Nov 13 2025

Science Fair Proposal

Student name: Katie

Project Title (be creative) – (Can be added later)

Popping Pearls

Project Question (What problem are you going to explore?):

Does the type of liquid used in popping pearls made with reverse Spherification affect how long it will take to get the ideal thickness in the Hypothesis based on your project question. Sodium alginate bath?

Example: **If**...(I do this) ....**then**...(this will result).. ....**because** .....

If different fluids are turned into Popping boba, then cream will work the best because Creams pH is closest to 7 which is nutral and more nutral fluids work better to make Popping Boba.

what would be the 'ideal' thickness?

Ready for this!

Variables:

Manipulated/Independent variable (what you change):

Type of liquid used

Responding/Dependent variable (what you watch for):

The force it takes to pop the pearl.

Interesting! How will you measure this force?

Controlled/Constant variables (what stays the same):

The amount of Sodium alginate, amount of Calcium lactate, amount of Distilled water The time in the blender, Amount of liquid mixed in, Calcium lactate, amount of, ketchup put in bath, Brand of Ketchup

Required materials: Sodium alginate, Calcium lactate, Distilled Water, Pocket Scale, baking scale, tin foil, PH meter, Syringe, Table Spoon, measuring cup, Glass bowls, Ketchup, Cream, Thick fries, metal Straw, force gauge, Blender, cream, juice.

Feasibility Check...

Feasibility Check:

Can you find at least three sources of information on the subject?	(Yes)/No
Is your experiment safe to perform (for yourself and others)?	(Yes)/No
Will you be able to get all the materials/equipment you need ?	(Yes)/No
Do you have enough time to do your experiment for November ~~end~~ ?	(Yes)/No

FOR STUDENT: I have discussed the project idea and the checklist with my parents/guardian and I am willing to commit to following through on this project.

Student Signature Katie Kay Date Nov. 6/25

FOR PARENT: **I have discussed the project idea and the checklist with my child** and I believe they can follow through with this project. I will support them, as needed, in the completion of this project. I understand that while parents can support their child in completing the project, the student is expected to do the work themselves and learn from their mistakes as part of the scientific process.

Parent Signature Andrea Yates Date Nov. 6/25

Approved by Teacher: Ann Bailey Date Nov 17/25

Background Reasearch

Vocabulary and Concepts

Facts	Meaning/examples
pH	Ph is the measurement of the acidity or basicity of a substance.
Spherification	Is the process that turns liquids into spheres with a jelly outside layer.
Molecular gastronomy	is a type of cooking that focuses on the physical and chemical reactions between different foods.
Force	Force is a push or a pull with magnitude and direction.

Science Fair Background Research

Source(s):	Date:	Question:	Notes: (in point form and remember to put in your own words)
https://www.youtube.com/watch?v=1Os0j8_o2RU https://www.youtube.com/watch?v=i_z22D_aOXQ https://www.youtube.com/watch?v=74RnO_wHX7k https://www.youtube.com/watch?v=WSRv89CiM-0 https://www.britannica.com/topic/molecular-gastronomyhttps://www.britannica.com/topi	Nov 8 Nov.9	What is spherification?	-Process in which liquid is given a jelly-like shell made from sodium alginate and calcium chloride -Sodium alginate comes from seaweed and is flavorless -Two types: basic and reverse spherification -Basic - when the sodium alginate is added to the liquid ingredient -Reverse - when the liquid ingredient is added to the calcium chloride -Basic spherification - thin layer of gel around it and the liquid used for the spherification cannot be too calcium rich or else it won't work -Reverse spherification - used for more calcium rich products; it has a thicker gelatinous layer and it takes longer -Add 1 gram of sodium alginate per every 100 ml -Distilled water should be used because tap water has additional calcium in it -Cool in the refrigerator for at least 1 hour

c/molecular-gastron		What is spherification?	-Try to make a 0.5 to 1% for the calcium based solution with 5 grams of calcium chloride and 1 ml of distilled water -Sodium alginate - used as a substitute gelling agent -Calcium chloride: has 2 positive charges and 1 negative charge and it balances out to neutral charges. (the calcium chloride turns when dissolved into its respective ions) -Since the calcium chloride has 2 positive charges, it binds 2 strands of the sodium alginate at once and that helps form the gel layer over the boba. -The alginate has 1 negative charge. When the 2 chemicals bond together, they create table salt which is why you have to rinse off the boba after you make it. -The longer the liquid sits in the calcium chloride bath, the more gel forms around it, which makes it more like solid boba then popping boba. -The longer the boba sat in the bath, the more gel it became. -Good boba should sit in the calcium bath for about 30 seconds to 1 minute. -Good boba has a thinner coating and should pop easily. - pH below 3.6 doesn't work for the spherification process and you will need to add some sodium citrate to the mixture to raise the pH. -The more acidic mixtures dissolve when added to the calcium bath. -The liquids that were mixed with the sodium alginate had to sit overnight in the fridge. -You have to let the mixture of sodium alginate in the fridge to let all

			of the bubbles and foam out of the mixture before you activate the spherification process.The bubbles in the mixture will sometimes prevent the spheres from forming. -Practice dropping the mixture in the container holding the liquid in it and drop droplets into the container. -Drop 1 inch above the bowl. -When sodium alginate dissolves, that's when the negatively charged molecules release themselves from the strands - The reaction only occurs when the ph is between 4 and 10. -When using spherification, the difference between basic or direct and reverse spherification is that in direct, the gelatous layer grows from the outside in, and with reverse the gelatous layer grows from the outside out. -Reverse spherification is for more calcium liquids like cream and yogurt.
https://www.britannica.com/topic/molecular-gastronomy	Nov 9	What is molecular gastronomy?	-Basically a type of cooking that focuses on the physical and chemical reactions between different foods
https://www.webstaurantstore.com/blog/3012/what-is-molecular-gastronomy.html?srsltid=AfmBOopgrnQdiDnea2DBPQO6LHbNe	Nov 10	Molecular gastronomy items	-Spherification - makes soft and squishy spheres for things like popping boba -Edible paper - used to add flavor to gourmet food dishes

NmweGSFT_z61RHMOf3TpNivCGPj	Nov 10	Molecular gastronomy items	-Flash freezing - used for making frozen decorations and garnishes for gourmet dishes
https://www.amazingfoodmadeeasy.com/info/modernist-ingredients/more/sodium-alginate	Nov 13	Sodium alginate	-Type of gelling agent harvested from brown seaweed -Mostly used for making spheres for gourmet dishes and making fruit caviar but also used to make popping boba -Sodium alginate works best with non acidic mixtures. -Mixtures that are more basic will make the process go more smoothly. -Adding water to a more jelly mixture will make the mixture more liquid-like. It's not just used for spherification, it's also used for just thickening items and acting as a regular gelling agent.
https://www.youtube.com/watch?v=vZ0ehaOEZKE	Nov 13	What is force?	Force = a push or pull -Measured in Newtons (N) -Has magnitude and direction(Vector) -More force applied faster it moves
https://www.britannica.com/science/pH https://www.youtube.com/watch?v=hLzO9pMUF6k		What is pH?	pH - a measurement of the acidity or basicity of a substance -A substance with a pH lower than 7 = acidic, while a pH higher than 7 = basic and a pH of 7 = neutral -pH measurement originated from a Danish biochemist, S.P.L. Sorensen -The measurement was to represent the hydrogen ion -pH measured with pH paper or pH meter -pH meter measures concentration of hydrogen in the solution -pH meter: better for measuring colored liquids like juices and sticky

			substances that you might use when working with foods -A substance with a higher concentration of hydrogen ions will be more acidic and a substance with a lower concentration of hydrogen ions will be more basic.
https://www.andilog.com/content/what-is-a-force-gauge.html'	Nov 13	What is a force gauge?	- measures the force from a push or pull test - unite is in Newtons or pounds - a force gauge is used to see if a part is good or not

Research Paragraphs

What is spherification?

Spherification is the process in which liquid is given a jelly-like shell made from sodium alginate and calcium chloride or calcium lactate. Sodium alginate comes from brown seaweed. There is direct or basic spherification and there is reverse spherification. Direct or basic spherification is when the sodium alginate is added to the fluid and dipped into the calcium

chloride or calcium lactate and reverse spherification is when the calcium lactate is added to the fluid and then dipped into the sodium alginate. The reaction occurs when the calcium chloride that has a plus 2 charge binds to the recently released strand of sodium alginate which has negative 1 charge and the calcium chloride binds to the sodium alginate strands at once because it has a plus 2 charge. That's what creates the jelly layer on the outside of the popping boba.its best to let the mixture that has the liquid in it to sit in the fridge for at least 1 hour to help the bubbles leave the mixture.

Molecular gastronomy

Molecular gastronomy is a type of cooking that's main focus is on the chemical and physical reactions between different foods. Molecular gastronomy is used to make creative and unique dishes, normally gourmet. Some examples are:

Spherification: used to make popping boba and fruit caviar.

Flash freezing: using liquid nitrogen to immediately freeze food, like ice cream, decorations and garnishes

Edible paper: is made with potato starch and soy beans infused with different ingredients in color to give a big burst of flavor.

What is force?

Force is either a push or a pull. It is normally measured in Newtons. The more force that is applied to an object, the faster it moves, where if less force was applied, it would move slower. Force has a vector showing which direction it is being moved, like up and down, north, west, east, south. Those directions are shown in the vectors. (the arrows)

How is force measured?

Force can be measured with a force meter. If it's measured with a force meter, it will be measured in Newtons. My boba pearls on the other hand will most likely be too small for the force meter to measure, so we are going to use a scale and eventually calculate the force in which I will turn the number into newtons. (hopefully)

What is pH?

pH is a measurement of the acidity or basicity of a substance. A substance with a pH lower than 7 is considered acidic, while a pH higher than 7 is considered basic and a pH of 7 is considered neutral. The pH measurement originated from a Danish biochemist, S.P.L. Sorensen. The measurement was to represent the hydrogen ion. pH is measured with pH paper or a pH meter. A pH meter measures the concentration of hydrogen ions that are present in the solution. A pH meter is better for measuring colored liquids like juices and sticky substances that you might use when working with foods. A substance with a higher concentration of hydrogen ions will be more acidic and a substance with a lower concentration of hydrogen ions will be more basic.

What is sodium alginate?

Sodium alginate is harvested from brown seaweed. It is used as a gelling agent. It can be used to make popping boba and used as a regular gelling agent. Sodium alginate works best when the mixture isn't too acidic. More basic substances work best with sodium alginate. It is used as the bath for reverse spherification and is mixed with the substance in direct or basic spherification.

What is a force gauge?

A force gauge is used to measure how much force it takes to make an object do something.

Nov 14 2025

How to make the Sodium alginate bath:

0.5g Sodium alginate with 100g water

1.0g Sodium alginate with 200g water

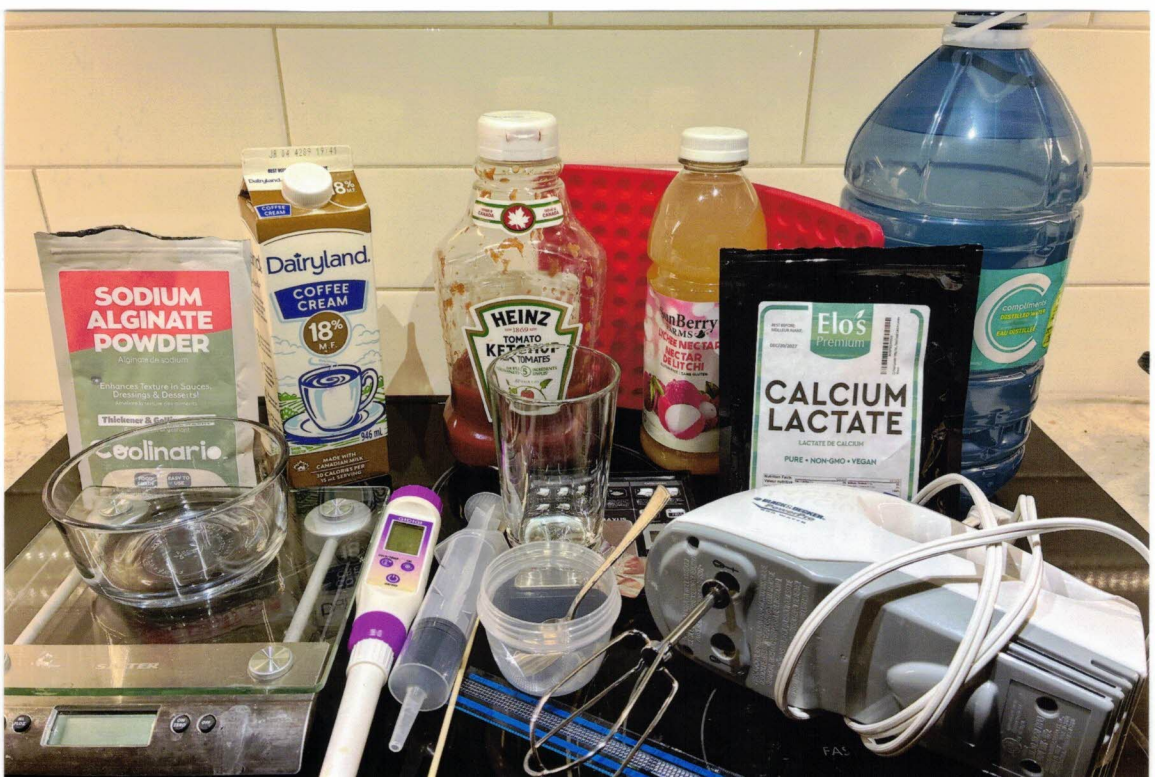
How to make calcium lactate.

2.0g calcium lactate with 100g liquid

Materials needed for my experiment:

Dec 30th 2025

- Calcium lactate
- Sodium alginate
- Pocket scale
- Weights (in grams)
- Distilled water
- Skewer sticks
- Baking scale
- Semi-Sphere silicon molds
- Lychee juice
- Ketchup
- Cream
- Thick fries
- Timer
- cooking sheet
- metal straw
- Glass cups + bowls
- hand blender
- Small spoon
- pH meter
- Cling rap
- Syringe



Procedure:

Dec 30th 2025

1) Mix the calcium and the liquid together
2) Measure pH
3) Use a syringe to fill semi-sphere molds with the liquid
4) Freeze the liquids in the molds
5) While the spheres are freezing, make the sodium alginate bath
6) Wait 1 hour
7) Take out frozen mold tray and pop out one frozen pearl
8) Weigh frozen pearl on a peice of tinfoil
9) Put it in bath and set a timer for increments of 30 seconds
Or weigh it again
10) measure height and diameter
12) Place weights on the pearls 1 at a time untill the pearl pops
13) Record measurments
14) Repeat

How to make a ketchup filled Fry:

1) Mix calcium into ketchup
2) Make Sodium algenate bath
3) Wait 1 hour
4) Get a Syringe and fill it. Then Squirt a worm of ketchup into it
5) Set a timer for 2.5 minutes
6) Take it out of the bath
7) make french fries
8) Hollow one out with a metal straw
9) Tap the ketchup worm into the fry
10) Shove leftover fry from straw into the remaining hole (optional)
11) Take a bite!!
12) Enjoy

Dec 30th 2025

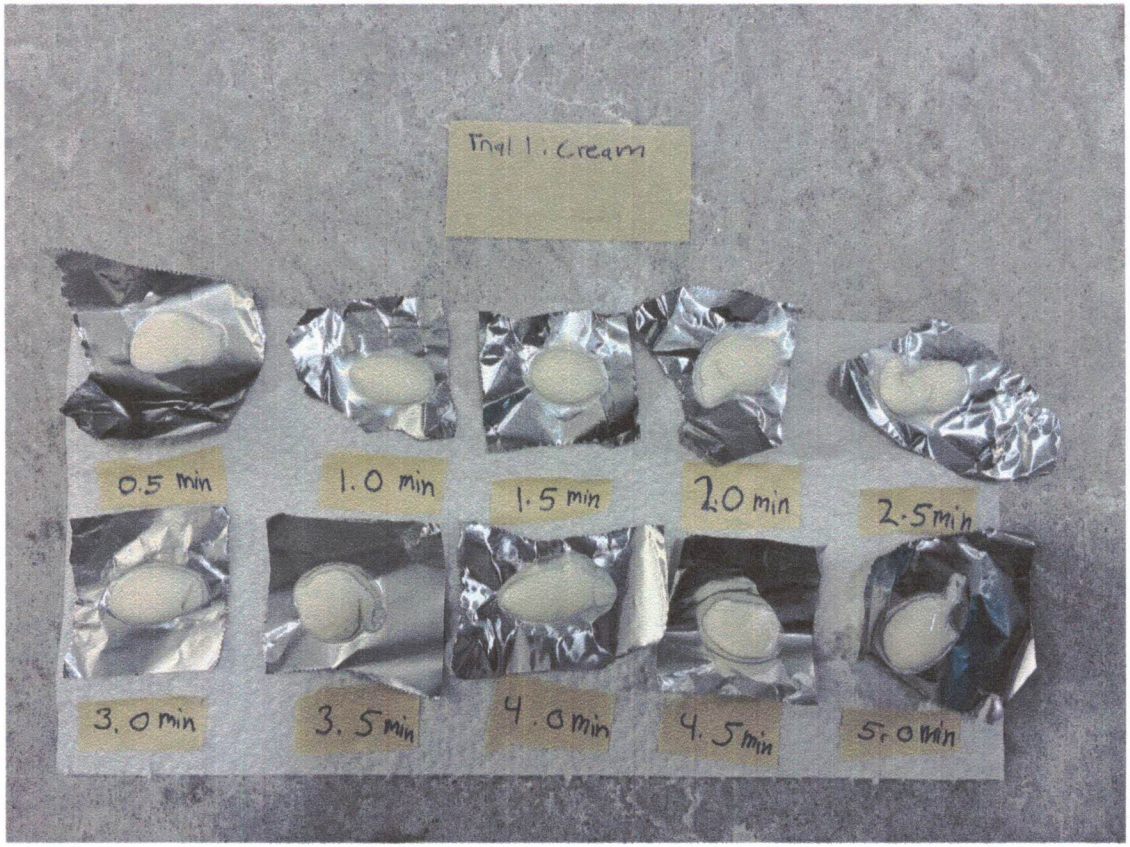
(No mold spheres)

Spheres are blobby and not simetrical.

The blobs seen to weaken the Pearl

Dec 30th 2025
(No mold spheres)

Are not spheres at all!!!



0.5 mins seems to be stronger then some of the other ones?

Dec 30th 2025
(No mold spheres)

A spoon isn't the way to go. The pearls don't look nice and are going against my background research.

The pearls seem to grow thicker the longer you leave them out.

Qualitative Observations:

Jan 24 2026

Ketchup: The ketchup pearls are a red color that looks slightly orange. They are sometimes hard to get out of the molds because they seem to stick to the sides. The pearls pop quite nicly.

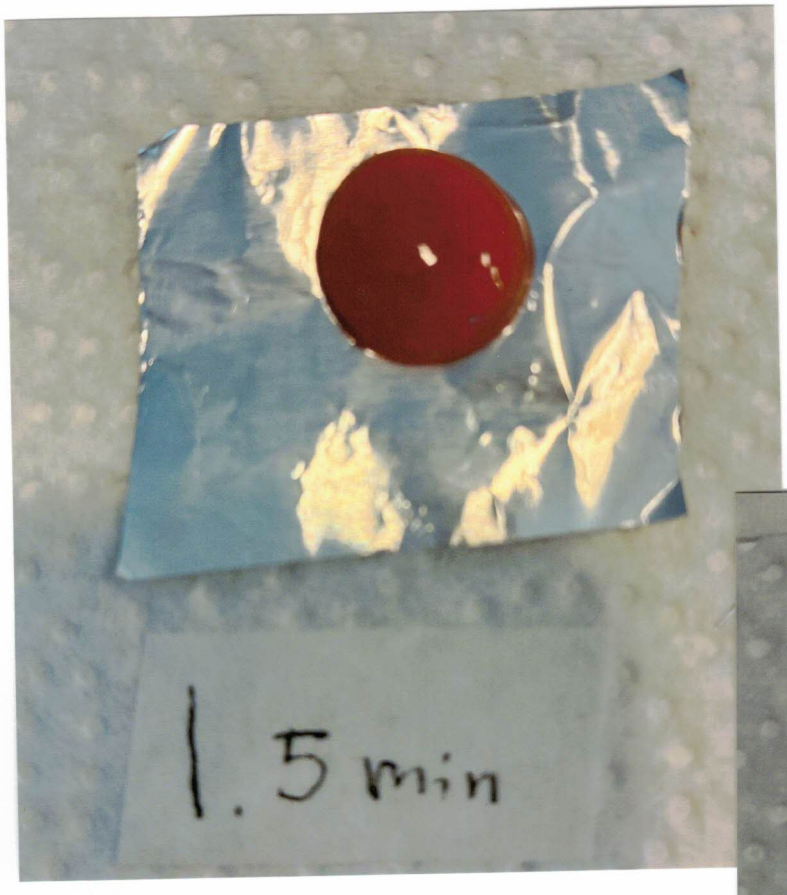
Jan 2d 2026

Cream: The cream pearls are a bright white color. The pearls are very good at coming out of the molds intact and are very hard to pop.

Jan 3d 2026

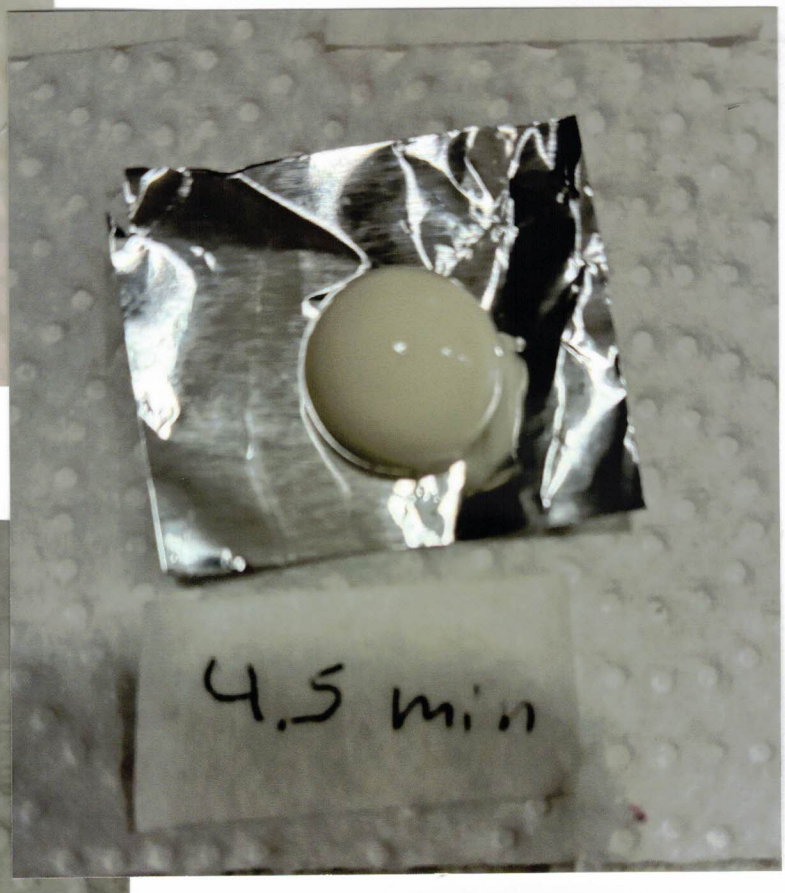
Lychee Juice: The lycheejuice pearls are a pale yellow color. The pearls come out of the molds quite nicly, though some of them are a bit sticky. The pale color makes it hard to tell if the pearl has popped or not.

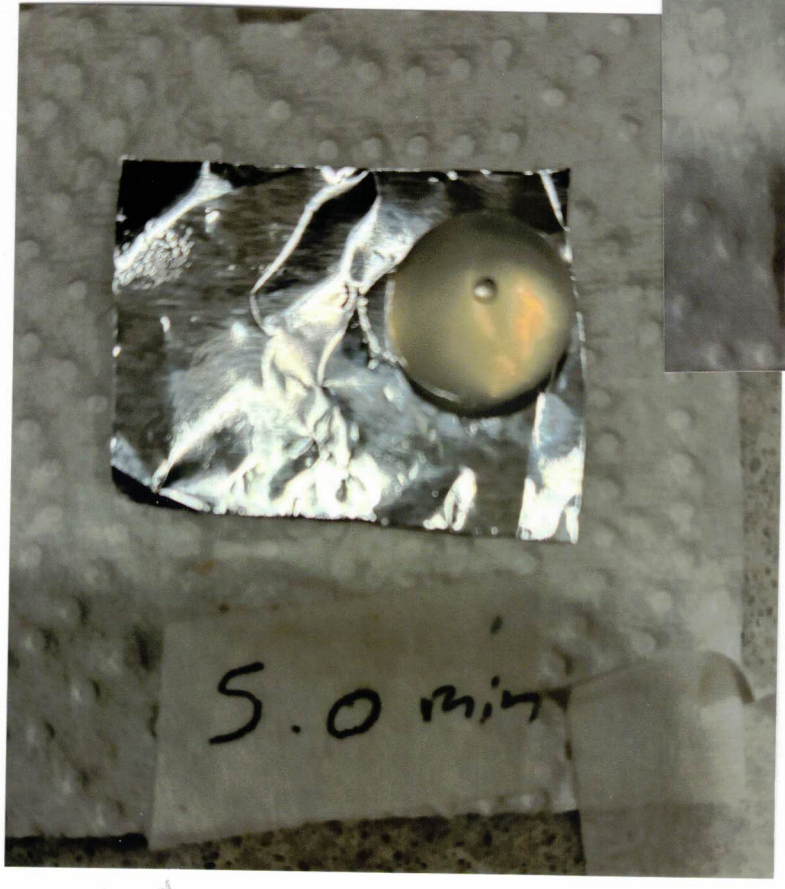
Jan 2nd 2026



<— 1 and a half minute Ketchup Pearl

Jan 2d 2026





↑
4 and a half Cream Pearl

<— 5 minute Lychee Juice pearl

Jan 3rd 2026

Jan 2nd 2026 pH: 3.84

Ketchup Trial #1

Time (min.)	Starting Weight (g)	Final weight (g)	Diameter (cm)	Height (cm)	Weight to pop the Pearl (g)
0.5	0.75	0.94	1.4×1.7	0.70	10
1.0	0.86	1.07	1.5×1.7	0.70	10
1.5	0.81	1.00	1.3×1.7	0.75	19
2.0	0.85	1.15	1.5×1.6	0.90	19
2.5	0.81	1.12	1.5×1.5	0.90	31
3.0	0.82	1.16	1.5×1.6	0.90	27
3.5	0.84	1.26	1.5×1.5	0.95	48
4.0	0.86	1.31	1.5×1.5	0.90	49
4.5	0.85	1.28	1.5×1.5	0.90	56
5.0	0.84	1.30	1.5×1.5	1.00	13083

Cream Trial #1

Jan 2nd 2026 pH: 6.02

Time (min.)	Starting Weight (g)	Final weight (g)	Diameter (cm)	Height (cm)	Weight to pop the Pearl (g)
0.5	0.73	1.00	1.4x1.5	0.75	40
1.0	0.75	1.00	1.5x1.5	0.90	90.12
1.5	0.77	1.00	1.4x1.5	0.85	143.85
2.0	0.77	1.12	1.5x1.5	0.90	190.10
2.5	0.76	1.07	1.5x1.5	1.00	205.41
3.0	0.79	1.17	1.5x1.5	0.95	231.43
3.5	0.81	1.17	1.5x1.6	1.00	219.81
4.0	0.80	1.21	1.5x1.6	1.00	256.05
4.5	0.79	1.21	1.5x1.5	1.05	315.31
5.0	0.79	1.25	1.6x1.6	1.10	235.85

Jan 3rd 2026 pH: 4.06

Lychee Trial #1

Time (min.)	Starting Weight (g)	Final weight(g)	Diameter(cm)	Height (cm)	Weight to pop the Pearl (g)
0.5	0.95	1.16	1.4x1.5	0.75	34
1.0	1.00	1.21	1.4x1.5	0.85	24
1.5	0.86	1.11	1.4x1.5	0.90	82.55
2.0	0.87	1.21	1.4x1.4	0.95	123.80
2.5	1.00	1.25	1.4x1.5	0.95	63.49
3.0	1.00	1.38	1.4x1.5	1.05	236.00
3.5	0.95	1.30	1.5x1.5	1.10	248.55
4.0	1.00	1.47	1.5x1.5	1.20	310.82
4.5	0.81	1.18	1.4x1.4	1.10	295.16
5.0	0.84	1.27	1.4x1.5	1.15	315.23

Jan 4th 2026 PH: 3.83

Ketchup Trial #2

Time (min.)	Starting Weight (g)	Final weight (g)	Diameter (cm)	Height (cm)	Weight to pop the Pearl (g)
0.5	0.85	1.08	1.5 x 1.5	0.70	15
1.0	0.86	1.13	1.6 x 1.5	0.75	17
1.5	0.86	1.13	1.6 x 1.5	0.80	14
2.0	0.85	1.21	1.6 x 1.5	0.80	16
2.5	0.86	1.20	1.6 x 1.6	0.80	31
3.0	0.87	1.27	1.6 x 1.6	0.80	30
3.5	0.89	1.26	1.5 x 1.6	0.85	54
4.0	0.85	1.30	1.5 x 1.6	0.90	49
4.5	0.87	1.40	1.6 x 1.6	0.90	51
5.0	0.84	1.31	1.5 x 1.5	0.90	70.07

Jan 4th 2026 pH: 6.09

Cream Trial #2

Time (min.)	Starting Weight (g)	Final weight (g)	Diameter (cm)	Height (cm)	Weight to pop the Pearl (g)
0.5	0.75	0.95	1.5x1.5	0.80	60.52
1.0	0.77	1.00	1.5x1.5	0.85	117.35
1.5	0.78	1.07	1.5x1.5	0.85	99.77
2.0	0.76	1.11	1.5x1.5	0.85	114.33
2.5	0.82	1.16	1.5x1.6	0.90	168.06
3.0	0.77	1.20	1.6x1.6	0.90	234.46
3.5	0.79	1.24	1.5x1.5	0.90	271.58
4.0	0.79	1.23	1.5x1.5	0.90	252.50
4.5	0.78	1.28	1.5x1.5	0.95	300.40
5.0	0.77	1.26	1.6x1.6	0.95	329.78

Jan 4th 2026 PH: 4.07

Lychee Trial #2

Time (min.)	Starting Weight (g)	Final weight (g)	Diameter (cm)	Height (cm)	Weight to pop the Pearl (g)
0.5	0.73	0.92	1.4x1.4	0.65	30
1.0	0.84	1.07	1.4x1.5	0.85	78.12
1.5	0.75	1.00	1.4x1.5	0.85	112.35
2.0	0.82	1.07	1.4x1.5	0.95	202.16
2.5	0.70	1.00	1.4x1.4	0.90	186.10
3.0	0.84	1.16	1.4x1.5	1.00	311.76
3.5	0.84	1.22	1.4x1.4	1.05	245.56
4.0	0.79	1.19	1.4x1.4	1.10	307.83
4.5	0.76	1.17	1.4x1.4	1.10	275.00
5.0	0.91	1.38	1.4x1.5	1.10	295.26

Jan 5th 2026 PH: 6.12

Cream Trial #3

Time (min.)	Starting Weight (g)	Final weight(g)	Diameter(cm)	Height (cm)	Weight to pop the Pearl (g)
0.5	0.76	1.00	1.4 x1.4	0.90	74.09
1.0	0.79	1.00	1.4 x1.5	0.80	136.29
1.5	0.79	1.05	1.5 x1.5	0.85	210.11
2.0	0.80	1.11	1.5 x1.5	0.90	260.00
2.5	0.78	1.12	1.5 x1.5	0.90	213.49
3.0	0.78	1.14	1.5 x1.5	0.90	292.56
3.5	0.83	1.17	1.5 x1.5	0.90	239.00
4.0	0.77	1.19	1.5 x1.5	0.95	254.94
4.5	0.75	1.21	1.5 x1.5	1.00	284.06
5.0	0.77	1.19	1.5 x1.5	1.00	328.88

Jan 5 2026 pH: 4.12

Lychee Trial #3

Time (min.)	Starting Weight (g)	Final weight(g)	Diameter(cm)	Height (cm)	Weight to pop the Pearl (g)
0.5	0.84	1.00	1.5x1.5	0.80	89.52
1.0	0.83	1.05	1.4x1.4	0.80	113.29
1.5	0.79	1.00	1.4x1.4	0.85	139.83
2.0	0.76	1.00	1.4x1.4	0.90	182.10
2.5	0.77	1.11	1.4x1.5	0.85	135.34
3.0	0.83	1.18	1.4x1.4	0.90	205.24
3.5	0.74	1.11	1.4x1.4	1.00	254.94
4.0	0.87	1.29	1.4x1.4	1.10	291.60
4.5	0.74	1.20	1.4x1.3	0.95	265.63
5.0	0.77	1.20	1.4x1.4	1.10	264.00

Ketchup Trial #3

Jan 7th 2026 pH: 3.7

Time (min.)	Starting Weight (g)	Final weight(g)	Diameter(cm)	Height (cm)	Weight to pop the Pearl (g)
0.5	0.86	1.10	1.5x1.5	0.70	16
1.0	0.91	1.15	1.5x1.6	0.75	16
1.5	0.88	1.20	1.5x1.6	0.75	21
2.0	0.92	1.22	1.5x1.6	0.80	30
2.5	0.87	1.22	1.5x1.6	0.80	35
3.0	0.83	1.26	1.5x1.5	0.85	30
3.5	0.84	1.26	1.6x1.6	0.90	39
4.0	0.86	1.32	1.5x1.5	0.90	45
4.5	0.86	1.32	1.5x1.5	0.90	41
5.0	0.89	1.40	1.6x1.6	0.90	70.06

Quantitative Observations

	Weight gain of pearl in sodium alginate bath (grams)								
	Ketchup			Cream			Lychee Juice		
Time in sodium alginate bath (minutes)	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
0.5	0.19	0.23	0.24	0.27	0.20	0.24	0.21	0.19	0.16
1.0	0.21	0.27	0.24	0.25	0.23	0.21	0.21	0.23	0.22
1.5	0.19	0.27	0.32	0.23	0.29	0.26	0.25	0.25	0.21
2.0	0.30	0.36	0.30	0.35	0.35	0.31	0.34	0.25	0.24
2.5	0.31	0.34	0.35	0.31	0.34	0.34	0.25	0.30	0.34
3.0	0.34	0.40	0.43	0.38	0.43	0.36	0.38	0.32	0.35
3.5	0.42	0.36	0.42	0.36	0.45	0.34	0.35	0.38	0.37
4.0	0.45	0.45	0.46	0.41	0.44	0.42	0.47	0.40	0.42
4.5	0.43	0.53	0.46	0.42	0.50	0.46	0.37	0.41	0.46
5.0	0.46	0.47	0.51	0.46	0.49	0.42	0.43	0.47	0.43

Quantitative Observations

	Height of pearl (cm)								
	Ketchup			Cream			Lychee Juice		
Time in sodium alginate bath (minutes)	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
0.5	0.70	0.70	0.70	0.75	0.80	0.90	0.75	0.65	0.80
1.0	0.70	0.75	0.75	0.90	0.85	0.80	0.85	0.85	0.80
1.5	0.75	0.80	0.75	0.85	0.85	0.85	0.90	0.85	0.85
2.0	0.90	0.80	0.80	0.90	0.85	0.90	0.95	0.95	0.90
2.5	0.90	0.80	0.80	1.00	0.90	0.90	0.95	0.90	0.85
3.0	0.90	0.80	0.85	0.95	0.90	0.90	1.05	1.00	0.90
3.5	0.95	0.85	0.90	1.00	0.90	0.90	1.10	1.05	1.00
4.0	0.90	0.90	0.90	1.00	0.90	0.95	1.20	1.10	1.10
4.5	0.90	0.90	0.90	1.05	0.95	1.00	1.10	1.10	0.95
5.0	1.00	0.90	0.90	1.10	0.95	1.00	1.15	1.10	1.10

Quantitative Observations

	Weight (grams) to pop pearl								
	Ketchup			Cream			Lychee Juice		
Time in sodium alginate bath (minutes)	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
0.5	10.00	15.00	16.00	40.00	60.52	74.09	34.00	30.00	89.52
1.0	10.00	17.00	16.00	90.12	117.35	136.29	24.00	78.12	113.29
1.5	19.00	14.00	21.00	143.85	99.77	210.11	82.55	112.35	139.83
2.0	19.00	16.00	30.00	190.10	114.33	260.00	123.80	202.16	182.10
2.5	31.00	31.00	35.00	205.41	168.06	213.49	63.49	186.10	135.34
3.0	27.00	30.00	30.00	231.43	234.46	292.56	236.00	311.76	205.24
3.5	48.00	54.00	39.00	219.81	271.58	239.00	248.55	245.50	254.94
4.0	49.00	49.00	45.00	256.05	252.50	254.94	310.82	307.83	291.60
4.5	56.00	51.00	41.00	315.31	300.40	284.06	295.16	275.00	265.63
5.0	130.83	70.07	70.06	235.85	329.78	328.8	315.23	295.26	264.00

Quantitative Observations

Table 1. Average weight gain of pearl (grams) for trials 1-3			
Time in sodium alginate bath (minutes)	Ketchup	Cream	Lychee Juice
0.5	0.22	0.24	0.19
1.0	0.24	0.23	0.22
1.5	0.26	0.26	0.24
2.0	0.32	0.33	0.28
2.5	0.33	0.33	0.30
3.0	0.39	0.39	0.35
3.5	0.40	0.38	0.37
4.0	0.45	0.42	0.43
4.5	0.47	0.46	0.41
5.0	0.49	0.46	0.44

Quantitative Observations

Table 2. Average height of pearl (cm) for trials 1-3			
Time in sodium alginate bath (minutes)	Ketchup	Cream	Lychee Juice
0.5	0.70	0.81	0.73
1.0	0.73	0.85	0.83
1.5	0.76	0.85	0.85
2.0	0.83	0.88	0.93
2.5	0.83	0.93	0.90
3.0	0.85	0.92	1.00
3.5	0.90	0.93	1.05
4.0	0.90	0.95	1.13
4.5	0.90	1.00	1.05
5.0	0.93	1.02	1.12

Quantitative Observations

Table 3. Average weight to pop pearl (grams) for trials 1-3			
Time in sodium alginate bath (minutes)	Ketchup	Cream	Lychee Juice
0.5	13.00	58.02	51.00
1.0	14.30	115.50	66.13
1.5	18.00	151.20	112.00
2.0	22.00	189.00	169.35
2.5	32.30	196.30	173.42
3.0	29.00	253.60	251.00
3.5	47.00	244.30	249.33
4.0	48.00	255.40	304.41
4.5	34.30	300.00	279.00
5.0	90.32	298.14	292.40

Quantitative Observations

Table 4. Average force to pop pearl (Newtons) for trials 1-3			
Time in sodium alginate bath (minutes)	Ketchup	Cream	Lychee Juice
0.5	0.127	0.570	0.503
1.0	0.141	1.133	0.648
1.5	0.176	1.484	1.098
2.0	0.216	1.855	1.661
2.5	0.317	1.926	1.701
3.0	0.285	2.487	2.462
3.5	0.462	2.396	2.446
4.0	0.471	2.506	2.986
4.5	0.337	2.943	2.736
5.0	0.887	2.925	2.868

Figure 1. Average weight gain of the pearl

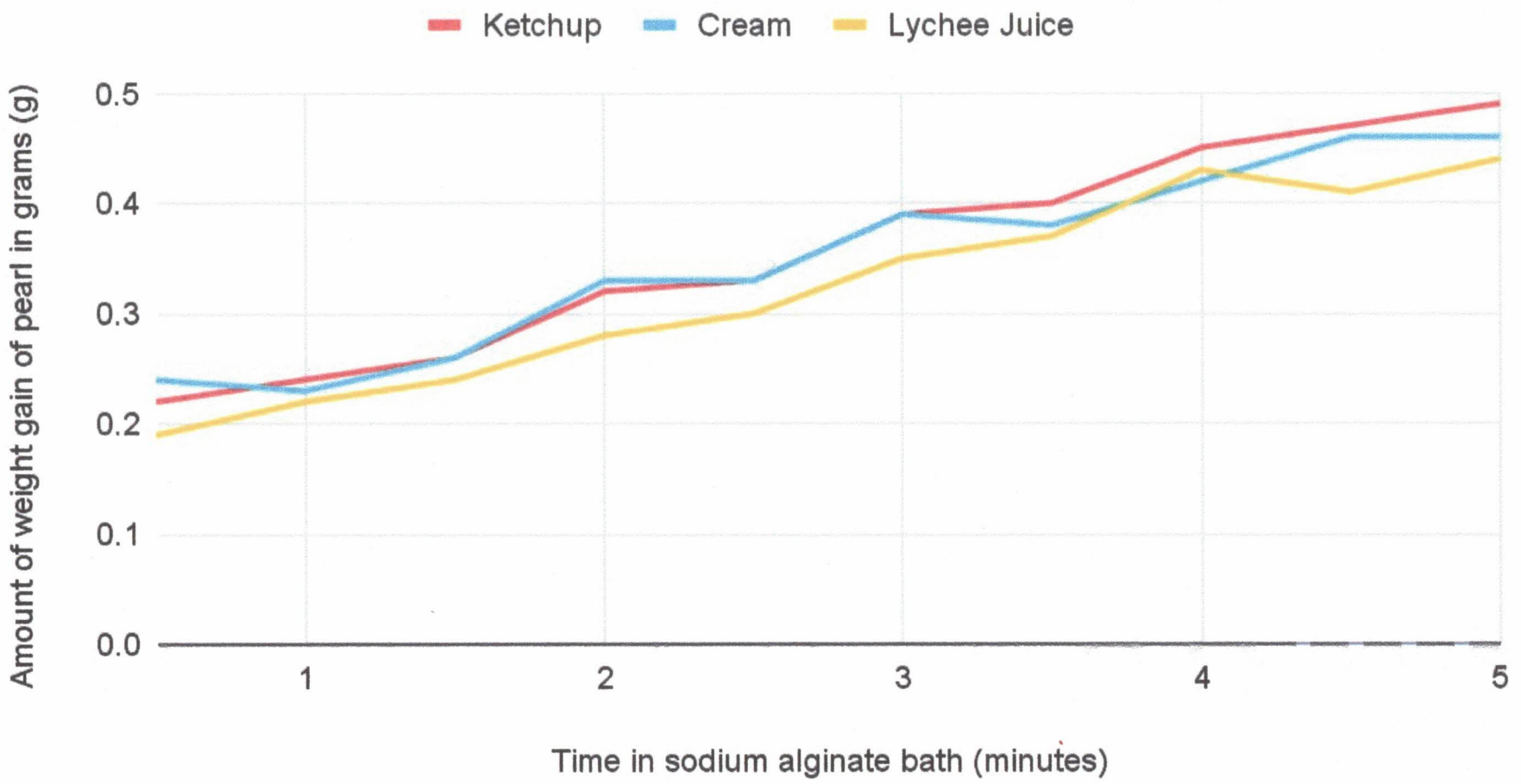


Figure 2. Average height of the pearl

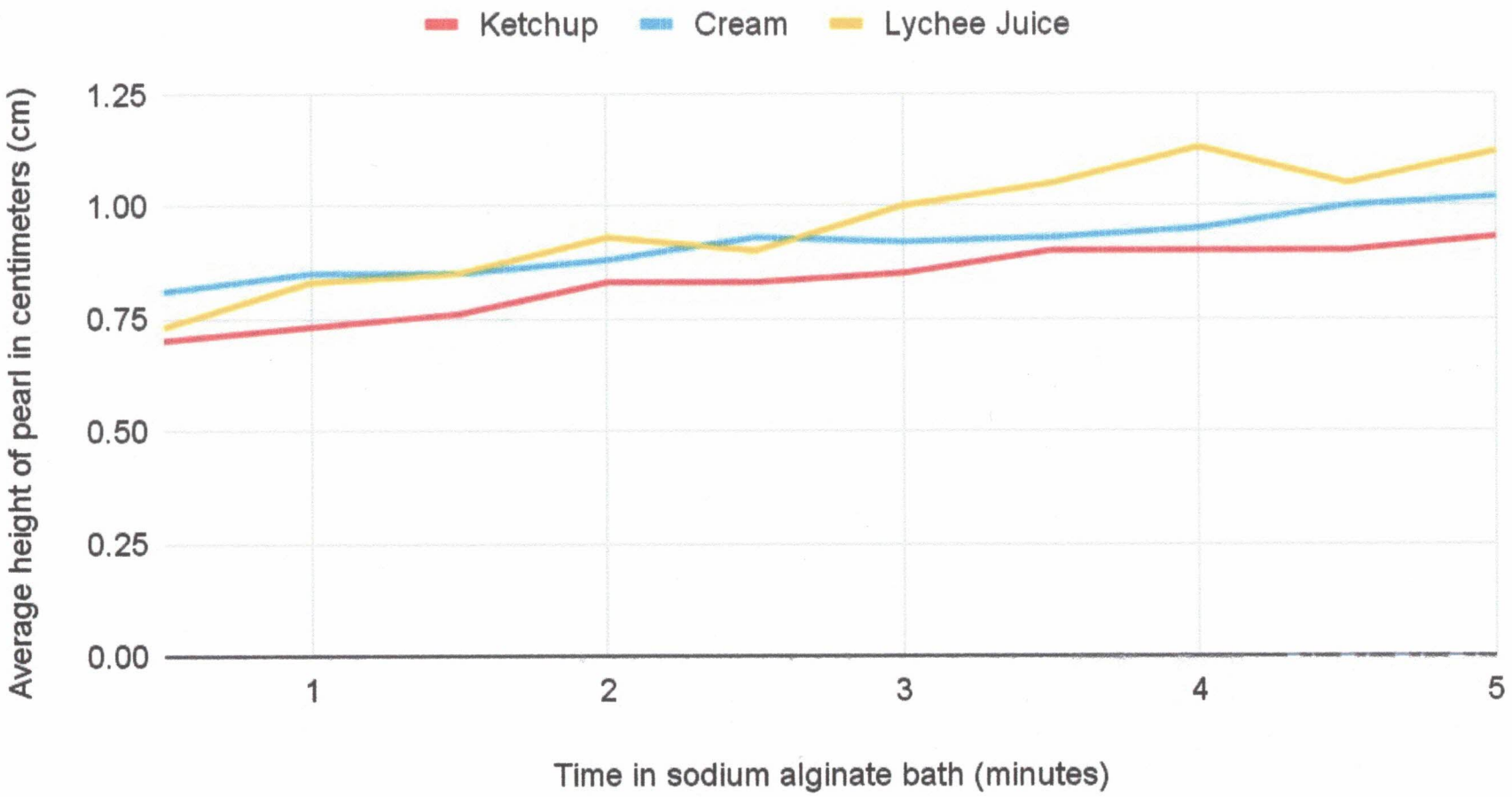


Figure 3. Average weight to pop the pearl

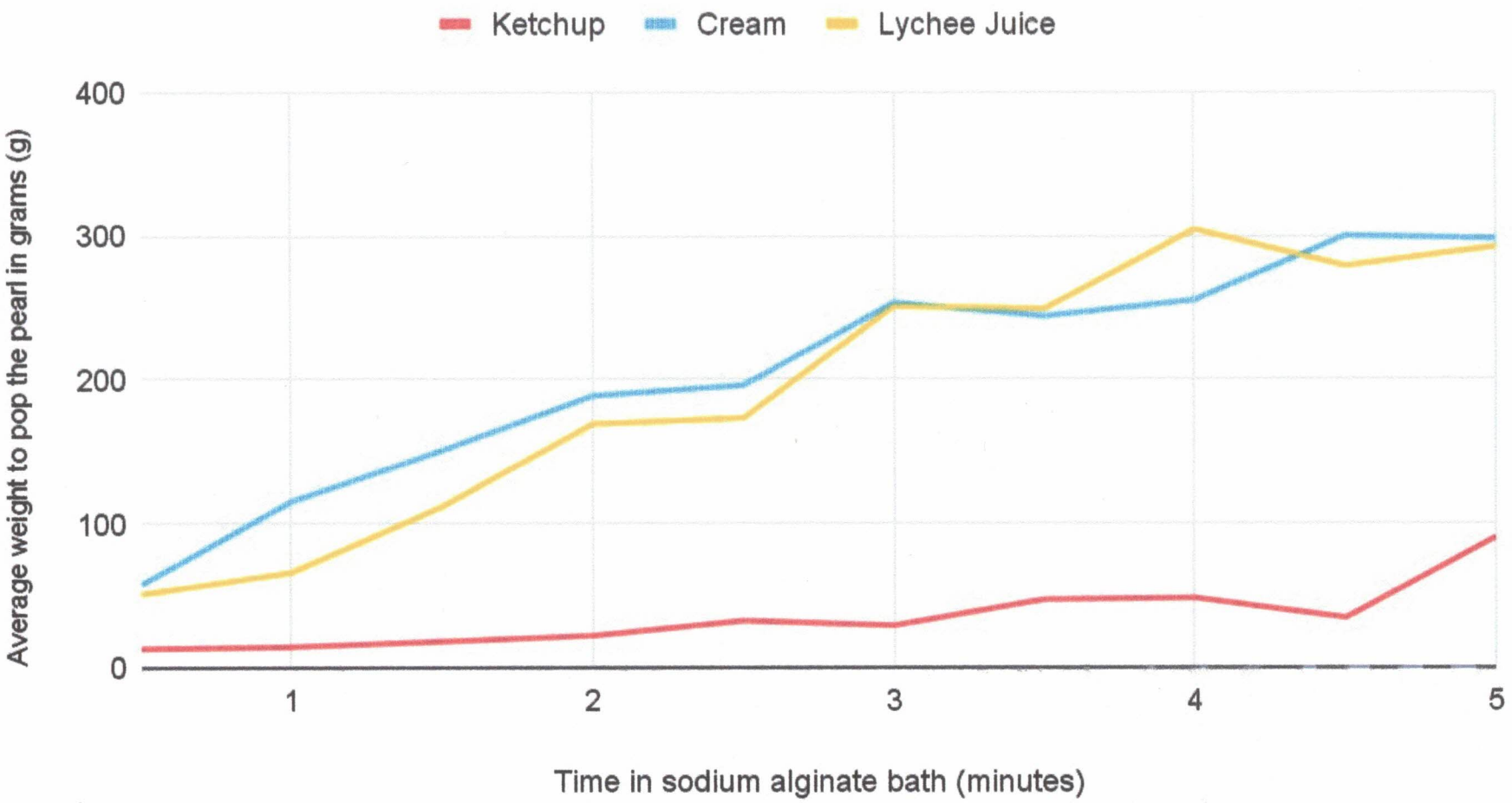
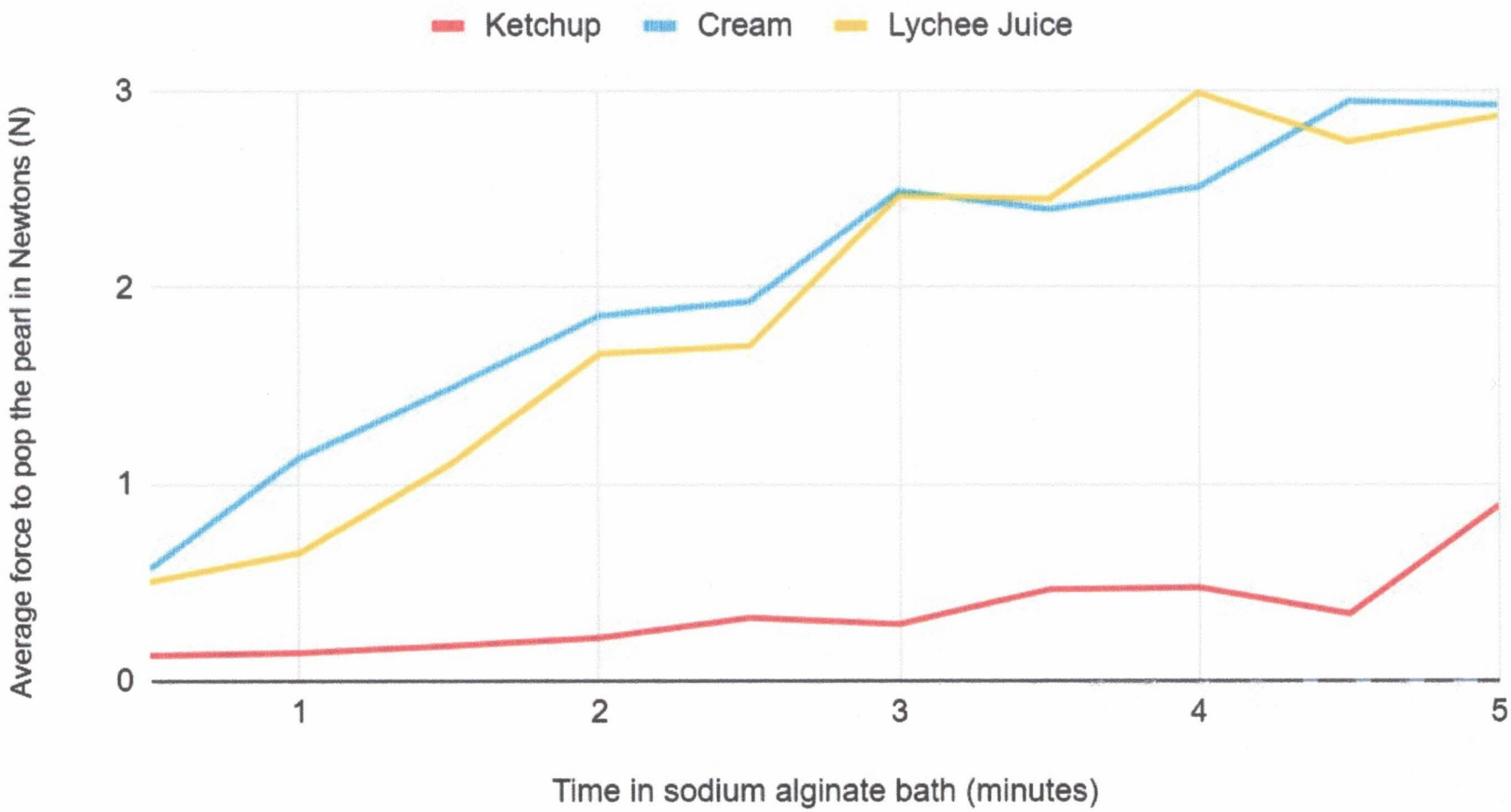


Figure 4. Average force to pop the pearl



Sample calculations:

Jan 10th 2026

① Average weight gain of pear in Sodium algenate bath:

Ketchup: 0.5 minutes

$$\frac{\text{Trial 1} + \text{Trial 2} + \text{Trial 3}}{3}$$

$$= \frac{0.19g + 0.23g + 0.24g}{3}$$

$$= 0.22g$$

0.19g
0.23g
0.24g
0.66g

3 | 0.66 → 0.22, 6, 6, 0

② Average height of pearl:

Ketchup; 0.5 minutes

$$\frac{\text{Trial 1} + \text{Trial 2} + \text{Trial 3}}{3}$$

$$= \frac{0.70g + 0.70g + 0.70g}{3}$$

$$= 0.70g$$

0.70
0.70
0.70
2.10

3 | 2.10 → 0.70, 21, 21, 0

③ Average weight (grams) to pop the pearl

Ketchup: 0.5 minutes

$$\frac{\text{Trial 1} + \text{Trial 2} + \text{Trial 3}}{3}$$

$$= \frac{10.00g + 15.00g + 16.00g}{3}$$

$$= 13.67g$$

10.00
15.00
16.00
41.00

3 | 41.00 → 13.6 (round to 7 at next because the 6 is infinite), 9, 18, 20

Density Calculations:

Jan 10th 2026

Lychee Juice:
Volume: 100mL
Mass: 98g
Density: 0.98g/mL

$D = \frac{M}{V} = \frac{98g}{100mL} = 0.98g/mL$

Cream:
Volume: 100mL
Mass: 103g
Density: 1.03g/mL

$D = \frac{M}{V} = \frac{103g}{100ml} = 1.03g/mL$

Ketchup:
Volume: 100mL
Mass: 142g
Density: 1.42g/mL

$D = \frac{M}{V} = \frac{142g}{100mL} = 1.42g/mL$

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Sumorization of graphs/Analysis/conclusion

Weight gain: Ketchup has gained the most and lychee juice the least. Cream is in between them. Lychee juice beat cream once, but otherwise was less weight. Cream and Ketchup are close, but Ketchup took the lead between the 3 and 5 minute mark. This was most likely due to density.

Height: Lychee juice is the tallest with cream only beating it sometimes. Ketchup didn't beat cream once. This was likely due to density.

Weight to pop: Cream took the most amount of weight to pop and Ketchup the least. Lychee juice was in the middle and only beat Cream twice, between the 3.5 and 4 minute mark.

Jan 11th 2026

Mini Conclusion: Ketchup is the heaviest (due to density). Lychee juice is the tallest (also due to density). Cream is the most durable to weights (due to pH). This means cream most likley had the thickest membrane, Lychee juice with the second thickest, and Ketchup with the thinnest. My hypothisis was supported.

Jan 17th 2026

Applications + Next steps

Applications

- My ketchup fry!! - less waste on tiny ketchup packets
- Popping coffee creamers - less waste too!
- Thicker or thinner boba
- Beginners know reverse = 2 to 3 minutes in bath
- Ketchup and mustard boba for hot dogs?? (hamburgers??)
- Juice for boba (popping)

Next steps

- Cream without Calcium lactate?
- different mold sizes
- Coating a pill to see if it could survive the stomach
- ~~Cool~~ different versions of food
- Direct instead of reverse
- Other liquids

Jan 18 2026

It Worked !!!

My ketchup fry!

Popped boba in the fry

Hollowed out ketchup fry

Ketchup pearl/worm