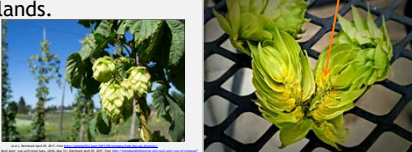


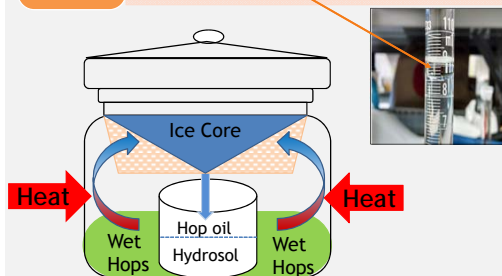
## Process Background

### Background and Objective

- As expressed by OilExTech's customer base, there is a demand for hop essential oil.
- Hop oil benefits include improved hair and skin health, reduced anxiety, stress, coughing, congestion and menstrual pain, and enhanced sexual performance.
- The hop essential oil is located in lupulin glands.
 
- Traditional steam distillation to extract hop oil takes 3-6 hours.
- Our goal is to optimize hop oil yields using OilExTech's microwave extraction system which takes 6 minutes in EssenEx™ 100 or 14 minutes in EssenEx™ 300.

### Methods

- Grind the hops and add water or 70% ethanol
- Add the hop mixture to the microwave extractor. Add 10 g of salt to the center beaker when using 70% ethanol.
- Attach the ice core (condenser) and microwave for 6 minutes in EssenEx™ 100 or 14 minutes in EssenEx™ 300.
- During extraction, microwaves heat the water which vaporizes the hop oil and water mixture. The vapor condenses on the ice core.
- Cool the hydrosol and oil. Then transport to a volumetric flask to measure the oil.

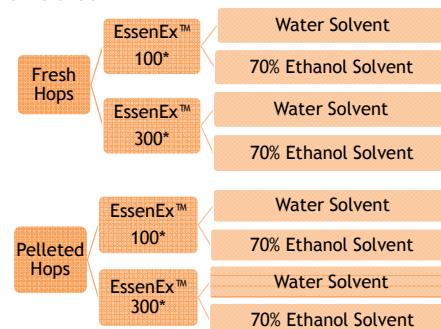


# HOP ESSENTIAL OIL MICROWAVE EXTRACTION

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Sponsored by  OilExTech  
Oil Extraction Technologies

### Variables



Amarillo hops were used for this project. A constant hop mass of 100 g and solvent volume of 40 mL was used for all trials. All 70% ethanol was premixed before adding to the hops.

\*EssenEx™ 100 runs for 6 minutes and EssenEx™ 300 runs for 14 minutes.

### Results

The effects of hop type (fresh or pellets), solvent type (water or 70% ethanol) and run time (6 or 14 minutes) on hop oil yield were investigated.

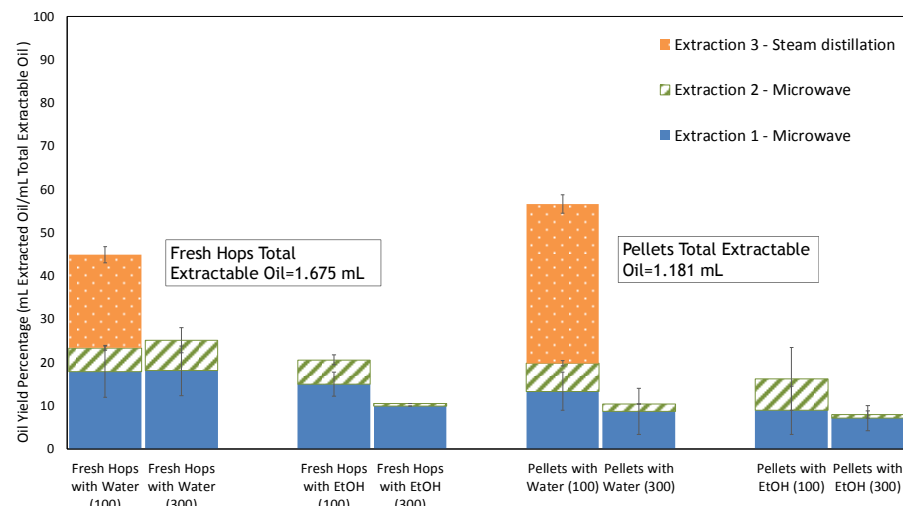


Figure 1. Oil yield percentage compares the extracted yield to the total extractable yield determined from steam distillation. This uses total extractable yields of 1.675 mL /100 g hops for fresh hops and 1.181 mL/100 g hops for pellets. All hops were finely ground with a blender. The error bars represent standard error.

### Conclusions

- Ground fresh hops have a higher oil yield than ground pellets in both microwave and steam extraction.
- There is no significant benefit for adding 70% ethanol as a solvent versus water.
- There is no significant benefit of a longer run time.
- A significant amount of hop oil is unaccounted for.
- The microwave extraction achieves approximately 1/5 of the total achievable oil yield.
- The major component of hop oil from microwave extraction is myrcene.

### Future Work

- Determine cause of unaccounted oil loss
  - Oil is left in the hydrosol—Use GC to test
  - Oil lost through oxidation—Test oil composition for varying sample dates using GC.
  - Oil vapor exited through microwave—Condense the vapors exiting the microwave exhaust tube and analyze using GC

## Gas Chromatography Results

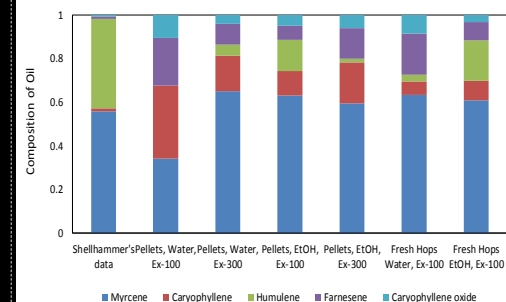


Figure 2. Approximate hop oil compositions are shown using a GC (HP 5890 FID) with a DBA capillary column with a 0.2 mm diameter, coating thickness of 0.35  $\mu$ m and column length of 20 m. The carrier gas (He) flowrate is 1 mL/min. A sample volume of 0.1  $\mu$ L was injected. Shellhammer's data used a different GC column.

### Acknowledgements

- Dr. Hackleman - Project support and guidance
- Bill Dean - Project support and guidance
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- Undergraduate Student Nick Spatafora - Steam distillation assistance
- Corvallis Brew Supply - Hop supply and general information
- Dr. Harding - Feedback on work and suggestions for improvement



Figure 3. The complete set for the EssenEx™ 100A is shown.