Organic Chemistry - Food Extract Laboratory

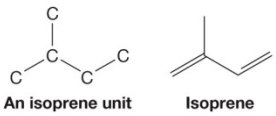
Purpose

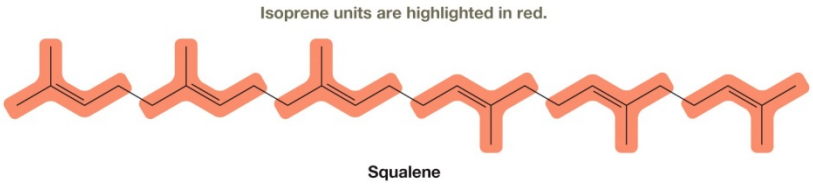
1. To prepare several flavoring extracts from fresh flavor sources and food-grade ethanol.
2. To learn about aromatic molecules in foods responsible for flavor, and their solubility characteristics.

Introduction

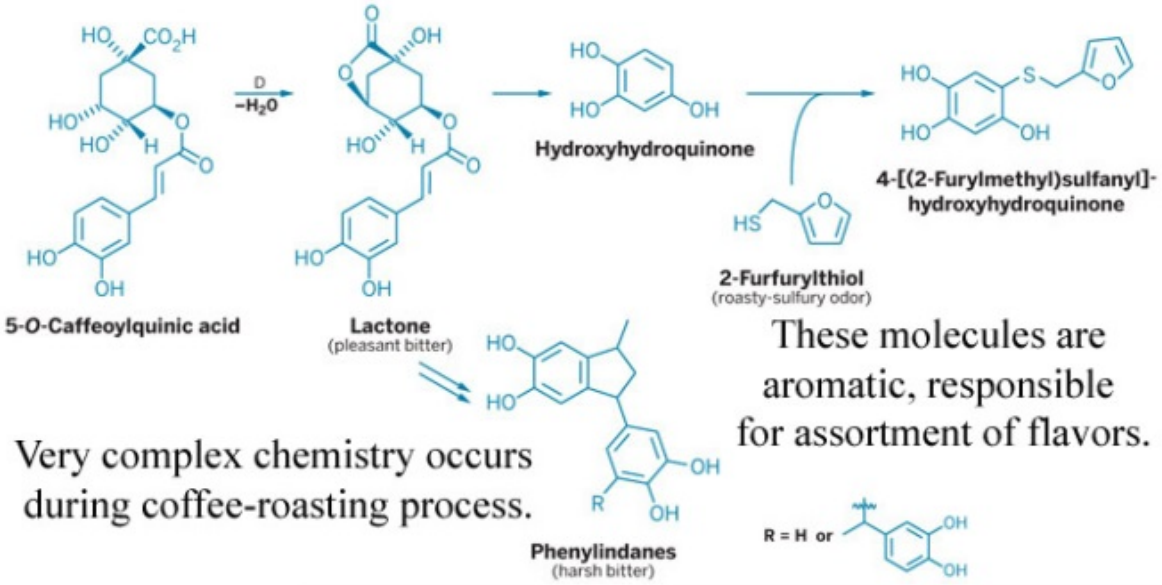
The plant molecules that impart flavor to foods can be categorized into three major classes:

1. ***Terpenes*** – naturally produced hydrocarbons whose carbon backbone can be separated into five-carbon units called isoprene units. These are responsible for the aromas of natural products, such as lemon fragrance, ginger, and pine.

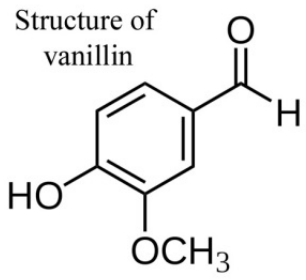




2. ***Phenolic compounds, or polyphenols*** – comprised of aromatic ring(s) with one or more –OH groups attached. These are responsible for the wonderful aromas associated with vanilla, chocolate and coffee. Aromaticity is often associated with the aroma of flavor molecules, but in organic chemistry it specifically describes a very stable, flat ring structure with delocalized electrons.



3. ***Alkaloids*** – also produced naturally by plants, contain a basic nitrogen. These produce a wide range of pharmacological effects, being used as stimulants (nicotine), analgesics (morphine), antimalarial agents (quinine), and antimicrobial (to name just a few). In chocolate, theobromine is principally responsible for its taste.



There are a number of means by which these molecules produced in roasted coffee and chocolate can be extracted. Since polyphenols and alkaloids have regions within their molecules that are both water- and lipid-soluble, an effective solvent should have both water and lipid soluble properties. There are many solvents which are quite effective at extracting these molecules, such as methanol (for lower molecular weight polyphenols), and acetone; unfortunately, both of these solvents are toxic. For a food-grade extract, we need a solvent that can be ingested. While water is very accessible and ingestible, its lack of a lipid soluble moiety, makes its ineffective in extracting polyphenols and alkaloids. A solvent of 45% concentrated ethanol, has been experimentally determined to be quite effective at extracting flavor molecules from coffee and chocolate. In industry, it is the solvent of choice for vanilla extracts as well.

In the coffee-roasting process, many aromatic molecules imparting flavors we perceive as fruity, chocolate, nutty, spice, caramel and vanilla are produced. These are readily captured in a solvent of 80-proof vodka or whiskey.

Recipes

Fresh-Roasted Coffee Extract

Prep time: 10 minutes
Yield: 200 ml

Ingredients
- 70 g fresh-roasted coffee beans
- 200 ml flavorless, food-grade 40% ethanol by volume (80-proof vodka will work)

Equipment/ tools
- mortar and pestle
- graduated cylinder to measure ethanol
- 600-mL beaker to hold the ethanol and coffee beans
- stirring rod
- laboratory stir-plate and magnetic stir-bar
- ½ pint capacity Ball canning jar, rim, and lid

Protocol

1. On the balance, weigh out 100. g of fresh-roasted coffee beans.
2. Using a mortar and pestle, gently crack the beans - the intent is not to grind them, but to gently break them open. Place the cracked beans in the 600-mL beaker.
3. Measure 350. ml of ethanol using the graduated cylinder, and pour over the beans.
4. With the stirring rod, stir the mixture well.
5. Place a magnetic stir bar in bottom of jar and allow to stir over magnetic stir plate for a few minutes.
6. When done stirring, cap the jar and shake, ensuring the seal is tight.
7. Store the jar in a dark, cool place and shake daily. After 14 days the extract can be used similarly to vanilla extract in recipes. For optimal flavor, allow the extraction to proceed for one month.
8. When ready to use or package, strain out the coffee beans using a sieve.