Preliminary Results

The oil mass extracted decreases as the scale-up volume increases because:

- Less energy is being used to produce steam for distillation in larger units. The increase in mass of scale-up systems absorbs more energy which removes some available energy for steam distillation.
- The extracted water/oil vapor mixture must travel an increased distance in larger units, making transfer more difficult.

Results for Final Design

The microwave duration was increased for increasing masses of orange peel. The higher the mass in the unit, the longer the microwave duration. Optimal microwave time was investigated for ideal oil yield and can be seen in Figure 5. The larger ice core produces more steam in the system and allows more oil to be extracted.

What are essential oils?

Essential oils are located in flowers, leaves, and stems of various botanicals.
- Examples: mint, lavender, citrus peel, juniper berries
- Uses: lotions, aromatherapy, cleaners, candles

How the Unit Works

1. The microwaves travel into the unit, heating up the ice, turning it into steam.
2. The steam travels through the pores of the material, carrying essential oil vapors out of the botanical.
3. The steam then condenses into the beaker containing both water and essential oil, this is called the hydrosol.
4. The oil is less dense than the condensed ice core which creates two separate liquid layers in the beaker.

EssenEx™-100 (Original Unit)

The EssenEx™-100 is a steam distillation unit used to extract essential oil from botanical materials in approximately 6 minutes with the use of an at home microwave.
- 2 L glass jar
- Holds up to 500 g of orange peel
- Designed for 200 mL ice core
- Typical oil extraction of 1-2 g

Project Objective

To scale-up original EssenEx™-100 design for processing increased amounts of botanical material in order to get more essential oil.

Preliminary Trials

- The amount of oil collected is dependent on the amount of ice core present.
- When is the ice core gone?

Concerns

- Oil yields are inconsistent based on various orange batches
- Mesh and lid compatibility
- Varying level of water in the mug alters energy consumption
- Ice core cracking and falling into the hydrosol during the microwave run

Conclusions

- Each unit has a different microwave time requirement per unit botanical mass due to an increase in total mass in the microwave.
- Final design chosen was Scale-Up #2:
  - 6 L glass jar
  - Holds up to 400-900 g of orange peel
  - Designed for 200 or 250 mL ice core
  - Uses larger beaker mesh (1.75 in taller and 0.5 in wider than original design)
  - Typical oil extraction of 3-5 g (botanical dependent)

Recommendations

- Optimize jar parameters (ice core size, jar insulation, microwave time range, cool down time) and experiment with other botanicals
- Investigation on the volume of water in the mug and the relationship to energy consumption

Acknowledgments

The team thanks Bill Dean, Dr. David Hackleman, Dubson Strickland, Jamba Juice & Dr. Phil Harding