

Spray Evaporation System for Dehydrating Mustard Seed Extract

BY: LESLIE HURTADO, SOPHIA BOWEN



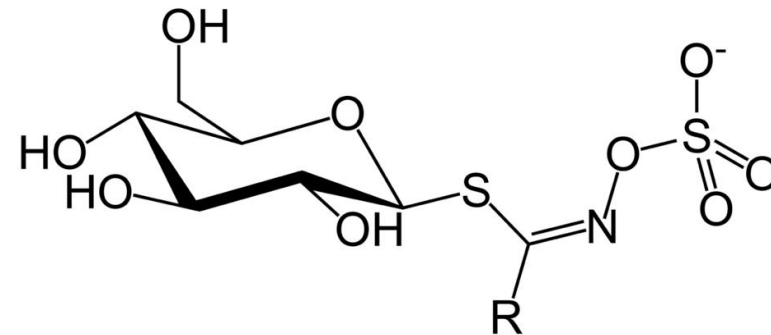
Objective

We aimed to create an evaporation system to dehydrate mustard seed extract, a byproduct of biodiesel that can be used as a pesticide. The current drying process uses a freeze-drying method, which is inefficient. Our goal is to reduce the drying time by half, reducing a significant bottleneck in the lab's biopesticide production.



Value Proposition

Mustard seeds contain glucosinolates, a compound which contributes to the plants defense against pests. Extractions of this compound would provide an organic alternative to pesticides. A shelf-stable powder can be extracted as a byproduct of mustard seed-based biodiesel production.



Background

- Mustard plants produce many useful chemical products
- Oils that can be processed into biodiesel
 - The byproduct of the biodiesel contains glucosinolates
 - Show promise on being used as biopesticides
- Drying methods available
- Drum dry, freeze dry, and spray dry
- Freeze drying currently takes three days for a 10-gallon batch

Key Product Requirements

- The extract should be at least 50% dry
- Reduce drying time by half
- No large drop in glucosinolate yields caused by thermal degradation
- No use of chemicals to aide with drying due to the extract being used in organic farming
- System can handle up to 10 gallons of product a day

Key System Components



THE HEATING
CHAMBER



THE HEAT SOURCE



THE SPRAY
SYSTEM

Validation

- Used water for testing before testing with extract
- Figured out a range of pressures with plastic nozzle
 - Had to retest pressures due to using copper nozzle to withstand a high heat
- Ran water through system a few times to see which nozzle setting gave a better mist



The Heating Chamber

- An iron funnel
- A 55-gallon aluminum drum
- 80/20 frame

The Heat Source

- Two 14.5 Amp Heavy-Duty Master Heat Guns
- Let them run for 5 minutes to heat up
- Heats the drum up to 100°C





The Spray System

- 5 Gallon Stainless Steel Sprayer
 - Used 30 psi
 - Changed plastic nozzle for metal hose nozzle
 - Modified and added copper tubing to withstand the high temperatures coming from drum



Final Design

Conclusion and Going Forward

- Heat guns did not reach a high enough heat to degrade glucosinolates
- Water content is reduced by 53% when extract is passed through system three times
- Higher drying when solution is warmer
- Figuring out a way to efficiently dry the extract
 - Possibly one or two times through
- Adding to the length of the drum to allow for more drying time

Capstone Project Schedule - Fall-Spring

Task Description	2021												
	Mar				Apr				May				
	3/5	3/12	3/19	3/26	4/2	4/9	4/16	4/23	4/30	5/7	5/14	5/21	5/28
Budget			■				■		■	■			
Poster	■						■	■	■				
Personal Logbook							■						
Project Portfolio	■												
Wikipage		3/9								■			
Prototype - Create design													
Prototype - Order parts													
Prototype - Build	■	■	■		■	■							
Prototype - Testing & Analysis				■	■	■	■						
Snapshot Days	3/9												
Design expo								■	■				
Project Final deliverables									■	■			

Schedule

Capstone Project Budget Template - Fall/Spring

Project: Dehydrating Mustard Extract

Last Updated **4/30/21**

Expense Items	Year								Item Total		
	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr			
Supplies / Parts / Services:											
Bulk Line - Plastic Fastener			\$ 0.59						\$ 0.59		
V Tube - Plastic Tubing (3 ft)			\$ 1.96						\$ 1.96		
Bulls Eye Brass Nozzle			\$ 9.99						\$ 9.99		
Brass Coupler			\$ 7.99						\$ 7.99		
Brass Adapter			\$ 3.49						\$ 3.49		
Thread Seal Tape			\$ 1.39						\$ 1.39		
3 ft Copper Tubing								\$ 3.30	\$ 3.30		
Ball Valve								\$ 12.95	\$ 12.95		
2 Heat Guns						\$ 289.00			\$ 289.00		
Copper Elbows								\$ 2.95	\$ 2.95		
Copper Adapter								\$ 2.95	\$ 2.95		
Copper Connector								\$ 1.95	\$ 1.95		
Sprayer						\$ 270.21			\$ 270.21		
Funnel								\$ 100		\$ 608.72	Expenses Subtotal
Shop Usage (est. Hrs):									Hours		
									0		
									-		
									Graduate Student Support	\$ -	including fringe
									Shop Overhead	\$ -	
									University Overhead	\$ 30.44	5% of all expenses
									Totals	\$ 639.16	\$ 1,000.00
											\$ 360.84
										Budget	Excess

Budget

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