Flavor Bites: *cis*-3-Hexenoic Acid

Application in berry, fruit and other flavors

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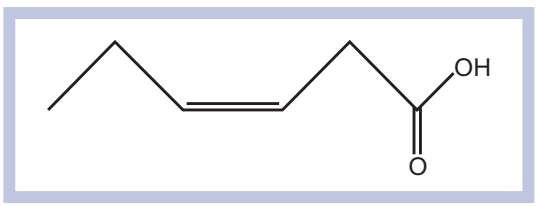
Even the most popular raw materials are likely to emit a repulsive odor if smelled in their undiluted form, and *cis*-3-hexenoic acid (FEMA# 4493), with its unattractive miasma of stale sweat, is no exception. Intuitively, this raw material shows no visible flavor connections; the most natural reaction by flavorists, thus, would be to keep this ingredient out of sight and out of mind.

Although *cis*-3-Hexenoic acid has no real antecedents, flavorists have been exploring the potential of similar simple aliphatic acids, such as butyric acid (FEMA# 2221) and hexanoic acid (FEMA# 2559), for many years. As such, these ingredients were being used in dairy flavors and even in non-dairy flavors, especially strawberry, where upon dilution the cheesy note possesses a useful, but barely detectable secondary character, and adds a little depth and realism to the flavor. However, a subtle cheesy note is one thing, the rank odor of old and uncared for undergarments, another. Nevertheless, as *cis*-3-Hexenoic acid has been widely found in nature (including fruits) it was clearly worth a few experiments. And to one's surprise, it exhibited a much stronger influence and helped create a fresher, more natural-tasting effect, than that produced by butyric or hexanoic acid.

There are several unsaturated aliphatic acids to be considered in conjunction with *cis*-3-hexenoic acid in flavor creation. *trans*-3-Hexenoic acid (FEMA# 3170), for instance, has a similar odor but is harsher, less green and notably less attractive. In fact, the two acids can be used interchangeably to some degree, but *cis*-3-hexenoic acid is the most preferred choice. *trans*-2-Hexenoic acid (FEMA# 3169) is even more sweaty, but surprisingly, almost equally useful. It is especially good in apple and tea flavors. 2-Methyl 2-pentenoic acid (FEMA# 3195) and 2,4-dimethyl 2-pentenoic acid (FEMA# 3143), on the other hand, are less sweaty and more reminiscent of cheese; yet again, they are valuable components of strawberry flavors. 2-Methyl 4-pentenoic acid (FEMA# 3511) is less sweaty, has a pungent character of rotten cheese, and is useful in cheese and tropical fruit flavors. 2-Methyl 3-pentenoic acid (FEMA# 3464) is cheesy, but can work well in cranberry flavors; 4-Pentenoic acid (FEMA# 2843) is reminiscent of rind washed cheeses such as Reblochon; and 2-pentenoic acid (FEMA# 4193) has a buttery, cheesy note that works well in strawberry flavors.



Berry Flavors

Strawberry: *cis*-3-Hexenoic acid adds depth, realism and a hint of green character to strawberry flavors. But it also adds a degree of freshness and ripeness. Starting levels of this material can be as low as 20 ppm in a flavor intended for use at 0.05% in ready-to-drink beverages; at this concentration the effect is real but very subtle. Although a more typical use level would be around 500 ppm, levels as high as 3,000 ppm can be used to give a slightly over-ripe effect. *cis*-3-Hexenoic acid can also be used in combination with 2-methyl 2-pentenoic acid to give an added level of ripeness.

Raspberry: In raspberry flavors, *cis*-3-hexenoic acid is far and away the best option from the group of unsaturated aliphatic acids. As in strawberry flavors, the use levels are variable, but marginally lower—10 ppm gives a subtle effect, 300 ppm is a typical use level and 2,000 ppm is the highest level that could be used, without descending the flavor into charicature.

Blackberry: Blackberry flavors benefit from the use of *cis*-3-hexenoic acid in a way similar to raspberry flavors. A typical level is 200 ppm, but higher levels can also add interesting effects.

Cranberry: A good starting level is around 500 ppm, but in these flavors, *cis*-3-hexenoic acid should ideally be used in conjunction with 2-methyl 3-pentenoic acid.

Other Fruit Flavors

Apple: Although *trans*-2-hexenoic acid is very effective in apple flavors, *cis*-3-hexenoic acid is an interesting alternative. It can be used either alone or in combination with *trans*-2-hexenoic acid to give a slightly fresher, less cooked effect, than that obtained from *trans*-2-hexenoic acid alone. Again, use levels vary with application, but 300 ppm is typical in a fresh apple flavor and more than 1,000 ppm can be used in apple juice flavors.

Pear: The effect of *cis*-3-hexenoic acid in pear flavors is similar to that in apple flavors and a typical use level is around 300 ppm.

Peach: *cis*-3-Hexenoic acid has a noticeable effect in peach flavors, adding juiciness and depth. Additions should be in the range of 100–200 ppm.

Apricot: Apricot flavors can also benefit from additions of *cis*-3-hexenoic acid with recommended use levels between 100 and 200 ppm.

Melon: As melon flavors are likely to be thin, around 30 ppm of *cis*-3-hexenoic acid can add depth to it.

Papaya: Around 100 ppm of this raw material adds authenticity to this flavor.

Grape: *cis*-3-Hexenoic acid adds realism to grape flavors and can be used at levels ranging from around 20 ppm in subtle white grape flavors, to around 200 ppm in Concorde grape flavors.

Kiwi: Kiwi is a subtle flavor, and an effective level of *cis*-3-hexenoic acid in its formulation is around 50 ppm.

Mango: Around 10 ppm of *cis*-3-hexenoic acid adds some depth and juiciness to mango flavors.

Passion Fruit: Passion fruit flavors can benefit from additions of 200–800 ppm of *cis*-3-hexenoic acid.

Pomegranate: Pomegranate flavors are becoming increasingly popular, and *cis*-3-hexenoic acid can be a significant part of the profile at around 1,000 ppm.

Cherry: Relatively high levels of *cis*-3-hexenoic acid, starting at around 1,000 ppm, can be used in cherry flavors.

Other Flavor Types

Tomato: Fresh tomato flavors can be enhanced by adding around 50 ppm of *cis*-3-hexenoic acid. Likewise, flavors that incorporate an element of processing (such as tomato juice) can accommodate up to 200 ppm of the raw material.

Tea: Realistic tea flavors are difficult to create. Both *trans*-2-hexenoic acid and *cis*-3-hexenoic acid can play an important part in the profile, alone or in combination. Combined levels of use can vary from 50–1,000 ppm.

Vanilla: Vanillin plays an important role in vanilla flavors, but it is usually over-accentuated. As most of the other components are useful only at low levels, a complex mixture is required to rebalance the effect of vanillin. The addition of a modest level of *cis*-3-hexenoic acid—around 20 ppm—can help increase the fruity notes and produce a flavor with a truer bean character.

Butter: Butter flavors, too, benefit from subtly increased complexity and reduced reliance on the major ingredients. Hence, around 50 ppm of *cis*-3-hexenoic acid can be helpful.

Licorice: Modest levels of *cis*-3-hexenoic acid, around 10 ppm, can add realism to these flavors.

Chicken: Although *cis*-3-hexenoic acid plays a minor role in chicken flavors, it can help at levels around 50 ppm.

Beer: Beer flavors can be enhanced by the addition of moderate levels of *cis*-3-hexenoic acid. The effect, however, is better in flavors that have a prominent hop note.

Cooked rice: One hundred ppm is a good starting level for *cis*-3-hexenoic acid in cooked rice flavors. Here, it helps to add complexity to this often simply constructed flavor.

Cheese: Finally, *cis*-3-hexenoic acid can be used in cheese flavors at relatively high levels, around 1,000 ppm to give a Gruyerelike character to these flavors.