

# Lighting up basil flavor

In this fifth article of our six-part series on potted and hydroponic culinary herb research at Michigan State University, we will show you how you can improve the flavor of basil with light intensity. **BY KELLIE WALTERS AND ROBERTO LOPEZ**

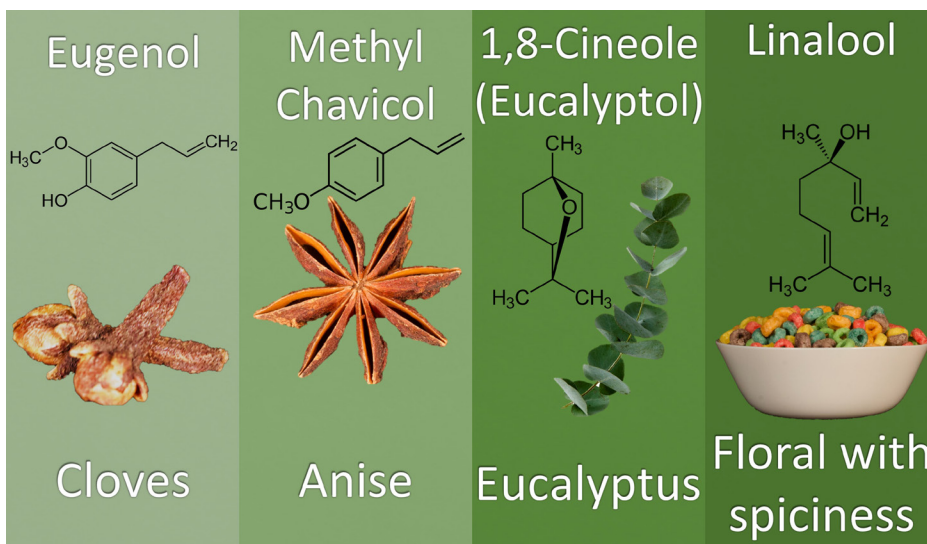
As a producer of fresh-cut basil, what is your main production goal? It is most likely to produce a quality crop with the highest possible yield while minimizing production time and input costs. Similar to produce, basil is sold by mass, so yield equals profitability. We know that we can steer plant growth, development and yield to meet our targets by manipulating environmental parameters such as light intensity, quality and photoperiod, as well as temperature and carbon dioxide concentration. However, crop quality parameters must also be preserved. Basil quality consists of many parameters including its appearance (color, blemishes, turgid vs. wilted, etc.), leaf-to-stem ratio, leaf size, shelf life, aroma and flavor. Without great aroma and flavor, basil would be no different from lettuce.

## Flavor compounds

We often think of flavor as only taste, but it is actually a combination of taste and aroma. Take basil as an example: What is the characteristic smell you associate with basil? How does that compare to its taste? This is a strong example of how taste and aroma work in concert. It also helps illustrate how volatile compounds, or compounds that can be airborne, are integral to the quality of certain crops.

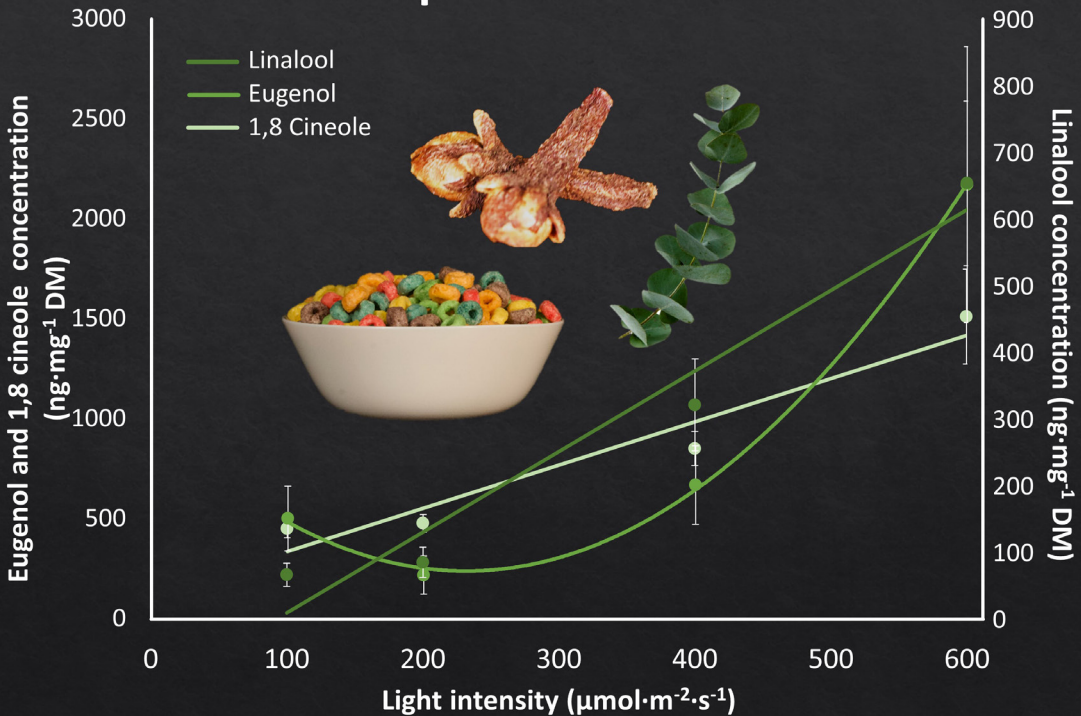
When investigating basil flavor, we have to quantify specific compounds. How do we decide which ones to focus on? There are many compounds that make up the characteristic flavor of basil, but we will focus on four compounds that contribute the most: eugenol, methyl chavicol, 1,8 cineole, and linalool (Fig. 1). Eugenol and methyl chavicol are the main flavor compounds in cloves and anise, respectively,

contributing to the clove- and anise-like aroma of basil. 1,8 cineole, also known as eucalyptol, contributes a eucalyptus-like flavor and is a main component of eucalyptus. Finally, linalool contributes a flavor that is described as “floral with spiciness” in the literature, but we think



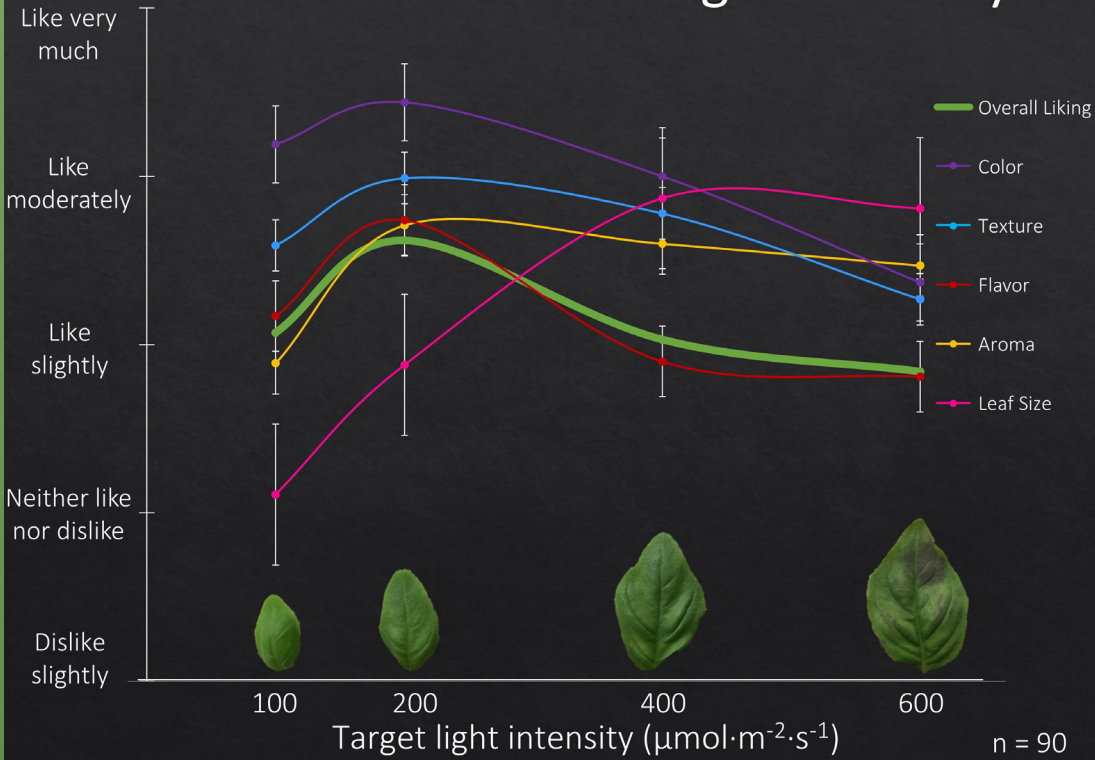
**Figure 1.** Eugenol, methyl chavicol, 1,8-cineole and linalool are four compounds that contribute to the characteristic flavor and aroma of basil.

## Flavor Compound Concentrations



**Figure 2.** Basil flavor compound concentrations in plants grown under 100, 200, 400 or 600  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ . Basil flavor compound concentrations tend to increase as light intensity during production increases.

## Consumer Preference: Light Intensity



**Figure 4.** Consumer sensory preferences for two-week old basil grown under 100, 200, 400 or 600  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ .

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it smells like Fruit Loops. Together, these compounds, along with several others, make up the basil flavor profile we love.

### Light = Flavor

How do our production practices influence basil flavor and the concentration of these compounds? We grew sweet basil 'Nufar' seedlings in a growth chamber under 100, 200, 400 or 600  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  for 16 hours each day to create daily light integrals of 6, 12, 23 or 35  $\text{mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$ . After two weeks, we harvested the seedlings. Overall, concentrations of three of the four compounds tended to increase as light intensity increased (Fig. 2).

The bigger question is, how did altering the light environment impact consumer perception and preferences? After all, while lab tests are important, at the end of the day, what really matters is whether a customer likes how the product looks and tastes. We conducted a sensory panel where samples were prepared, randomized and supplied one at a time along with water and saltine crackers to consumer panelists through a sliding door (Fig. 3). The panelists answered a series of questions regarding their perception of the basil they consumed. What we found was that overall liking (green line) was greatest when young basil was grown under 200  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  compared to lower or higher light intensities (Figure 4). But why is this the case? Trends in plant color, texture and flavor mirror the overall liking trend. Panelists described a deeper green coloration of leaves grown under lower light intensities compared to those grown under 400 or 600  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  of light (purple line). While plants grown under 600  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  appeared normal when harvested, bruising occurred when leaves were rinsed gently for consumption (Fig. 4). Additionally, the texture (blue line) of the leaves grown under 600  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  was more frequently described as "wilted" or "chewy." Besides the

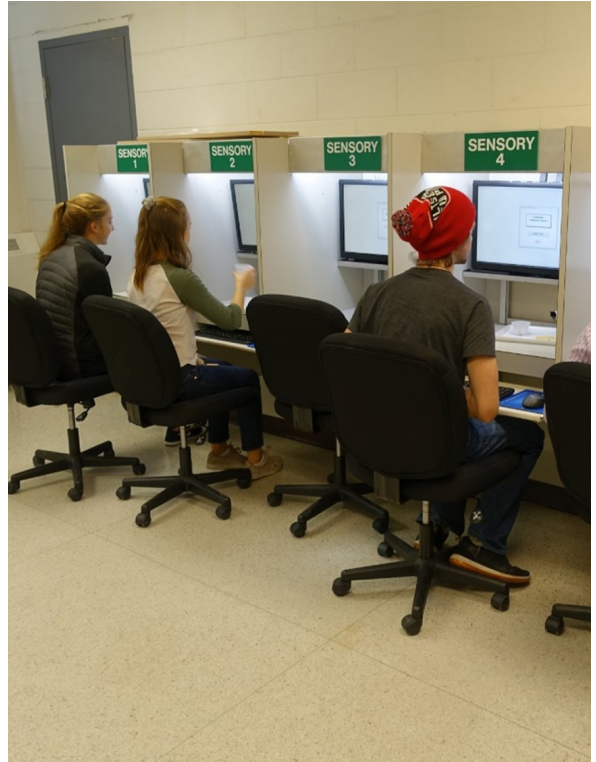


Figure 3. Consumer sensory panel setup.



discoloration and texture differences, flavor (red line) was a large contributor to overall consumer liking. Basil grown under  $100 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  did not have a strong flavor, but those grown under  $200 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  had the characteristic basil flavor panelists expected. However, as light intensity increased up to  $400$  and  $600 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ , the flavor was too intense. Panelists described the basil grown under high intensities as “bitter” and “spicier.”

Aroma preferences (yellow line) had an interesting trend where plants grown under  $100 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  had the lowest rating because the aroma was not strong enough. As light intensity increased to  $200$  to  $600 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ , aroma preference leveled off because it is more difficult to saturate aroma in a large room compared to a sample having too strong of a flavor.

Additionally, the participants preferred the larger leaf size (pink line) of plants grown under higher light intensities. Again, these were two-week old seedlings; the plants grown under  $100 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  had fairly small leaves. The positive aspect to small leaves, as some panelists suggested, is that entire leaves could be used to garnish a dish.

### What implications do these insights have for production?

There are some limitations to this study. Young basil plants were used in the analysis and consumer sensory study, where basil is often transplanted and grown longer before harvesting. Additionally, panelists tasted the basil as a whole leaf by itself, not in pasta, caprese salad or any other delicious dish. However, there are still some important takeaways from this work. We know that light intensity has a large impact on

the concentration of flavor compounds in basil, and we know that consumers can perceive the difference. If the basil you are growing is not flavorful enough, consider adding more light. If it is too flavorful, consider shading the crop. Keep in mind that altering the light environment will not only influence flavor, but yield as well. Additionally, for greenhouse-grown basil, light differences across seasons may influence the flavor and overall quality of your crop. To produce a crop with year-round flavor consistency, supplemental lighting or shading will mostly likely be needed. Finally, if your goal is to produce basil for different purposes, the “light” level is an effective tool to manipulate to produce low-flavor intensity basil for fresh eating, such as in caprese salads, and high-flavor basil for freshly processed foods, such as pesto. **PG**

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