A Novel Approach to Flavor Development

Using an Equation to Make Flavors

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I believe that tasting is the key to flavor development. Elsewhere[1] I have described a categorizing technique we use at Craftmaster to taste materials and systematically collect information about them. With this information, which is free of the errors and biases of reports in the scientific literature, flavor chemists can create flavors without relying on existing formulas.

The Equation

At Craftmaster we make flavors with the help of the following equation:

$$X = \frac{(CI) * (FA)}{(TA)}$$

where

X = % of active material in the concentrated flavor
CI = Concentration Index.

This is the amount of flavor in the final product in parts per million (ppm) written as a percent.

100 ppm = 0.01%
10 ppm = 0.001%
5 ppm = 0.0005%
1 ppm = 0.0001%
FA = final volume or weight of product
TA = volume or weight of the flavor added

Let's assume I want 10 ppm of a material in a syrup. What concentration should I have in the flavor if it uses the flavor at one ounce per 100 lbs of syrup?

$$X = \frac{(CI) * (FA)}{(TA)}$$

$$X = \frac{(0.001\%) * (1{,}600 \text{ oz})}{(1.0 \text{ oz})}$$

$$X = 1.6\%$$

This is the last of three articles adapted from Frank Fischetti's speech "A Novel Approach to Flavor Development" presented at the Society of Flavor Chemists symposium "Flavors '94" in March 1994.

Here's another example. I have a 1% alcoholic solution of any aromatic. What will be the final concentration of the aromatic if I use it at 0.1 cc/100 cc?

$$X = \frac{(CI) * (FA)}{(TA)}$$

$$1\% = \frac{(X\%) * (100 \text{ cc})}{(0.1 \text{ cc})}$$

$$X\% = 0.001\% \text{ or } 10 \text{ ppm}$$

Butter Flavor From a Flavor Character Item

Let's make a flavor. We'll assume that I have a customer who desires a margarine flavor. We'll assume that I have tasted a wide variety of materials that I have classified as flavor character items, flavor contributory items and flavor differential items (as described in the previous article in this series).[1] I collect all my notes from various tasting sessions. I also collect data from my cards, my books and my mind. I decide from all this what I want to try. I try each material at the level my notes suggest and put it in the customer's base. In my notes I find that diacetyl at 3 ppm is a flavor character item (a material whose taste resembles the taste of some other substance) for butter. This was determined in water. Since I don't know what it tastes like in the customer's base, I put it in at 3 ppm, the level suggested by my notes. Now let's go to the equation. I make 100 cc of a 1% solution of diacetyl, so:

$$1\% = \frac{(0.0003\%) * (100 \text{ cc})}{(X \text{ cc})}$$

$$X \text{ cc} = \frac{(0.03\%) * (1.0 \text{ cc})}{(1.0\%)}$$

$$X \text{ cc} = 0.03 \text{ cc}$$

I would use 0.03 cc of the 1% alcoholic solution in the 100 cc of the customer's base and taste it. If it's good, I leave it. If not, I can use it at different levels or reject it completely.

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Do this with all the materials and end up with a formula that looks like this:

Margarine Base

Diacetyl	3 ppm	1.3%
Butyric acid	5	2.1
Acetyl methyl carbinol (acetoin)	30	12.6
Lactic acid	200	84.0
	238 ppm	100.0%

Now I take this flavor and put it into the customer's base to flavor 1,000 lb lots (16,000 oz). I have 100% flavor, and I want to use it at 238 ppm in the customer's margarine.

$$100\% = \frac{(0.0238\%) * (16{,}000 \text{ oz})}{(X \text{ oz})}$$

$$X \text{ oz} = 3.80 \text{ oz}$$

Since I can't use 1,000 lbs easily in the laboratory, I'll use 100 cc.

$$100\% = \frac{(0.0238\%) * (100 \text{ cc})}{(X \text{ cc})}$$

$$X \text{ cc} = 0.0238 \text{ cc}$$

Let's check the calculation using diacetyl.

$$100\% = \frac{(X\%) * (16{,}000) * (100)}{(3.80 \text{ oz}) * (1.30\%)}$$

$$X\% = 0.0003\% \text{ or } 3 \text{ ppm}$$

or

$$1.3\% = \frac{(X\%) * (16{,}000 \text{ oz})}{(3.8 \text{ oz})}$$

$$X\% = 0.0003\% \text{ or } 3 \text{ ppm}$$

From just this simple 100 cc quantity, I created a flavor without the aid of any formulas. When creating flavors in this way, you know what happens? Every flavor you make is reasonable on the first try. In this case we got a margarine flavor. It may not be optimized, but it's a reasonable flavor. I can add to it or subtract from it to bring it closer to what I want, but I've certainly cut off a good deal of experimentation. When creating a flavor in this way, we usually find that we have to lower the usage level. It really is a time-saving approach. All you really have to do is to take the trouble to taste your materials, record, retrieve and use your materials. It also offers the opportunity to recombine your materials.

Butter Flavor From a Flavor Contributory Item

Let's suppose at this point the flavor I just developed is not exactly what I want. I want to use ethyl oenanthate as a contributory or differential item. A flavor contributory item is an additive whose taste helps to create, enhance or potentiate a given flavor. A flavor differential item is an additive whose taste has little if any character reminiscent of a given flavor. These terms are more completely defined elsewhere.[1]

My notes from previous tasting sessions tell me that ethyl oenanthate is a flavor contributory item to butter at 5 ppm. I now want to know what percentage I would have to use in my concentrate so that I get 5 ppm ethyl oenanthate in my final product. I've got 16,000 oz of margarine, and I use my flavor at 3.8 oz. Using ethyl oenanthate at 5 ppm, what percent would I have in my concentrated flavor?

$$X = \frac{(0.0005\%) * (16{,}000 \text{ oz})}{(3.8 \text{ oz})}$$

$$X = 2.1\%$$

I now go back to my original figures and recalculate my new formula.

Margarine Formula

Diacetyl	3 ppm	1.2%
Butyric acid	5	2.1
Acetyl methyl carbinol (acetoin)	30	12.3
Ethyl oenanthate	5	2.1
Lactic acid	200	82.3
	243 ppm	100.0%

I now have to use this flavor at 243 ppm.

$$100\% = \frac{(0.0243\%) * (16{,}000 \text{ oz})}{(X \text{ oz})}$$

$$X \text{ oz} = 3.89 \text{ oz}$$

Let's check with acetyl methyl carbinol (acetoin).

$$12.3\% = \frac{(X\%) * (16{,}000 \text{ oz})}{(3.89 \text{ oz})}$$

$$X\% = 0.003\% \text{ or } 30 \text{ ppm}$$

So you see, this is a rather quick way to arrive at a new formula without the use of or reliance upon existing formulas. I don't care if you're in flavor applications. I don't care if you're in flavor development. When you want to find out if a flavor component works in your product, use this simple equation to find the use level. You can revise the formula easily, adding any other material that you want to try. Use the additional material in the margarine base at the ppm you desire. If it works, add it to your concentrate. Then go back into the margarine again and taste it. You must always do this. There is no easy way to tell how ethyl oenanthate is going to behave in the base. The procedure, then, is: alone in the margarine base (to determine applicability and level), then into the concentrate, then back into the margarine base. Why? Because you can't be sure there is no incompatibility developing between the ingredients in the base and/or the concentrate. If there is, it will show up with this procedure. (What will you see? Additive, synergistic and antagonistic effects are possible.)

New Flavors From Not-Yet-Isolated Items

One of the values of the above system is that it forces you to pay attention to your materials (your tools). Also, it forces you to learn your materials. You have to, otherwise you'll never use them properly.

The thing I like best about it is that you don't need anybody's formulas. You do it all by yourself. It's very easy to start with a formula, but when you start with a formula, typically all your subsequent formulas are like the original one; your components tend to be the same. You find you're changing amounts but not components. You're playing games.

The easiest way to teach a formula is to present several instances and point out their common properties. However, it is not the easiest way to discover new patterns. So start without a formula. It's a better way. You can see it is also a way to teach creativity.

I look at flavor work as insightful problem solving with unexpected pitfalls. What do I mean by this? If I see something happening in a flavor, I think: what would it be like if I put it into another flavor? You use cis-3-hexenol in strawberry, and then you add this note to a raspberry flavor; not only do you have a creation, but you're also in violation of a patent.

At another moment you might be tasting or smelling coriander when you detect a smoky or a roasted note. You know that cocoa has such roasted notes, so you try coriander oil in your cocoa flavor. How did you detect the roasted note in coriander? By tasting, smelling and paying attention to it. Other examples might be the use of maltol in both raspberry and strawberry, or ethyl maltol in strawberry and green grape.

Let's assume you have a flavor compound with four notes or characters in it. Let's call them A, B, C and D. You cannot identify A, B, C or D from the complex unless you have seen them isolated as A, B, C and D, or perhaps you have seen them in combinations. But you can imagine each one. No flavor chemist in the world, no matter how knowledgeable, can identify something he hasn't seen, smelled, tasted or imagined. How can he do it? He tries. We all try. But we can't do it.

So you've got to see these items isolated and/or in various combinations to find out what they taste like and what they do by themselves (what their contribution is). You must have seen it, and have an idea of it in your head. Then, and only then, can you abstract it from the total. By paying attention, by tasting, smelling and categorizing your materials, you arrive at a starting point for your formula. By using the equation with just small samples in your laboratory, you can create flavor. I don't say they are all going to be "world beaters," but you can arrive at a reasonable formula a lot faster this way than you can by just guess work. And, you'll learn a lot more.

References

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1. F Fischetti Jr, *Perf & Flav* **19**(6) 11-17 (1994)
2. See also F Fischetti Jr, *Perf & Flav* **20**(1) 23-30 (1995)