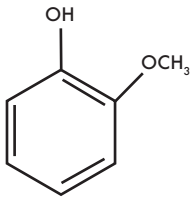
BEER OFF FLAVOR:
HOP SMOKE TAINT



Volatile phenols (VPs) from wildfire smoke are potent aroma compounds with relatively low sensory thresholds that contribute smoky, meaty, medicinal, and other smoke-related characteristics to food and beverages. Hops exposed to wildfire smoke may contain VPs that can transfer to beer, potentially resulting in smoke-related off-flavors or muted hop aromas depending on the intensity and duration of the smoke exposure. While research regarding smoke off-flavor in hops and beer is currently underway, it is still limited at the time of writing.

HOW DOES SMOKE SMELL OR TASTE?

Sensorial attributes associated with the smoke off-flavor may include: smoky, campfire, ashy, burnt, acrid, savory, soy sauce, umami, meaty, beef jerky, artificial BBQ, vanilla, medicinal, chemical, antiseptic, and Band-Aid®, among others. Many of these aromas come from VPs such as guaiacol, above, as well as 4-methylguaiacol, *o*-cresol, *p*-cresol, *m*-cresol, syringol, and 4-methylsyringol. However, the sensorial impacts of these compounds vary considerably depending on the fuel source, length of smoke exposure time, and concentration of each compound in the beer or raw material.

For example, beers with high levels of guaiacol and 4-methylguaiacol might smell smoky or like vanilla while beers high in cresols might smell more medicinal or chemical. Further complicating the issue, low concentrations of VPs may not reach the sensory threshold to be perceived as smoky but might mask the typical flavor characteristics of the beer or raw material, dampening citrus and overall hop aroma intensity, for example. Other as-yet-unidentified compounds might also contribute to the hop smoke off-flavor in beer.

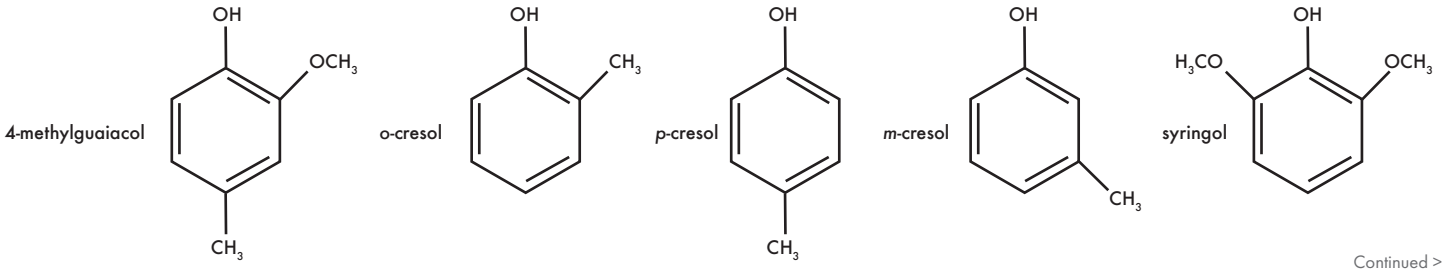
HOW IS SMOKE MEASURED?

The simplest way to assess smoke off-flavor is through sensory evaluation of the beer or raw material. The American Society of Brewing Chemists (ASBC) is currently drafting Sensory Analysis 20 – Hop Smoke Taint, which will provide a guide for assessing smoke taint in hops upon receipt or possibly during selection. In brief, hops are added to water to form a slurry, which is then incubated for 24 hours and then smelled by a panel. ASBC Sensory Analysis 15 and 16 also offer methods for analyzing hops via hop teas and hop grinds, respectively. Upon receipt, hop lots should be assessed to ensure they meet the brewer's desired aroma traits.

HOW IS HOP SMOKE TAINT PRODUCED IN BEER?

When plant material is burned, VPs are released into the air, which then travel miles from the fire and may be deposited on hops in hopyards or during kiln drying. Using smoke-affected hops during dry-hopping has been shown to transfer smoke-related characteristics to beer. Anecdotally, some brewers have observed that using smoke-affected hops during boiling for bittering additions did not result in noticeable smoky characteristics in the final beer. Using hops during wort separation or during fermentation, such as during mid-fermentation dry-hopping, may result in smoky beer, though no publicly available studies have been conducted in this area. Brewers have also indicated success blending small amounts of smoky hops (50% or less) with clean lots to mitigate the transference of smoke aromas.

Additionally, glycosylated phenols (GPs) have been identified by the wine industry as another class of compounds associated with smoke taint. GPs are precursor forms of VPs bound to a sugar like glucose. During wine fermentation and subsequent aging, VPs are released from the sugar, whether through enzyme-assisted or acid hydrolysis, becoming aromatic and contributing to smoke off-flavor in wine. Anecdotally, when using smoky hops in contact with yeast, brewers have noticed that yeast strain may play a role in the final smoke off-flavor intensity of the beer. This indicates that GPs might also be a source of smoke off-flavor in beer, though there is currently no published research in this area.



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WHEN DOES SMOKE BECOME AN OFF FLAVOR?

When smoke becomes perceptible and detracts from the intended aromatic profile of the beer, smoke becomes an off-flavor. Smoke off-flavor may present directly as smoky, medicinal, or meaty, or it may present indirectly by dampening other aromas like citrus and overall hop intensity. In beer styles like Rauchbier, smoke beer, smoke porter, Grodziskie, and some Scottish-style ales, smoke would not be considered an off-flavor, but rather a key feature of the style.

HOW IS HOP SMOKE TAINT CONTROLLED IN THE BREWERY?

The best way to control hop smoke taint character is to avoid using hops with smoky attributes. Regularly conduct sensory evaluations of the beer and raw ingredients, including during aging since VPs may continue to release from GPs during storage.

As mentioned above, some brewers have observed that using smoke-affected hops during boiling as bittering additions did not result in noticeable smoky characteristics in the final beer. If hops smell smoky, then consider substituting the hops with a different lot or variety.

Do:

- ❏ Use hops that have minimal smoke qualities.
- ❏ Smell hops before dry-hopping to assess smoke character.
- ❏ If possible, have volatile phenol and glycosylated phenol concentrations measured by a lab.
- ❏ Assess beers for smoke off-flavor before releasing and during storage.

Avoid:

- ❏ Hops exposed to high levels of smoke during harvest or kilning.
- ❏ Hops that smell smoky or muted.
- ❏ Dry-hopping with smoke-affected hops, though smoke-affected hops might be useable during boiling as bittering additions or when blended with clean lots.

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