α -acids do not give staling carbonyls

Hops as antioxidants



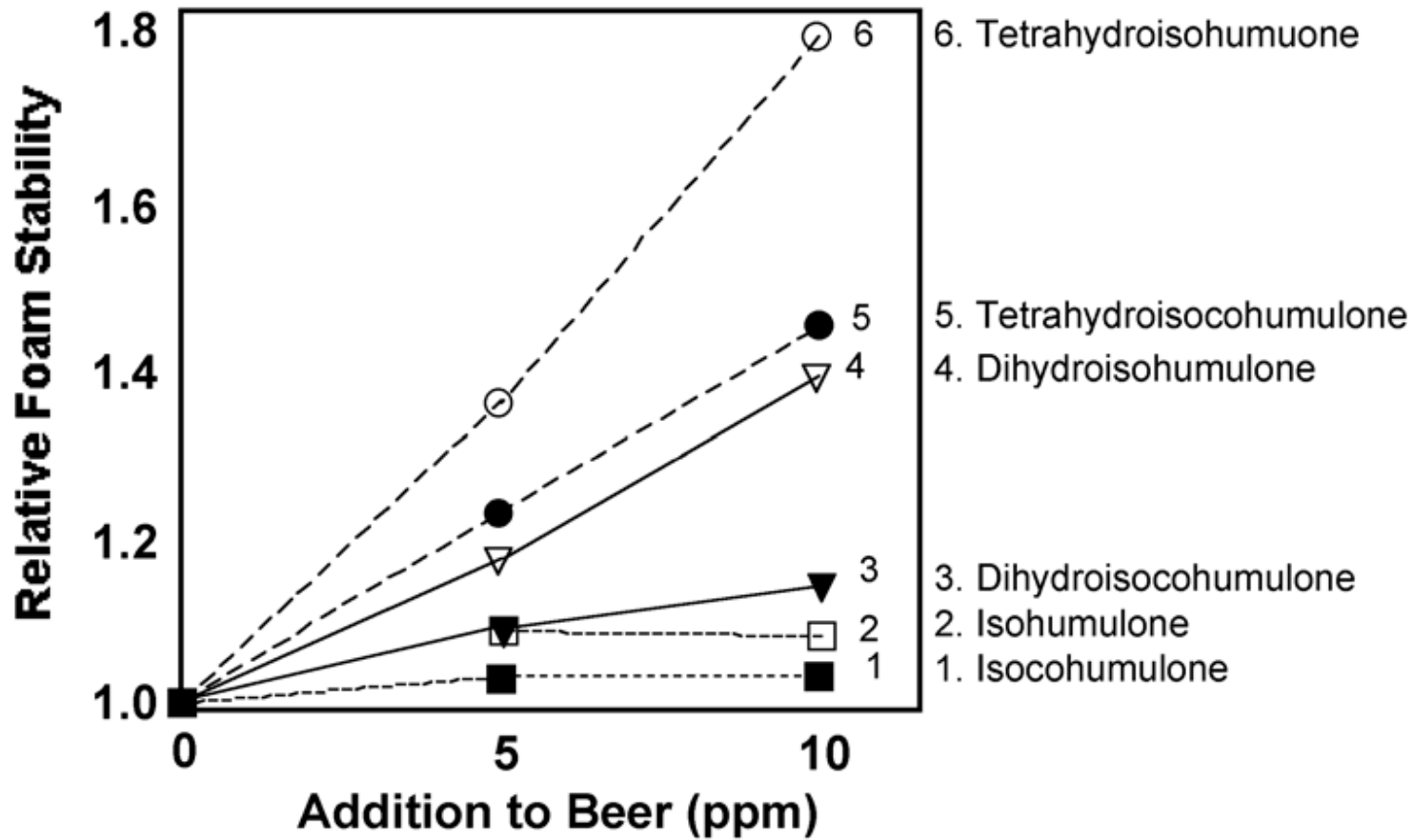
Hops and foam





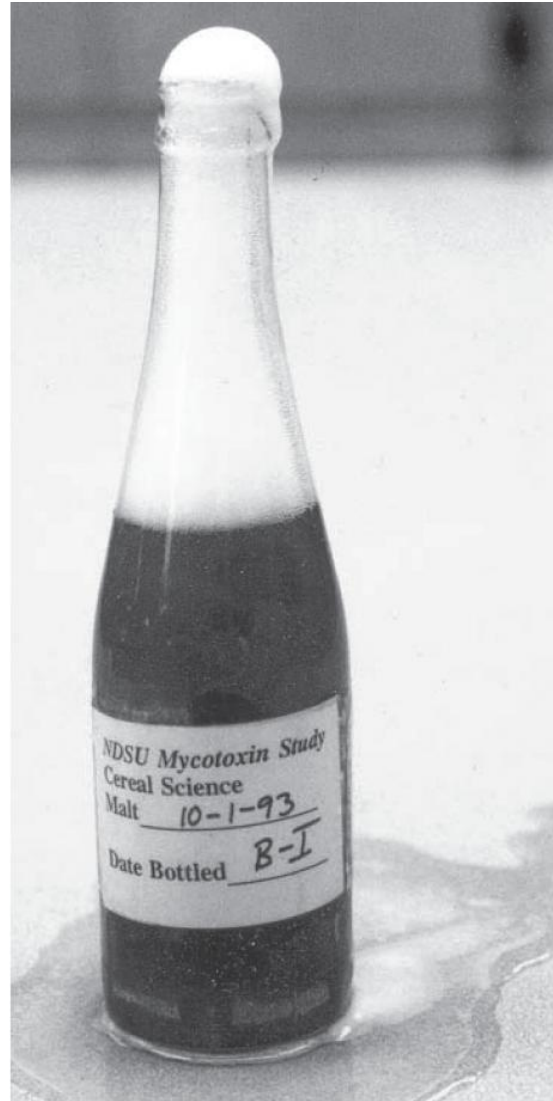
The *trans* isomers concentrate in foam to a greater extent than the *cis* isomers, with especial concentration of the *trans* isomers of isohumulone and isoadhumulone







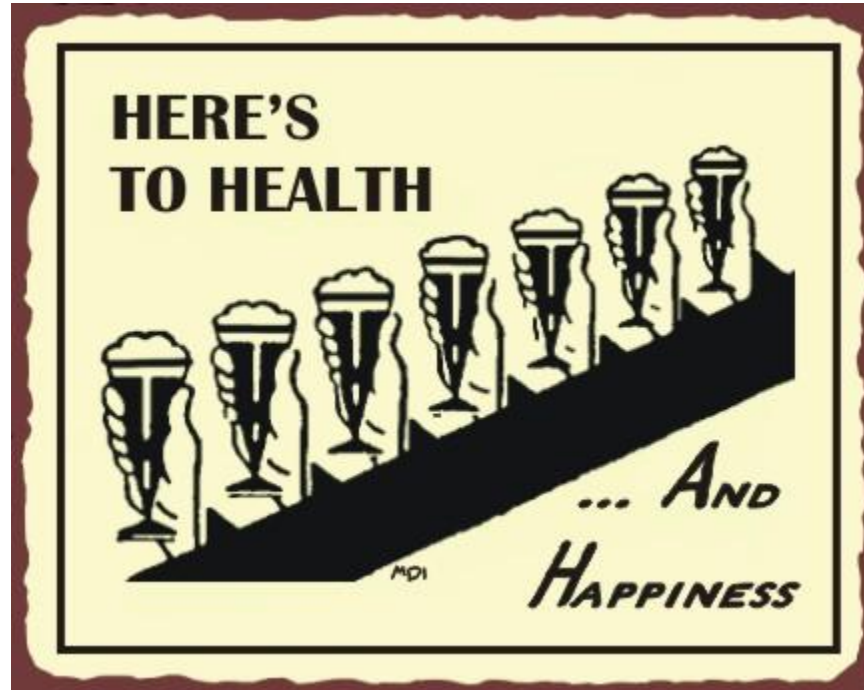
Hops and gushing



Antimicrobial properties of hops

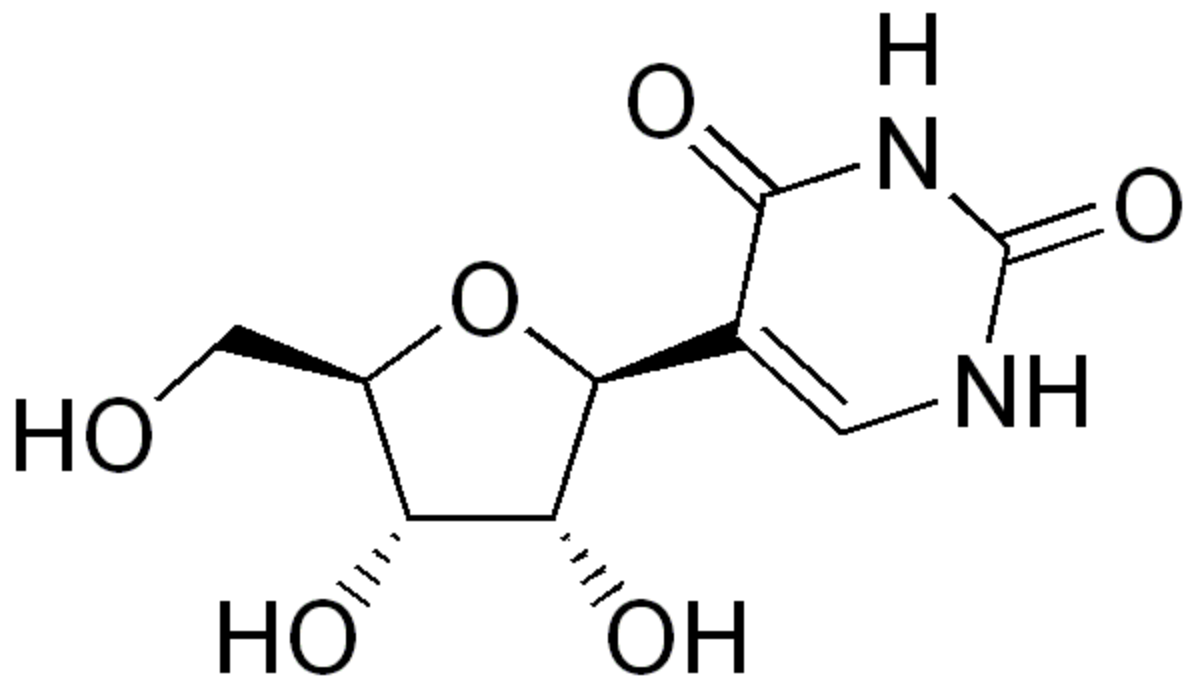


Hops and health

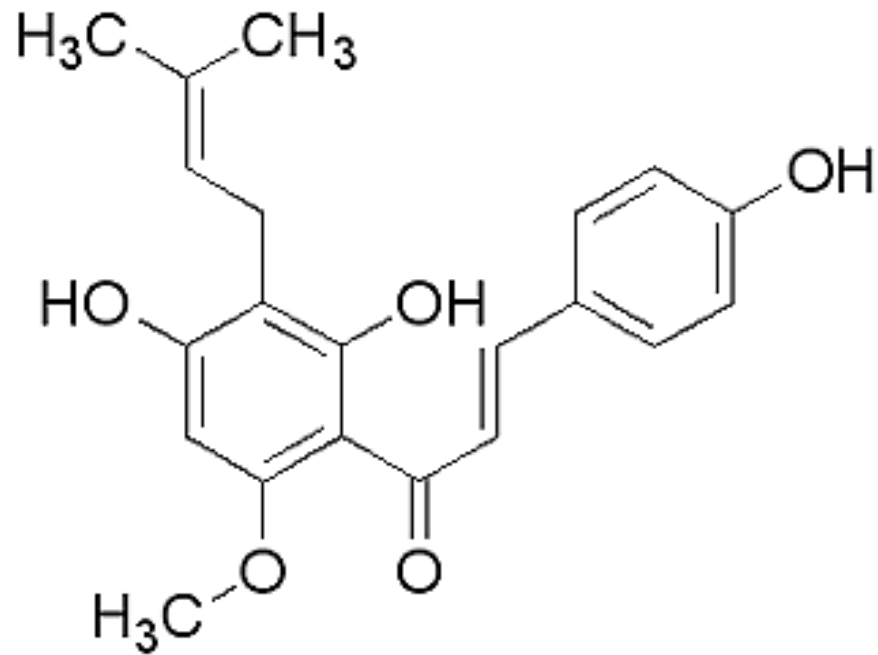




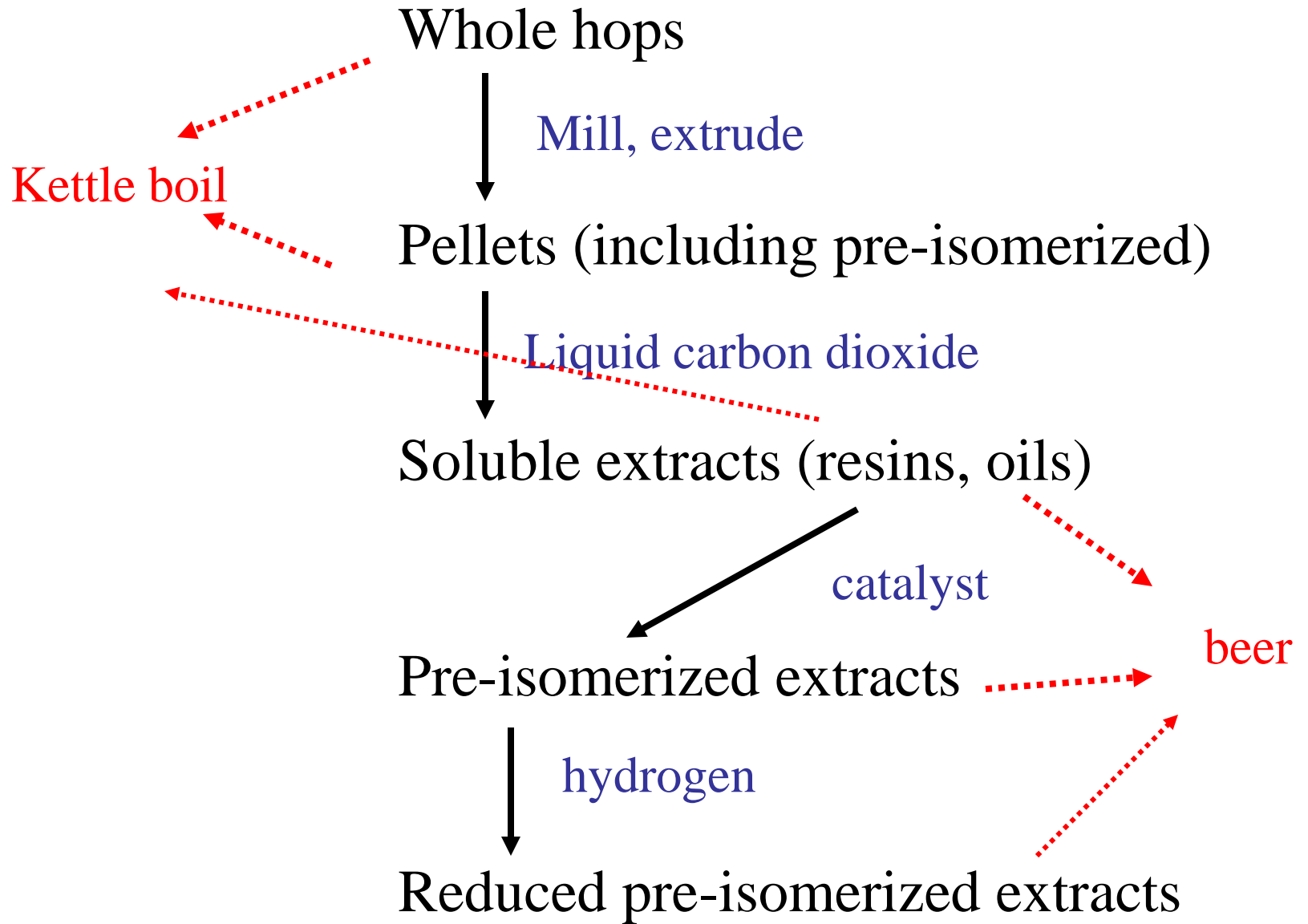
Pseudouridine



Xanthohumol



Hop preparations



Is the price of hops fair?



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