CREW (Climate Restorative Edible Water): Saving the Planet 1 Plastic Bottle at a Time

Ariv V. Vaidya

British International School of Boston, Boston, MA

INTRODUCTION

"The main fuel to speed our progress is our stock of knowledge, and the brake is our lack of imagination" (The book: The Fragile Earth). This project takes the first step in imagining a world that encapsulates water in climate friendly polymers instead of plastic bottles.

- This project has created an edible water bottle which addresses both the necessity for liquid encapsulation and another creative way of replacing plastic **(Figure 1)**.
- There has been lots of chemical speculation regarding the ingredients necessary in obtaining spherification. Therefore, certain preliminary tests were conducted in terms of the quantity and the chemicals to use. It was concluded from the preliminary tests that sodium alginate and calcium lactate were the most appropriate for this method. But, branching from these 2 chemicals, are two different methods: reverse and direct spherification (which are use these two chemicals in a different order).
- This project aims to tell which method was more ideal in terms of sturdiness and stability.

FIG. 1 **Image of Direct Spherification in Different Sizes**

OBJECTIVES

The main objective of this project is to investigate if liquid encapsulation can replace plastic bottles.

- Our proposal aimed at identifying the best encapsulated liquid in terms of independent variables like sturdiness and stability, which was conducted by using different sized balls and dropping them from different heights.
- This would then allow us to find the "optimal point", which is the best size to sturdiness ratio. Stability was by placing the encapsulated liquids in different temperature conditions i.e., fridge (3°C), freezer (-4°6), room temperature (15°C) and warmth (35°C), and periodically drop the balls from the optimal height, to ultimately conclude which temperature was the best.
- Both results would then allow a comparative analysis of reverse spherification and direct spherification.

METHODS: CREATING CREW

Direct Spherification:

- Make a 0.5% solution with sodium alginate and distilled water (ratio of 1: 200)
- Make a 3% solution with calcium lactate and distilled water (ratio of 1:33)
- Take 5 grams (or the desired quantity), pour it in a spoon, and put the sodium alginate solution into the calcium lactate bath

Reverse Spherification:

- Make a 3% solution with calcium lactate and distilled water, or other viscous liquid (ratio of 1: 33)
- Make a 0.5% solution with sodium alginate and distilled water (ratio of 1: 200)
- Take 5 grams (or the desired quantity), pour it in a spoon, and put calcium lactate into the sodium alginate bath

METHODS: TESTING CREW

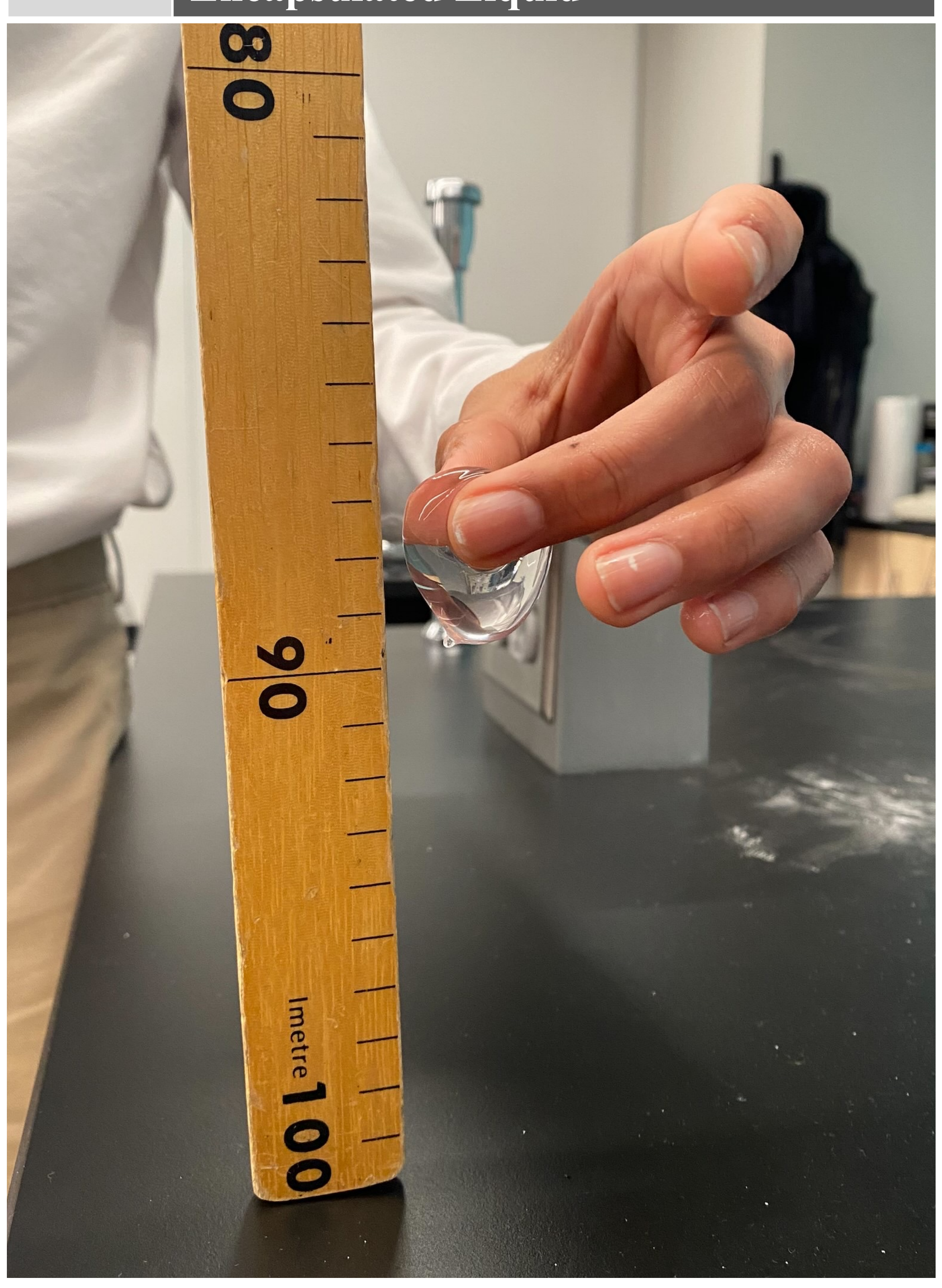
Sturdiness:

- Using the optimal point from above, make encapsulated liquids with this measurement.
- Hold the yard stick perpendicular to the surface that the encapsulated liquid is being dropped (**Figure 2**)
- Drop the encapsulated liquid from 1 centimeter and keep increasing this height until the encapsulated liquid pops
- Take notice of this "maximum height" and repeat steps 2 and 3, changing the size of the encapsulated liquid
- When this is graphed, find the mid-point on the X axis, which becomes the optimal point

Method for stability:

- Using the optimal point from above, make encapsulated liquids with this measurement.
- Put them in different environments i.e., (-14, 3, 15, and 35 degrees Celsius)
- Drop these encapsulated liquids periodically (around every 24 hours) by holding a yard stick perpendicular to the table and noting the maximum height dropped until it popped (**Figure 2**)

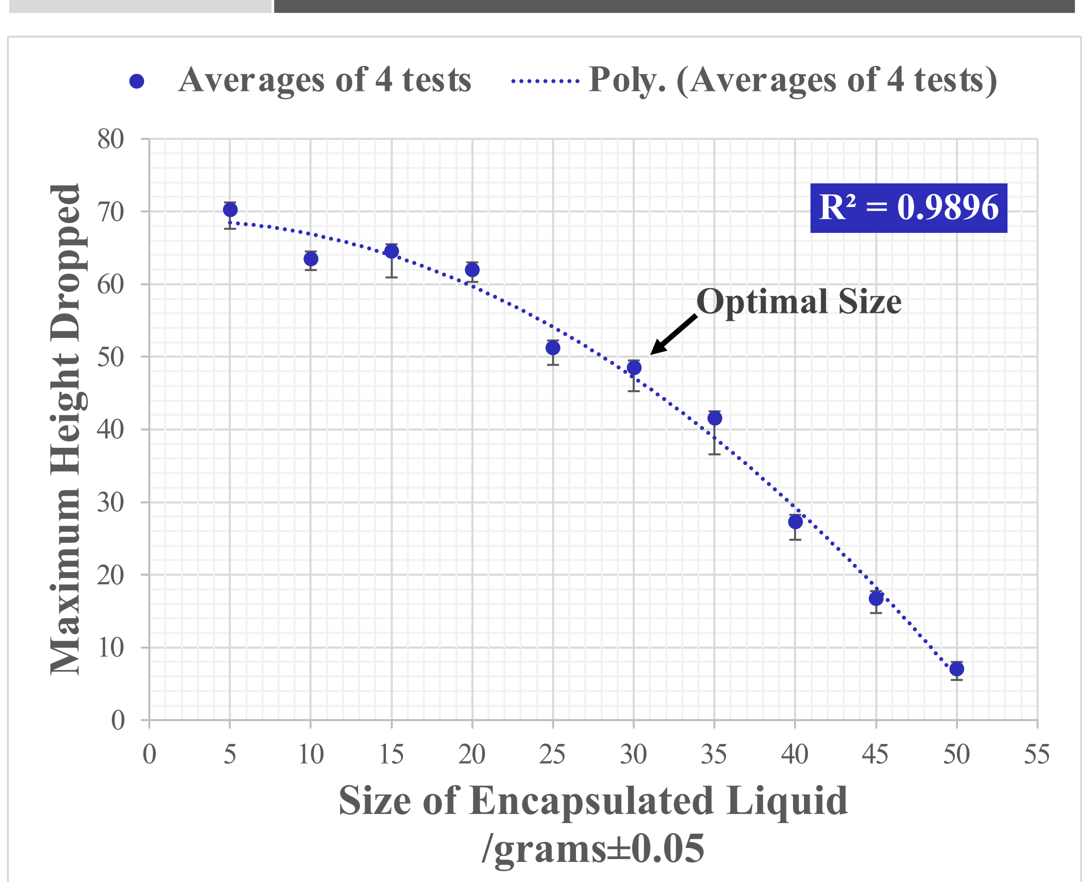
FIG. 2 **Demonstration for Dropping the Encapsulated Liquid**



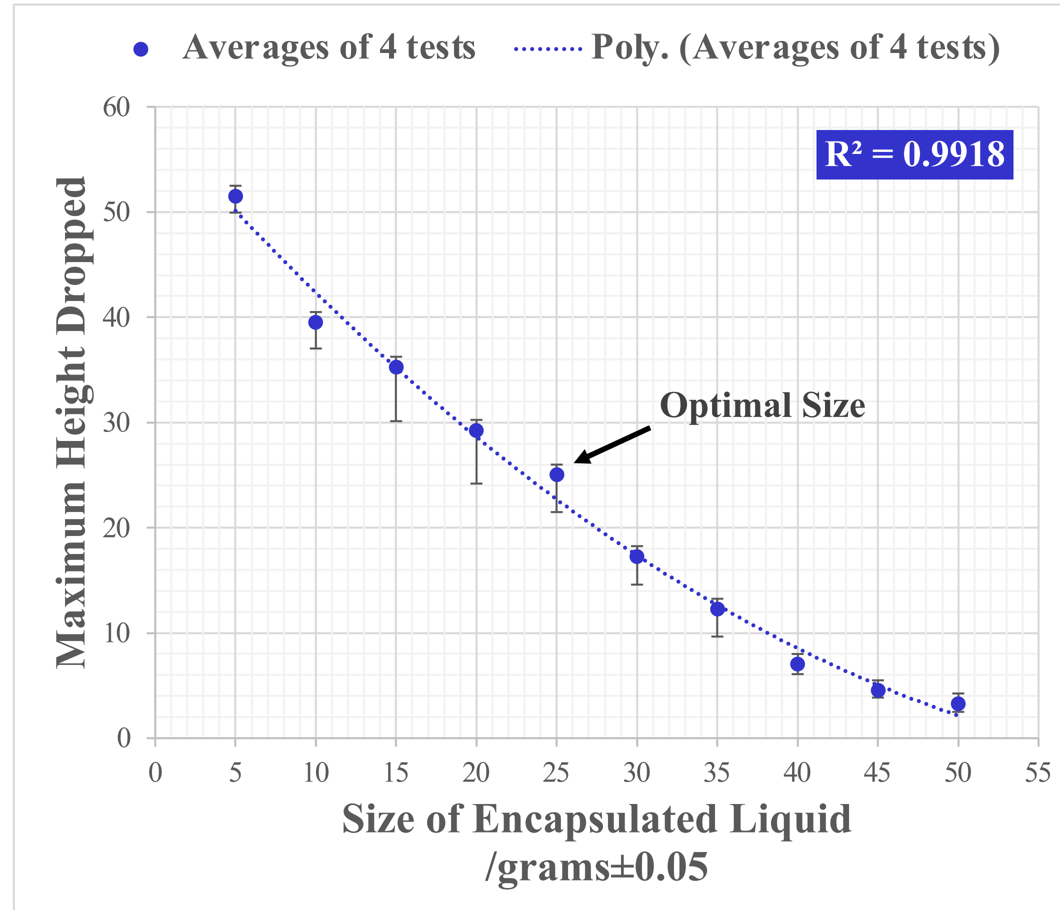
RESULTS: STURDINESS & SIZE

- Regarding sturdiness and maximum size, both, the reverse and direct spherification followed the trend line, considering that they both had a correlation of above 0.98, indicating a very strong positive correlation.
- The optimal point on reverse spherification was a mass of 25 grams and a drop height of 26 centimeters, whereas for direct spherification, the drop height was 48 centimeters (**Graphs 1 & 2**).

GRAPH 1 **Direct Spherification: Sturdiness and Maximum Size**



GRAPH 2 **Reverse Spherification: Sturdiness and Maximum Size**



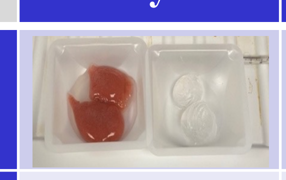
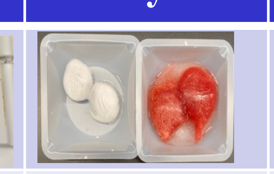
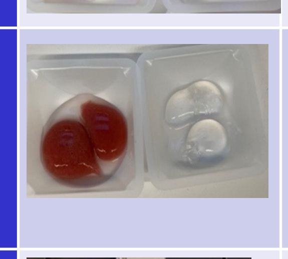
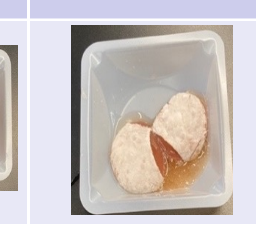
RESULTS: STABILITY

- When testing stability, the fridge seemed to have the longest longevity, and the colors in the encapsulated liquid looked bright and appealing (see tables 1 and 2)

Stability Quantitative

TABLE 1	Spherification			Reverse spherification		
Temp.	Test 1	Test 2	Mean	Test 1	Test 2	Mean
-14°C	∞	∞	∞ Frozen	∞	∞	∞ Frozen
3°C	60	60	60	48	60	54
15°C	24	36	32	24	12	24
35°C	24	12	18	36	24	30

Stability Quantitative

TABLE 2	Day 1	Day 2	Day 3
Freezer (-14°C)			
Fridge (3°C)			
Room Temp. (-15°C)			
Warmth (35°C)			

SUMMARY

- The size of the encapsulated liquid influences the maximum height dropped. A smaller object would have a smaller surface area, and therefore result in a less of an impact.
- As you make the encapsulated liquid larger, it tends to become more of a spheroid rather than a sphere. This connects to a principle: P=F/A, which states that as the surface area of an object increases, the pressure being put on the object will also distribute resulting in a lower impact (and vice versa).
- Not only this, but the fridge temperature being the favored option was due to its tendency to prevent bacteria growth, as well as retaining the liquid within the encapsulated liquid.

CONCLUSION

Encapsulated liquid spherification has the potential to replace plastic bottles. *Liquid encapsulation is not only the future of cleaner environment and molecular gastronomy but also our world.*

ACKNOWLEDGEMENTS

I acknowledge the leadership and engagement of Mr. McLean and Mr. Smith (the science teachers at the British International School of Boston). They were key mentors and teachers for reviewing and advising on experimentation, data analysis, data interpretation analysis and poster presentation