



# Flavor Bites: *cis*-3-Hexenyl Formate

In search of ideal green notes

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Many, many flavors, especially fruit flavors, benefit from the presence of a subtle green note. Often it can simply add a subtle hint of freshness to, for example, a ripe banana flavor. Sometimes it can be a very important aspect of the overall character, as in the case of a green apple flavor.

By far the most widely used green character is *cis*-3-hexenol (CAS# 928-96-1, FEMA# 2563) and the results of simply adding this ingredient alone can be quite impressive. The resultant green character is attractive and somewhat reminiscent of fresh cut grass. This can be all that is required when the overall green note is only subtle, but it can seem a little too harsh in some flavor types, especially at higher use levels.

Using *cis*-3-hexenol in combination with a second green note can provide a softer and more attractive option than using the alcohol alone. The most obvious (and by far the most common) choice for a second green note to add complexity is *cis*-3-hexenyl acetate (CAS# 3681-71-8, FEMA# 3171). This chemical is also predominantly green, but the profile is softer, less like fresh cut grass and more fruity.

This process can be taken a step further by adding higher esters, especially *cis*-3-hexenyl butyrate (CAS# 16491-36-4, FEMA# 3402), *cis*-3-hexenyl isovalerate (CAS# 35154-45-1, FEMA# 3498) and *cis*-3-hexenyl hexanoate (CAS# 31501-11-8, FEMA# 3403). These chemicals give additional complexity and are especially



useful when very high levels of green character are required with minimal harshness. They are also very useful when the flavor will be subjected to heat in the intended end product and less volatile ingredients become a priority.

Within the family of *cis*-3-hexenyl esters this leaves a few “poor relations” that are used much less frequently. In some cases this is justified, but *cis*-3-hexenyl formate

(CAS# 33467-73-1, FEMA# 3353; **F-1**) has always seemed to me to be unjustifiably ignored. The problem with this ingredient is that, far from being softer and more fruity than *cis*-3-hexenol, it is actually notably harsher and more pungent. The aroma is still predominantly green, but it is so harsh that the effect can become decidedly raw.

Like the other *cis*-3-hexenyl esters, *cis*-3-hexenyl formate can work well

alone but there is often an advantage to using it in combination with *cis*-3-hexenol. The precise ratio will vary dramatically with the effect required. Interesting effects can be obtained anywhere from a 10-to-1 dominance of the alcohol to a 10-to-1 dominance of the ester, but an approximately equal mixture is the ratio most commonly used.

All of the dose rates given below are the levels of *cis*-3-hexenyl formate to be used in flavors that are intended to be dosed at 0.05% in a ready-to-drink taster, beverage or bouillon. They all assume that the chemical is used alone, without other green notes.

## Berry Flavors

**Raspberry:** Even though *cis*-3-hexenyl formate is not widely used in the general world of flavors, the use of this ingredient in raspberry flavors is so advantageous that, once it has been tried, it is actually quite a challenge not to use it! Successful levels can be quite varied, but a good starting point in a flavor is 100 ppm. At this level the unripe note is evident but not dominant or unnatural. An electrifying effect can be obtained by using levels of 500 to 800 ppm in flavors—no subtlety at all at this level but the very attractive combination of unripe, raw notes and red berry characters is unique.

**Blackberry:** Blackberry flavors are similar in many ways to raspberry flavors but the effect is more restrained. Used at 100 ppm, *cis*-3-hexenyl formate is equally effective for a subtle note but higher levels work less well.

**Strawberry:** Combinations of green notes work especially well in strawberry flavors and the role of *cis*-3-hexenyl formate is necessarily less pronounced. Effective levels in flavors can vary between 10 and 100 ppm, but 50 ppm is a good place to start.

**Blackcurrant:** This ingredient can be used in blackcurrant flavors either alone or in combination with other

green notes. A good place for trials to begin is 20 ppm, and very high levels of use should be avoided.

**Cherry:** Similar levels, around 20 ppm, of *cis*-3-hexenyl formate work well in all styles of cherry flavors and add a subtle layer of naturalness to the profile.

**Blueberry:** Realistic blueberry flavors are quite subdued in character, and a level of 10 to 15 ppm in a flavor will add a little to the natural effect without being obviously unripe.

## Other Fruit Flavors

**Grape:** The green character is important in almost all types of grape flavors and 100 ppm of *cis*-3-hexenyl formate is a reasonable starting level in a flavor. Radically higher levels should be avoided because the green character can overwhelm the other notes, which are often rather delicate and floral.

**Apple:** The levels that can be used successfully in apple flavors vary radically, depending on the style of the flavor, but 50 ppm in the flavor is a good place to start.

**Plum:** Similar levels, around 50 ppm, are also useful in plum flavors, adding a hint of skin character and realism.

**Kiwi:** This is a delicate flavor but, like grape and apple, the green note is key to the profile. A good range to try is 20 to 40 ppm.

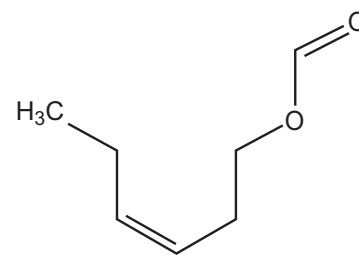
**Banana:** Banana flavors can easily become too sweet, heavy and cloying, and the raw green character of *cis*-3-hexenyl formate provides a good counterbalance at around 30 ppm in a flavor.

**Melon:** Melon, and especially watermelon, flavors can gain extra brightness and realism from judicious additions of this ingredient, usually in the area of 20 ppm.

**Mango:** The best level of use in a typical ripe mango flavor is around 10 ppm but higher levels can be used, possibly even up to 100 ppm, in markets where a deliberately raw, skin note is desirable.

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**Peach:** Low levels, in the region of 10 ppm, are all that is required in peach and apricot flavors to give a subtle hint of skin character and a degree of added realism.

**Passion fruit:** Similar levels work well in passion fruit and pineapple flavors. The effect is only subtle but the added authenticity is noticeable.

## Savory Flavors

**Tomato:** All tomato flavors, even those that are characteristic of tomato puree, contain significant green characters and *cis*-3-hexenyl formate can play a very useful role in adding realism and pungency. Ideal levels will vary from around 20 ppm in flavors with a cooked character to 200 ppm in raw tomato flavors.

**Bell pepper:** This ingredient is equally important in bell pepper flavors and helps to round out the dominant pyrazine green note. Levels similarly vary from 20 ppm in cooked flavors to 200 ppm in raw flavors.

**Tea:** Both black and green tea flavors benefit from the raw green note of this ingredient. Levels of use range from 10 to 100 ppm depending on the style of tea.

**Herbs:** Herb flavors, especially sweet basil, can benefit in the same way as fruit flavors from the addition of *cis*-3-hexenyl formate in conjunction with *cis*-3-hexenyl acetate to add realism.

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