CHARACTERIZATION OF BOTANICALS FOR HOME ESSENTIAL OIL MICROWAVE EXTRACTION

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BACKGROUND

- The EssenEx™ 100A from OilExTech uses steam extraction to produce essential oils in a kitchen microwave
- Essential oils can be used for medicinal applications, aroma therapy, flavoring, etc.
- Oil yields from botanicals depend on material age, water content and gland location
- Conventional microwaves cycle on/off at powers less than 100%, whereas inverter microwaves operate at constant power
- Extraction of essential oils commonly uses a hot steam generator to heat the botanicals, total extraction methods like steam distillation yield 1-5 mL oil/100 g material
- According to Masango (2005), the oil in the gland begins to vaporize, rupturing the gland tissue and is carried away by the steam
- When the oil has vaporized, the water and oil vapor is condensed and separated by their specific gravities
- Botanicals with oil glands on the surface (lavender) are easier to extract because the diffusion path is shorter compared to those with oil glands inside the plant (hops), where the oil must diffuse through more plant tissue

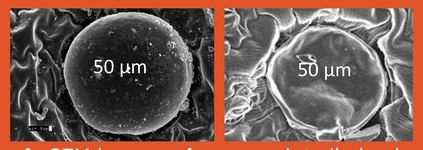

Figure 1. SEM images of peppermint oil gland pre-extraction (left) and post-extraction (right) (Velasco, 2007).

- The Clausius-Clapeyron Equation (below) relates vapor pressure (P^*) and temperature (T) and is dependent on the heat of vaporization (ΔH_{vap}) of different components

$$ln\left(\frac{P_2^*}{P_1^*}\right) = \frac{-\Delta H_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

PROJECT OBJECTIVES

- Does the microwave type and unit placement affect the energy absorbed? Will a lower power/higher run time yield more oil?
- Does hops oil have biocidal properties?
- How does steam distillation work?

MATERIALS AND METHODS

Microwave Efficiency

- Heat 240 mL DI H_2O in conventional and inverter

Microwave Run Time (s)	
Power	Off-Center | Center
100%	15, 30, 45, 60
50%	30, 60, 90, 120

Table 1. Experimental conditions for microwave efficiency

Oil Extraction

- Process 100 g of botanicals: cut stems off lavender; grind hops for 10 s (Ko *et al.*, 2017).
- For dry botanicals add 40 mL H_2O
- Place botanicals in EssenEx™ 100A unit, Figure 4

Biocidal Test Kits

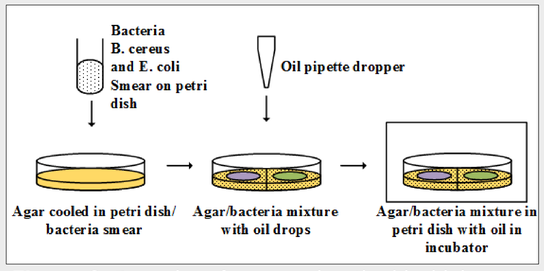

Figure 2. Procedure for preparing the biocidal test kits from Carolina Science.

RESULTS

- There was surprisingly no advantage to the inverter microwave, the conventional microwave is more efficient and the differences in energy absorbed are negligible, Figure 3.
- Unit placement in the microwave has no significant affect on energy absorbed, Figure 3.

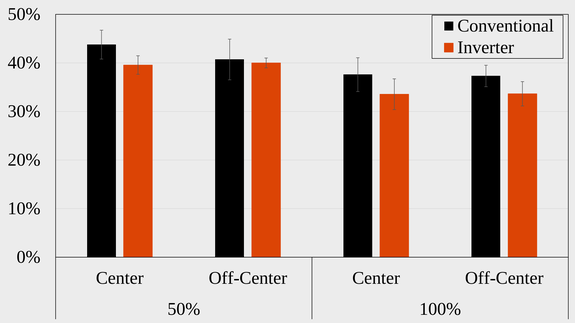

Figure 3. The efficiencies of each microwave found from heating a mug of water center and off-center in the microwave.

Figure 4. The EssenEx™ 100A unit (OilExTech, 2018).

- Amarillo hop oil yield increased with an increased run time and decreased power, while lavender oil yields showed no difference, Figure 5.

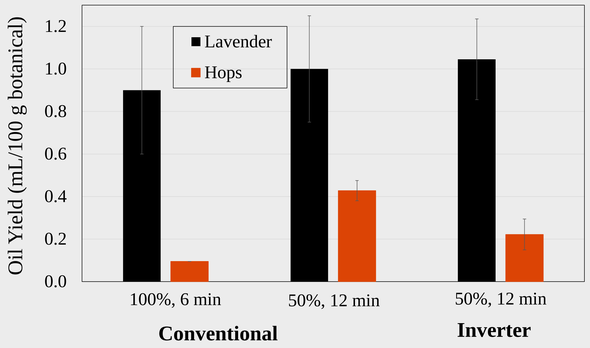

Figure 5. The oil yields of Amarillo hops pellets and lavender given two different power/time settings compared on the conventional and inverter microwave.

- Lavender oil yield does not change because it is surface rate limited, while the hops are diffusion rate limited, Figure 5. The team has sought to explore this hypothesis by estimating the vapor pressures of hops, lavender, and other oils known to work with the EssenEx™, Figure 6.

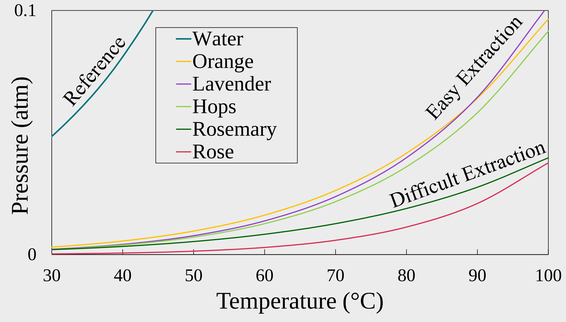

Figure 6. Estimated vapor pressures of Amarillo hops, lavender, water and common essential oils. If there is a working range of vapor pressures for the EssenEx™ 100A, one could estimate the vapor pressure of any botanical to predict if it would yield oil.

CONCLUSION

- There is no advantage to using the invertor microwave. For customers, unit placement in the microwave does not impact oil yield.
- Oil yield is related to the vapor pressure of the most volatile oil compounds, but the water content, oil gland location, and age of the botanicals also affect oil yield
- For botanicals with diffusion rate limited extraction and inherently low oil yields, a lower power/long time extraction can increase oil yields

FURTHER WORK

- Complete biocidal tests with *E.Coli* and *B. Cereus*
- Predict whether botanicals are viable for extraction by the EssenEx™ 100A based on their estimated vapor pressure and oil location
- Compile a list of botanicals that work in the EssenEx™ and their corresponding prep methods

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