

Materials and Process

Opportunity

Botanical oil is not efficiently extracted using traditional techniques such as steam distillation or supercritical CO₂ extraction. OilExTech's EssenEx™ 100 microwave extraction unit decreases extraction time and minimizes oil degradation. An alternative solvent approach was evaluated to increase oil yield in the unit.

Objective

- Investigate alternative solvents for oil extraction
- Quantify solvent effectiveness by evaluating oil yield with solvent vs. without solvent
- Optimize best alternative solvent for use in EssenEx™ 100 unit

Background

EssenEx™ 100

OilExTech developed the EssenEx™ 100 microwave oil extraction unit for home use in 2012. The EssenEx™ 100 extracts essential oils from botanical material in approximately 6 min whereas standard steam distillation methods take 4-6 hrs.



Product Output

Essential oils can be found in large quantities in the seeds, peels, or fleshy part of the fruit. These oils are most commonly extracted for use in food products, but are more commonly used in health and aromatherapy products. The team investigated hops and oranges.



Solvent Candidates

The four criteria used to evaluate alternative solvents were low boiling point, large molecular weight, low toxicity, and overall compatibility with botanical oil. The solvents chosen for investigation were:

- Ethanol
- Ethyl acetate
- Isopropanol
- Methyl THF



ESSENTIAL OIL EXTRACTION VIA ALTERNATIVE SOLVENTS

A quick, easy, and environmentally friendly approach

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Sponsored by OilExTech

Methods

The EssenEx™ 100 Unit uses microwave energy to boil water contained in botanical material, which then carries essential oil to an ice core where it condenses and collects in a beaker.

Botanical Preparation

Both orange peels and hops were blended prior to extraction. Dried hops were soaked in water and/or solvent prior to extraction. Orange peels did not need to be rehydrated and were kept in the freezer to preserve freshness. Citra hops from Hopunion and orange peels from Nearly Normal's, Safeway, and White Wind Superfoods were used in extractions.

Microwave Extraction

- 100 g of blended botanical material was placed into the extraction unit
- Solvent was added to the unit, either before or after adding the botanical material
- The unit was run in the microwave for 6 - 6.5 min depending on the material

- 1 • Microwave transfers energy to water and solvent mixture.
- 2 • Pressure increase ruptures oil glands releasing essential oils.
- 3 • Water and solvent mixture carries oil to the ice core.
- 4 • Water, solvent, and oil condense on ice core and hydrosol collects in beaker.



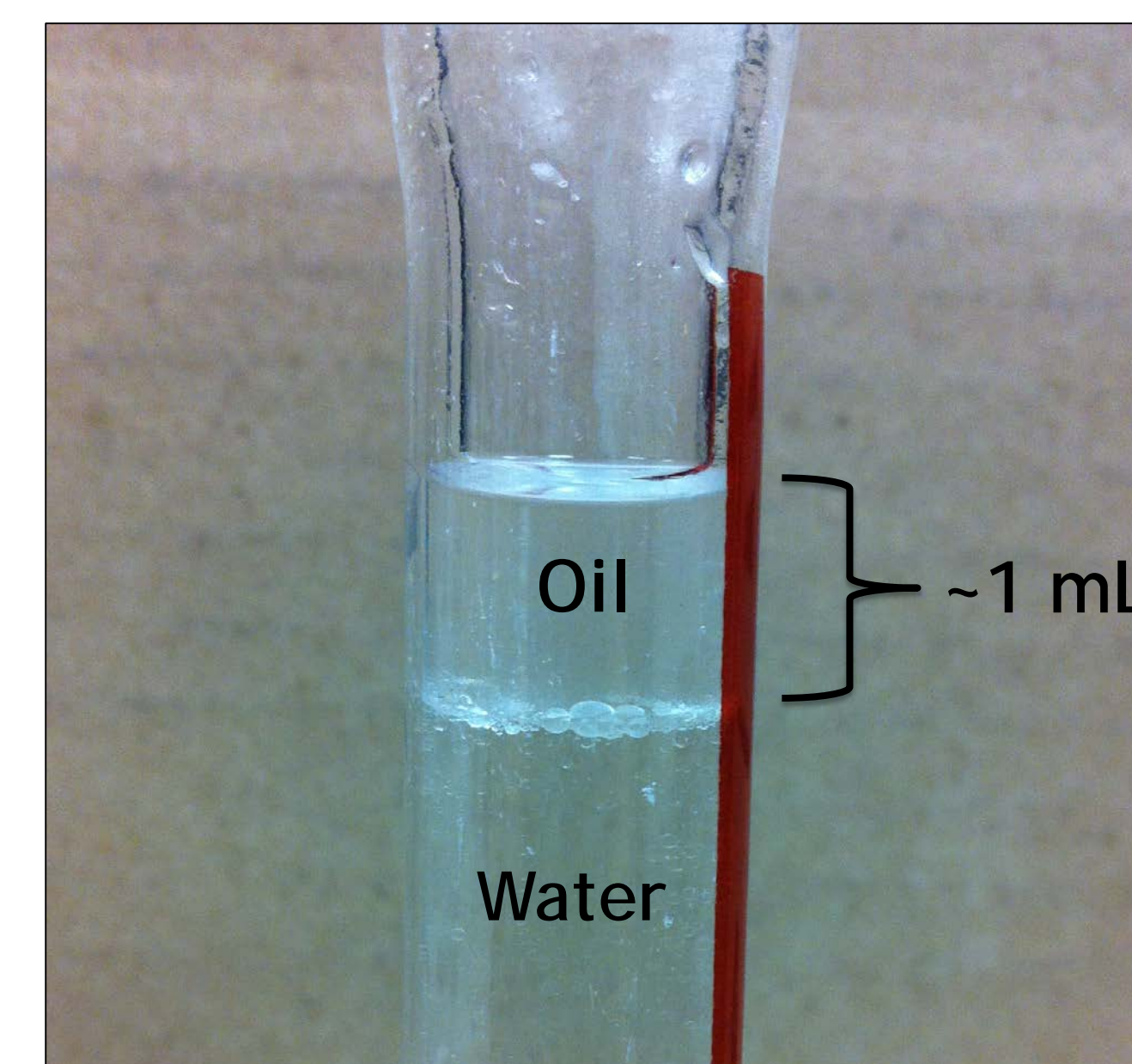
S Solvent: 46-88 g/mol

W Water: 18g/mol

O Oil: ~136 g/mol

Separation

The hydrosol mixture was poured into a volumetric flask and the essential oils were pipetted off the top.



Total oil collected was weighed and yield was determined as a fraction of the original dry weight of the botanical material.

Conclusions

- Fresh botanical material has a higher oil yield
- Ethanol and isopropanol increase orange oil yield
- Ethanol and isopropanol did not increase hop oil yield
- Ethyl acetate and methyl THF were not viable solvents due to miscibility with oils investigated

Future Work

- Evaluate solvent viability
 - Cost
 - Ease of use
 - Customer safety
- Evaluate solvent compatibility with oils
- Find optimal solvent volume
- Run optimal solvent parameters with other botanical material (e.g. lemongrass, mint, thyme, lavender)

Acknowledgements

- Dr. Hackleman - Faculty lead and alternative solvent guidance
- Bill Dean - Project sponsorship
- Jackie Toftner - Solvent consultation
- Hopsteiner - Hop oil donation
- White Wind Superfoods and Nearly Normal's - Orange peel donation
- Dr. Harding - Project guidance

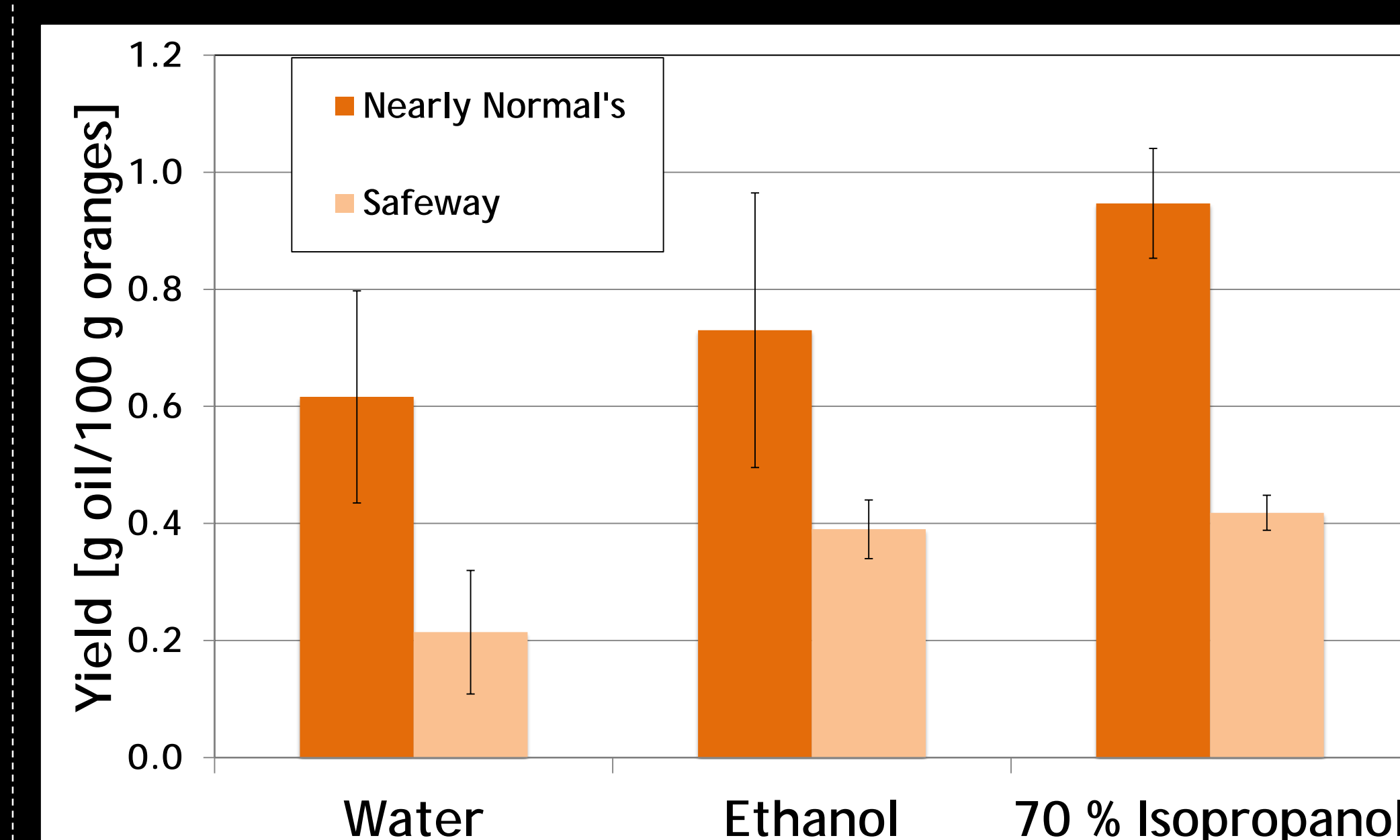
Experimental Results

Solvent Characteristic Matrix

Common Name	Chemical Formula	Molecular Weight g/mol	Boiling Point °C	Miscible with Hop Oil	Miscible with Limonene	FDA Approved
Isopropanol	C3H8O	60.1	82.6	Partial	No	Class 3
Ethyl acetate	C4H8O2	88.11	77.11	Partial	Yes	Class 3
Ethanol	C2H5OH	46.07	78.37	Yes	No	Class 3
Methyl THF	CH ₃ C ₄ H ₇ O	86.13	78	Yes	Yes	Class 2 (THF)
Limonene	C10H16	136.23	176	Yes	N/A	GRAS

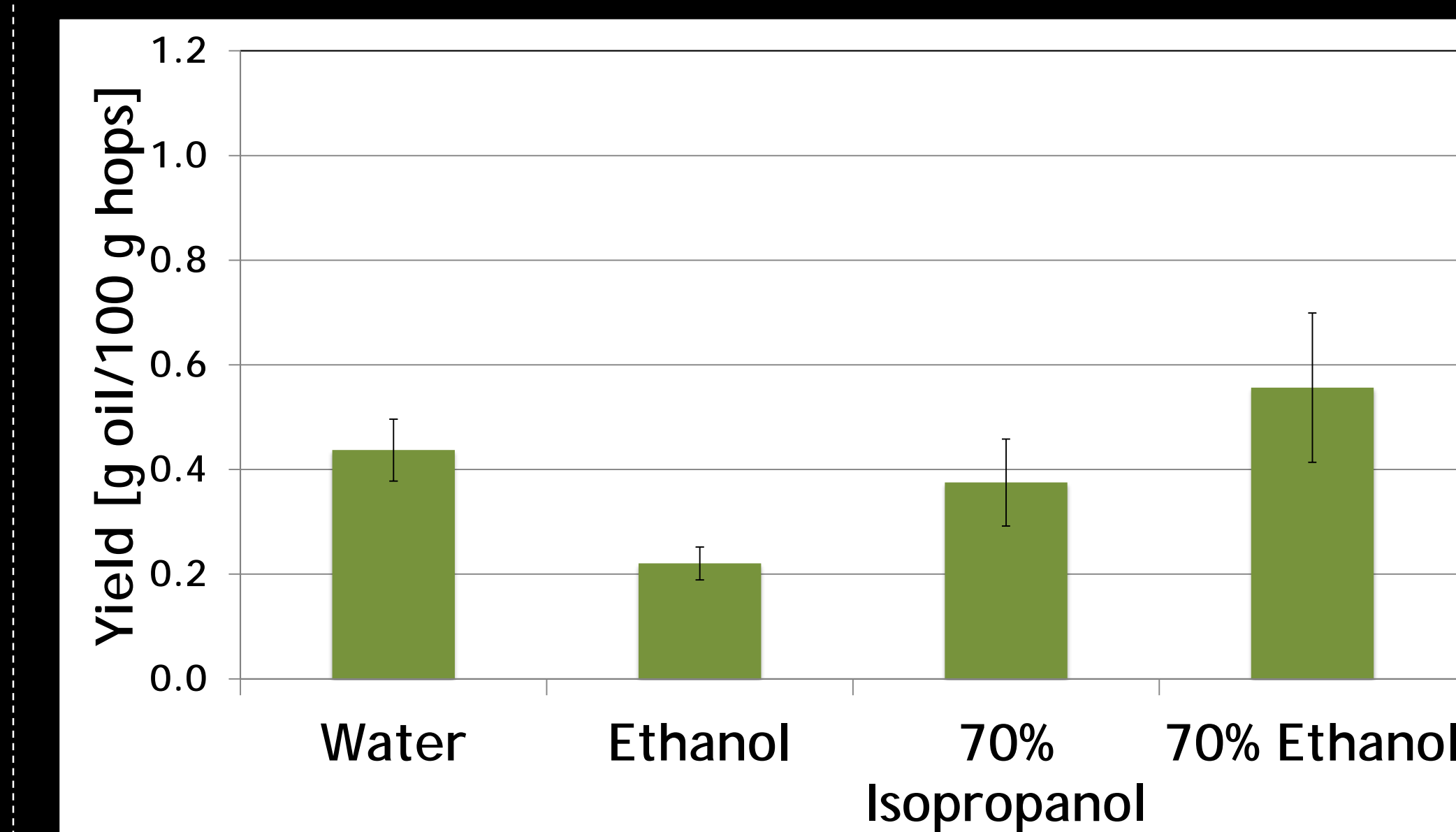
Matrix used to evaluate solvent viability and compatibility.

Orange Oil with Solvent



Ethanol increased the oil yield by 18% and isopropanol increased the oil yield by 54% in Nearly Normal's oranges.

Hop Oil with Solvent



Hop oil yield decreased with pure ethanol and 70% aqueous isopropanol, but increased by 27% using a 70% aqueous ethanol solution.