

B E E S B A N A N A S B E N I G N

Apis mellifera (European Honeybee)

Musa acuminata (Banana)

**Bees and bananas safely produce isoamyl acetate.
Green chemistry can help humans do the same.**

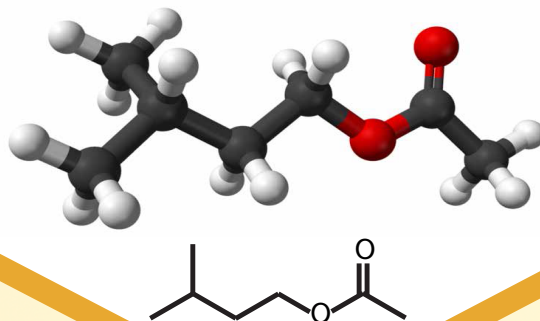
Bees do it:

When one sting from a honeybee leads to many stings, isoamyl acetate is involved¹. The sting gland produces isoamyl acetate, along with a series of pheromones, to initiate colony defensive behaviors and attract other honeybees to the location. Additional bees start stinging the potential colony invader and eventually the invader is driven off.

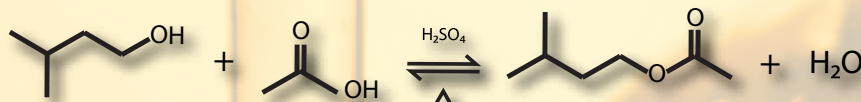
Bananas do it:

The banana plant uses a mix of compounds, including isoamyl acetate, to create its distinctive aroma and taste². The flavor attracts a variety of animals, which help disperse the plant seeds in healthy ecosystems; store bought bananas are seedless by design. As bananas ripen, Isoamyl Acetate is released - attracting decomposers such as the fruit fly³. You can see this when bananas are left on the counter.

Isoamyl acetate

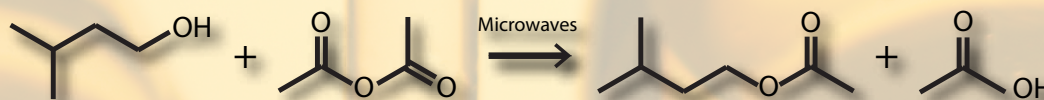


We can do it:



Isoamyl acetate is used in many products, adding banana flavor to food, providing a sweet smell, or serving as an ingredient in varnishes. The trouble is that man made isoamyl acetate is synthesized through the Fischer esterification reaction (above), which requires the use of sulfuric acid as a catalyst and ether to extract the chemical.

Using the principles of green chemistry, can we stop using sulfuric acid and ether?
Green chemists are working to develop such techniques. An example is the reaction below.⁴



**Green for all life,
in all things.**



References:

- 1 = Winston, M (1991) The Biology of the Honey Bee. Harvard University Press. 281 pages
- 2 = Beekwilder, J; Alvarez-Huerta, A; Neef, E; Verstoppen, F; Bouvmeester, H; Aharoni, A (2004) Functional Characterization of Enzymes Forming Volatile Esters from Strawberry and Banana. Plant Physiology 135(4); 1865-1878
- 3 = Oppliger, F; Guerin, P; Vlimant, M (2007) Neurophysiological and behavioral evidence for an olfactory function for the dorsal organ and a gustatory one for the terminal organ in Drosophila melanogaster larvae. Journal of Insect Physiology 46(2); 135-144
- 4 = Preparation of 3-Methylbutylacetate (Banana Oil) in the Microwave Oven, <http://greenchem.uoregon.edu/ACSGoingGreenSite/PDFs/20050315TuesPM/1339BrownLab.pdf>
Last accessed 3/16/15

Definitions:

- Pheromones:** Chemicals that are secreted in our sweat and other bodily fluids that are believed to influence the behavior of the opposite sex, such as triggering sexual interest and excitement.
- Colony:** Honey bees are social insects that live in colonies. Honey bee colonies consist of a single queen, hundreds of male drones and 20,000 to 80,000 female worker bees. Each honey bee colony also consists of developing eggs, larvae and pupae.
- Synthesis:** To make (something) by synthesis, especially chemically.

