

The Bitter Truth about Beer Flavor Development

The National Association of Flavors and Food-Ingredient Systems (NAFFS) examines the contribution of hops and other extracts in creating unique flavor profiles.

The difference between tasting and drinking is thinking, said Polly Barrett, director of flavors R&D and applied technology at Kalsec. During her presentation to NAFFS (www.naffs.org) attendees at the Dog & Cask restaurant in New Jersey, Barrett outlined how flavor complexity is achieved in today's diverse beer market.

Complex Flavor

The character of hops is a crucial element to the flavor of beers, Barrett explained, providing desired bitterness and lingering impression, as well as notes such as woody, grapefruit, linalool and geraniol.

This character is a core piece of a flavor matrix of yeast-derived (ex: diacetyl, isoamyl acetate and ethyl hexanoate), grain-derived (ex: bitterness and maltiness, smoky, vanilla, chocolate and caramel), off note (butyric, catty, "light-struck," etc.), mouthfeel (astringency, metallic, tingling, numbing, etc.) and aging (acetaldehyde, papery, almond, etc.) characteristics. Other aromatic components include:

- Hexoses for sweetness and flavor potentiation
- Dextrins for smoothness, body and sweetness
- Carbonic acid for tingling and acidity
- Sulfates for drier bitter potentiation
- Lactic, pyruvic, malic, succinic, fatty, caprylic, capric and isovaleric acids for cheesy and sweaty-goaty facets
- Phenolic substances like vanillin and catechin
- 4-Vinylguaicol, which offers a clove impression
- β -Ionone for berrylike notes
- β -Damascenone for tobacco character
- Dimethyl sulfide for sweet corn
- Hydrogen sulfide for rotten egg
- 3-Methyl-2-butene-1-thiol for skunky character at ppt levels
- Ethyl hexanoate for red apple and anise impressions
- Isobutyl isobutyrate for pineapple and grape

Other key aromatic ingredients include acetaldehyde, *trans*-2-nonenal, benzaldehyde, diacetyl, 2,3-pentanedione, β -ionone and β -damascenone.

Higher gravity brewing produces more esters and more flavor, said Kalsec hops fellow Mike Babb. Hop compounds can add geranyl acetate, limonene and many other components to the beer. Hop oil can be combined with extracts to achieve more complexity and raspberry-citrus notes.



Meanwhile, the use of casks or exposure to wood chips can change character post-brewing.

To demonstrate how various extracts and aromatic chemicals could be applied to change the character of beer, Barrett and Babb presented a range of demos on a base of a leading American light beer. A with-linalool sample dosed at 8 ppm was subtle enough that not all attendees were able to pick up the aroma or flavor. There was an isoamyl acetate sample that imparted an interesting banana note. The with-epoxides sample delivered waxy, cedar and woody elements. A sample containing 20 ppb isolone, a hop acid, had a clean, bitter, almost metallic taste that was not overly aromatic.

Babb also presented a range of beers to show the differences in profiles. An old ale had notes of caramel, hay, leather, wood,



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raisin and malt. A doppelbock, which is cold-fermented, had deep caramel and almost burnt notes, along with raisin notes and sweetness. An American pale ale had a grapefruit character and floral component. Finally, a Trappist beer had notes of plum, cherry, raspberry, banana and bubblegum, and featured 9.8% alcohol.

Bitter Impact

The impact of hops and hops extracts in beer is measured by IBU (international bitterness units), said Barrett. Today, many new launches are heavily hopped, with brands, particularly microbrews, trying to outdo one another on IBUs. This escalation is a boon to hop oil suppliers as there are limits to what hops alone can accomplish.

As Barrett said, “We sell bitterness.”

Since bitterness is difficult to measure and time is crucial to flavor, it is important for formulators to accurately measure IBUs. IBUs are measured using spectrophotometric measurements such as HPLC for isomerized alpha acid, in addition to trained bitterness tasting panels. Aside from contributing bitterness, hop products can impart foam enhancement and light stability in beers. They can also add an element of realism in non-alcoholic formulations. The extracts can be added at the fermentation stage or post-fermentation as add-ins.

Beer Boom

Latin America and Asia represent significant growth markets for beer, said Babb, with future growth anticipated in India and Africa. Today, China is the leading market for beer, despite that its per capita consumption is low.

The market has been marked by significant consolidation, rendering American brewer Anheuser-Busch as a global leader. Independent brewers now number more than 2,700 in the

United States, compared to 1,200 brew pubs, 120 regional craft brewers and 24 large brewers. Another 1,500 brew pubs are in planning, which will help grow craft brewers’ market share, which currently stands at 7%, and expanding at 15%/year.

Customers are seeking consistency, cost controls and efficiency in their brewing practices. While lighter beers appeal to more consumers, mainstream brewers are beginning to recognize the value and appeal of flavorful beers. Top brewers are slowly duplicating some of the facets of more experimental brands, launching products that hide their ties to the parent corporation. For many beer drinkers, a sense of small-scale brewing is preferable.

Craft brewing is focused on in-your-face aroma and flavor, Babb explained. That market segment is highly experimental and seasonal and almost exclusively interested in whole hops, fruits, spices and other naturals. Craft brewers try to fit their processes into their own personal concept of natural, which puts a premium on formulating as close to the original grain, hops, spices and other ingredients as possible with a minimum of processing. Ironically, these brewers tend to view natural extracts as “cheating,” the antithesis of true brewing. Small brewers tend to source locally and don’t want a mass-produced feel to products. Their consumers are similarly finicky and have an almost cultish affinity for specific craft brews.

Craft brewers use 10 times the amount of hops as typical U.S. light lagers. Each brand is pushing the envelope for bitterness, trying to outdo one another. Interestingly, said Babb, as people get accustomed to escalating bitterness, consumers’ ability to detect and prefer more bitterness increases. What the ceiling could be for IBUs in beer, Babb couldn’t say.

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