

Crystal cookery – using high-throughput technologies and the grocery store as a teaching tool

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Undergraduate Research Experiences

The Hauptman-Woodward Medical Research institute has been running an undergraduate summer intern program sponsored by local organizations for over a decade.

Students are paid a stipend.

Students spend **10 weeks** conducting individual research projects in PI laboratories. Each research project is related to the PI's research.

At the end of these 10 weeks, each student presents an overview of the project and their research to the institute staff and their peers.

Depending on the year numbers can range from 10-20.

Information is available at

<http://www.hwi.buffalo.edu/outreach/internships.html>



Why use crystals as a 'hook' for this?

They are stunningly beautiful.

They link biology to many other disciplines.

For some proteins, it's not hard to get them.

The Scientific Method

THE SCIENTIFIC METHOD... FOR TEN-YEAR OLDS



* THIS IS SURPRISINGLY CLOSE TO HOW REAL SCIENTISTS ACT AT CONFERENCES.

Practical Considerations

Practical Considerations

Logistics

- Where do I sit?
- Where are the supplies?

Time

- Get to a point where you have time to analyze results and make conclusions
- Ensure there is time to prepare a presentation
- Plan the experiment so that the first few days are getting used to the environment
- In reality, a 10 week program is 8 weeks of solid work for a new entry

Interest

- A student is not a pipetting robot (which are more expensive but really cool)

1. Define the question

Define the question (my motivation)

Undergraduate students add a dynamic component to the lab and it's gratifying to be influential at this point of a potential new scientist's career.

I have a group of new undergraduate summer students coming into the lab for 10 weeks (I couldn't say no). I have limited information on their expertise, I don't know how they will interact with the rest of the laboratory.

I have preliminary data on these but require experimental proof.

I need safe projects to test their expertise, one that identifies strengths and weaknesses, allows me some time to do my research, and one where they benefit and enjoy the experience.

Define the question (from a science viewpoint)

Science:

Crystallization – Chemistry, Physics and Biology

Structural biology – Medicine, Pharmacy, Energy, Agriculture, Veterinary studies etc.

Lots of hooks.

Silver Bullets are a carefully researched and designed library of compounds with the potential and ability to promote crystallization.

Each Silver Bullet solution contains between 2 and 20 small molecules.

The solutions use low concentrations of these small molecules.

Searching for silver bullets: An alternative strategy for crystallizing macromolecules. Alexander McPherson and Bob Cudney. *Journal of Structural Biology* 156 (2006) 387-406.

A novel strategy for the crystallization of proteins: X-ray diffraction validation. Steven B. Larson, John S. Day, Robert Cudney, and Alexander McPherson. *Acta Cryst.* (2007) D63, 310-318.

2. Gather information and resources

Gather Information and Resources (set questions)

What are Silver Bullets?

Explore the commercial and scientific literature. Introduce citation searching

How do they work?

Understand the literature, ask questions, communication in the laboratory.

What chemicals promote crystallization?

3. Form a hypothesis

Form a hypothesis (based on guidance)

What are the proteins?

What is their function?

What chemicals might interact with them?

What might promote crystallization?

What grocery store items might influence crystallization ?

Choose Proteins
(20 in our case)

Proteins used in this work, listed with molecular weights (MW) and experimental (where available) or calculated pI.

Protein name	Concentration (mg ml ⁻¹)	MW (kDa)	pI†	Source	Manufacturer‡
A Ubiquitin	10	9	6.8 (E)	Bovine erythrocytes	Sigma U6253
B Cytochrome <i>c</i>	10	12	9.6 (E)	Bovine heart	Sigma C2037
C Lysozyme	50	14	10.7 (E)	Chicken egg white	Sigma L7651
D β -Lactoglobulin A	10	18	5.1 (E)	Bovine milk	Sigma L7880
E Thaumatin	10	21	12 (E)	<i>Thaumatococcus daniellii</i>	Sigma T7638
F Papain	31	23	9.3 (E)	Papaya	Sigma P4762
G Chymotrypsinogen A	10	25	9.1 (C)	Bovine liver	Worthington LS005630
H Chymotrypsin	10	26	8.3 (E)	Bovine liver	Worthington LS001448
I Lipase	10	27	4.4 (E)	<i>Aspergillus niger</i>	Sigma 84205
J Proteinase K	10	27	8.9 (E)	<i>Tritirachium album</i> limber	Worthington LS004222
K Ovalbumin	20	44	5.1 (E)	Chicken egg white	Sigma A5503
L Hemoglobin	20	64	7.1 (E)	Bovine erythrocytes	Worthington LS00242
M Hemoglobin	10	67	8.1 (E)	Horse erythrocytes	Sigma H4632
N Hemocyanin	4.5	73	5.9 (T)	<i>Limulus polyphemus</i>	Sigma H1757
O Creatine kinase	10	81	7.4 (E)	Rabbit muscle	Sigma C3755
P Lactoferrin	10	90	8 (E)	Bovine milk	Sigma L9507
Q Concanavalin A	10	102	8.35 (E)	Jack bean (<i>Canavalia ensiformis</i>)	Sigma L7547
R Alcohol dehydrogenase	10	141	6.91 (C)	Yeast (<i>Saccharomyces cerevisiae</i>)	Worthington LS001069
S Catalase	16	240	5.5 (E)	Bovine liver	Sigma C30
T Urease	10	480	4.9 (E)	Jack bean (<i>Canavalia ensiformis</i>)	Worthington LS003887

† For pI, T = theoretical (calculated), C = catalog value and E = experimental data. ‡ Worthington Biochemical is listed as Worthington. The catalogue number is listed after the manufacturer information.

Available commercially in large quantities at reasonable cost

Choose Chemicals
(96 in our case)

Our Chemical Stock Room

Note:

1. The lack of safety equipment
2. No MSDS's
3. Presence of non-scientific staff
4. The most expensive 'chemical' is well under \$10
5. Everything is available in 'large' quantities
6. No expensive lab equipment

Number	Name	Ingredients, where available
1	Bubbles	0.5 cup dish soap, 1.5 cups water, 2 teaspoons sugar
2	White vinegar	Select sun-ripened grain, diluted with water
3	Clorox kitchen cleaner	Not available
4	White grape juice	White grape juice, citric acid, ascorbic acid, potassium metabisulfite
5	Dove Weightless Moisturizers hairspray with natural movement – extra hold	SD alcohol 40-b alcohol denatured, dimethyl ether, hydrofluorocarbon 152A, VA/crotonates/vinyl neodecanoate copolymer, acrylates/hydroxyesters acrylates copolymer, aminomethyl propanol, fragrance (parfum), sodium benzoate, cyclohexylamine, dimethicone copolyol, cyclopentasiloxane, silk amino acids, alanine, glycine, serine, arginine, isoleucine, cystine, histidine, glutamic acid, lysine, <i>Borago officinalis</i> seed oil (<i>Borago officinalis</i>), palmitic acid, stearic acid, linoleic acid, oleic acid, eicosenoic acid, glycerin
6	Scope mouthwash	Alcohol, glycerin, flavor, polysorbate 80, sodium saccharin, sodium benzoate, cetylpyridinium chloride, benzoic acid, Blue 1, Yellow 5
7	Nyquil liquid, cherry flavored	Acetaminophen, dextromethorphan HBr, doxylamine succinate, alcohol, citric acid, FD&C Blue No. 1, FD&C Red No. 40, flavor, high-fructose corn syrup, polyethylene glycol, propylene glycol, purified water, saccharin sodium, sodium citrate
8	Proactive Solution revitalizing toner	Glycolic acid, <i>Hamamelis virginiana</i> (witch hazel) extract, <i>Anthemis nobilis</i> flower extract, <i>Rosa canina</i> fruit extract, <i>Aloe barbadensis</i> leaf juice, sodium PCA, panthenol, glycerin, propylene glycol, allantoin, polysorbate 20, hydroxyethylcellulose, sodium hydroxide, benzophenone-4, tetrasodium EDTA, imidazolidinyl urea, methylparaben, propylparaben, fragrance (parfum), Blue 1 (CI 42090), Yellow 5 (CI 19140)
9	Sudafed PE children's nasal decongestant	Phenylephrine HCl, citric acid, edetate disodium, FD&C Red No. 40, flavor, glycerin, sodium benzoate, sodium carboxymethylcellulose, sodium citrate, sorbitol, sucralose
10	Red wine vinegar	Red wine vinegar (reduced with water to 5% acidity), potassium metabisulfite
11	Coca Cola, Diet	Carbonated water, caramel (color), aspartame, phosphoric acid, potassium benzoate, natural flavors, citric acid, caffeine
12	Listerine anticavity fluoride rinse	Sodium fluoride, sorbitol solution, alcohol (21.6%), poloxamer 407, sodium lauryl sulfate, phosphoric acid, sucralose, dibasic sodium phosphate, D&C Red No. 33, FD&C Blue No. 1
13	Kosher dill spears juice	Vinegar, salt, calcium chloride, natural flavor, garlic oil, polysorbate 80, Yellow 5, Blue 1
14	Sparkling beverage, diet, peach grapefruit	Carbonated water, citric acid, potassium citrate, natural flavor, aspartame, potassium benzoate (a preservative), acesulfame potassium
15	Heinz All Natural cleaning vinegar	Not available
16	Febreze fabric refresher	Alcohol, odor eliminator derived from corn, fragrance
17	Alcon Opti-Free disinfecting solution	Sodium chloride, sodium borate, propylene glycol, Tearglyde proprietary dual-action reconditioning system (Tetricon 1304, nonanoyl ethylenediaminetriacetic acid) with Polyquad (polyquaternium-1) 0.001% and Aldox (myristamidopropyl dimethylamine)
18	Hydrogen peroxide	Stabilized hydrogen peroxide 3%
19	Fat-free milk	Fat-free milk, vitamin A, vitamin D3
20	Clean & Clear deep-cleaning astringent	Salicylic acid, alcohol (24.5%), algae extract, <i>Aloe barbadensis</i> leaf extract, benzophenone-4, denatonium benzoate, dimethicone propyl PG-betaine, fragrance, glycerin, isoceteth-20, PEG 32, propylene glycol, sodium citrate, Blue 1

5	Dove Weightless Moisturizers hairspray with natural movement – extra hold	SD alcohol 40-b alcohol denatured, dimethyl ether, hydrofluorocarbon 152A, VA/crotonates/vinyl neodecanoate copolymer, acrylates/hydroxyesters acrylates copolymer, aminomethyl propanol, fragrance (parfum), sodium benzoate, cyclohexylamine, dimethicone copolyol, cyclopentasiloxane, silk amino acids, alanine, glycine, serine, arginine, isoleucine, cystine, histidine, glutamic acid, lysine, <i>Borago officinalis</i> seed oil (<i>Borago officinalis</i>), palmitic acid, stearic acid, linoleic acid, oleic acid, eicosenoic acid, glycerin
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28	Palmolive gel dishwasher detergent	laureth-8 sulfate, sodium oleth sulfate, sodium methylparaben, DMDM hydantoin, magnesium laureth-8, magnesium oleth sulfate, polyquaternium-10, propylene glycol, disodium EDTA
29	Purell instant hand sanitizer	Isopropyl alcohol, glycerin, carbomer, fragrance, aminomethyl propanol, propylene glycol, isopropyl myristate, tocopheryl acetate
30	Airborne baby wash	Not available
31	Dawn Plus dishwashing liquid	Biodegradable surfactants (anionic and nonionic), enzymes
32	Excedrin	Acetaminophen, aspirin, caffeine, benzoic acid, carnauba wax, hydroxypropyl cellulose, hydroxypropyl methylcellulose, microcrystalline cellulose, mineral oil, polysorbate 20, povidone, propylene glycol, simethicone emulsion, sorbitan monolaurate, stearic acid, FD&C Blue 1, titanium dioxide
33	Brach's Star Brites cinnamon mint candy	Corn syrup, sugar, artificial and natural flavor, titanium dioxide color, Red 40, Red 3, Blue 1, Yellow 6
34	Dish detergent, lemon-scented	An aqueous solution of anionic and nonionic surfactants, stabilizers, perfume, colorant and quality control agents
35	Arm & Hammer pure baking soda	Sodium bicarbonate

Number	Name	Ingredients, where available
36	Totally Light 2 Go cranberry pomegranate mix	Citric acid, ascorbic acid (vitamin C), artificial flavor, potassium and sodium citrate, acesulfame potassium, purified polyphenols, natural and artificial pomegranate flavor, sucralose, gum arabic, magnesium oxide, FD&C Red 40, tricalcium phosphate, FD&C Blue 1
37	Tilex mildew root penetrator and remover	Sodium hydroxide, sodium hypochlorite
38	Lemon juice	Lemon juice from concentrate, sodium benzoate, sodium metabisulfite and sodium sulfite, lemon oil
39	Maple extract	Pure maple syrup concentrate, alcohol, glycerin, sugar, caramel (color)
40	Balsamic vinegar	Balsamic vinegar
41	Afta aftershave lotion	SD alcohol 40, PEG 8 stearate, PPG-2 myristyl ether propionate, fragrance, triethanolamine, carbomer, diazolidinyl urea, methylparaben, PEG 2 stearate SE, stearic acid, propylparaben, allantoin, BHT, disodium EDTA, D&C Green No. 5, FD&C Yellow No. 5
42	Heinz tomato ketchup	Lycopene, tomato concentrate, distilled vinegar, high-fructose corn syrup, corn syrup, salt, spice, onion powder, natural flavors
43	Crystal Light raspberry lemonade mix	Citric acid, potassium citrate, calcium phosphate, aspartame (phenylketonurics: contains phenylalanine) (sweetener), raspberry juice solids, natural and artificial flavor, acesulfame potassium (sweetener), soy lecithin, artificial color, Red 40, Blue 1, tocopherol
44	Ground pepper	Black pepper
45	Powder dishwasher detergent	Sodium carbonate, sodium silicate, enzymes
46	Ground cinnamon	Ground cinnamon
47	Salt, iodized	Salt, calcium silicate, dextrose, potassium iodide
48	Avon Personal Match loose powder	Not available
49	Cascade automatic dishwasher detergent	Fragrance(s)/perfume(s), surfactants, sodium silicate, sodium sulfate anhydrous, cleaning agents, colorant/pigment/dye, bleach, sudsing agent, water softeners (complex sodium phosphates/sodium carbonate)
42	Heinz tomato ketchup	Lycopene, tomato concentrate, distilled vinegar, high-fructose corn syrup, corn syrup, salt, spice, onion powder, natural flavors
52	Centrum multivitamin/multimineral supplement, tablets	Dibasic calcium phosphate, magnesium oxide, potassium chloride, calcium carbonate, microcrystalline cellulose, ascorbic acid (vitamin C), ferrous fumarate, DL-alpha tocopheryl acetate (vitamin E), acacia, anhydrous citric acid, ascorbyl palmitate, beta carotene, biotin, boric acid, BHT, calcium pantothenate, calcium stearate, cholecalciferol (vitamin D), chromic picolinate, corn starch, crospovidone, cupric sulfate, cyanocobalamin (vitamin B12), DL-alpha tocopherol, FD&C Yellow 6 Aluminium Lake, folic acid, gelatin, hydrogenated palm oil, hypromellose, lutein, lycopene, maltodextrin, manganese, magnesium sulfate, medium-chain triglycerides, modified food starch, niacinamide, nickelous sulfate, phytonadione (vitamin K), polyethylene glycol, polyvinyl alcohol, potassium iodide, pregelatinized corn starch, pyridoxine hydrochloride (vitamin B6), riboflavin (vitamin B2), silicon dioxide, sodium ascorbate, sodium benzoate, sodium citrate, sodium metavanadate, sodium molybdate, sodium selenate, sorbic acid, stannous chloride, sucrose, thiamine mononitrate (vitamin B1), titanium dioxide, tricalcium phosphate, vitamin A acetate (vitamin A), zinc oxide. May also contain less than 2% of: sodium aluminium silicate
53	Folgers classic roast coffee	100% pure coffee
54	Gerber Graduates Finger Foods cherry puffs	Rice flour, whole-grain oat flour, wheat starch, wheat flour, sugar, cherry powder, cherry juice concentrate, tri- and dicalcium phosphate, mixed tocopherols, natural flavor, zinc sulfate, soy lecithin, alpha tocopheryl acetate (vitamin E), electrolytic iron
55	Ibuprofen	Ibuprofen USP, carnauba wax, cellulose, corn starch, FD&C Yellow No. 6, fumed silica gel, hypromellose, lactose, magnesium stearate, polydextrose, polyethylene glycol, sodium starch glycolate, stearic acid, titanium dioxide
56	One a day women's prenatal complete prenatal multivitamin plus DHA	Calcium carbonate, cellulose, ferrous fumarate, magnesium oxide, ascorbic acid, dicalcium phosphate, DL-alpha tocopheryl acetate, croscarmellose sodium, maltodextrin, niacinamide, gelatin, acacia, polyvinyl alcohol, zinc oxide, D-calcium pantothenate, corn starch, titanium dioxide, polyethylene glycol, magnesium stearate, talc, cupric sulfate, silicon dioxide, pyridoxine hydrochloride, calcium silicate, riboflavin, thiamine mononitrate, hypromellose, beta-carotene, FD&C Red No. 40 Lake, folic acid, vitamin A acetate, potassium iodide, cholecalciferol, cyanocobalamin. Liquid gel: marine lipid concentrate, gelatin, glycerin, methacrylic acid copolymer, propylene glycol, glyceryl monostearate, triethyl citrate, triacetin, soy lecithin
57	Halls Defense Supplement drops	Isomalt, sodium ascorbate, citric acid, natural flavoring, ascorbic acid, aspartame, acesulfame potassium, beta carotene (color), Red 40, soy lecithin
58	Women's vitamins	Not available
59	Clover honey	Honey
60	Spices	Salt, garlic salt, pepper, pickling spice, rosemary flakes, oregano, thyme flakes, dill weed, bay leaves, crushed red pepper, parsley flakes, paprika, cinnamon, all spice, ground mustard, celery salt, whole pepper, minced onion
61	Triaminic Children's Thin Strips	Dextromethorphan HBr, acetone, alcohol, dibasic sodium phosphate, FD&C Red 40, flavors, hydroxypropyl cellulose, hypromellose, maltodextrin, microcrystalline cellulose, polyacrilin, polyethylene glycol, pregelatinized starch, propylene glycol, purified water, sorbitol, sucralose, titanium dioxide
62	Mary Kay Timewise day solution	Not available
63	Mary Kay cleanser	Not available
64	Mary Kay microdermabrasion	Not available
65	Isopropyl rubbing alcohol	91% isopropyl alcohol
66	Clorox daily sanitizing spray	Sodium hypochlorite 0.0095%, other ingredients 99.9905%

Number	Name	Ingredients, where available
67	Ron Bacardi rum	Not available
68	Golden Fields fiber	Oat bran, wheat germ, psyllium seed husks, rice bran fiber, red wheat bran
69	Windshield washer fluid	Not available
70	Lemon Lime Gatorade	Sucrose syrup, glucose-fructose syrup, citric acid, natural lemon and lime flavors with other natural flavors, salt, sodium citrate, monopotassium phosphate, ester gum, Yellow 5
71	Rite-Aid aspirin	Aspirin, acetylated monoglycerides, anhydrous lactose, colloidal silicon dioxide, croscarmellose sodium, edible ink, FD&C Red No. 40 Lake, FD&C Yellow No. 6 Lake, hypromellose, hypromellose phthalate, microcrystalline cellulose, mineral oil, polyethylene glycol, polysorbate 80, yellow iron oxide
72	Chiavetta's marinade	Vinegar, salt, spices, fresh garlic, xanthan gum
73	Splenda no-calorie sweetener	Dextrose, maltodextrin, sucralose
74	Sugarfree Redbull	Carbonated water, sodium citrate, taurine, glucuronolactone, caffeine, acesulfame K, aspartame, inositol, xanthan gum, niacinamide, calcium pantothenate, pyridoxine HCl, vitamin B12, natural and artificial flavors, colors
75	Monster Energy	Carbonated water, sucrose, glucose, citric acid, natural flavors, taurine, sodium citrate, color added, <i>Panax ginseng</i> root extract, L-carnitine, caffeine, sorbic acid, benzoic acid, niacinamide, sodium chloride, glucuronolactone, inositol, guarana seed extract, pyridoxine hydrochloride, sucralose, riboflavin, maltodextrin, cyanocobalamin
76	Tums cool relief	Calcium carbonate USP, Blue 1, corn starch, flavors, mineral oil, Red 40, sodium polyphosphate, sucrose, talc, Yellow 5 (tartrazine), Yellow 6
77	White sugar	Sugar
78	Nestle Nesquik strawberry	Sugar, maltodextrin, artificial flavors, citric acid, Red 40, salt, Blue 1, vitamins and minerals
79	Sesame Street Fizzy Tub Colors	Sodium bicarbonate, pentasodium triphosphate, succinic acid, citric acid, PEG 8, glycerin, denatonium benzoate, fragrance, FD&C Yellow 5, FD&C Blue 1, D&C Red 33.
80	L'Oreal Bare Naturale gentle mineral makeup, classic tan 470	Titanium dioxide, zinc oxide, talc, boron nitride, dimethicone, <i>Copernicia cerifera</i> (carnauba) wax, cetyl dimethicone, trimethylsilyloxyisilicate, triisocetyl citrate, <i>Aloe barbadensis</i> leaf juice, tocopherol, panthenol. May contain: titanium dioxide, zinc oxide, bismuth oxychloride, iron oxide
81	Tums E-X 750 antacid/calcium supplement, chewable tablets	Calcium carbonate USP, sucrose, calcium carbonate, corn starch, talc, mineral oil, natural and artificial flavors, adipic acid, sodium polyphosphate, Red 40 Lake, Yellow 6 Lake, Yellow 5 (tartrazine) Lake, Blue 1 Lake
82	McCormick sprinkles	Not available
83	Tylenol Cold, multisymptom, daytime, rapid-release gelscaps	Acetaminophen, dextromethorphan HBr, phenylephrine HCl, benzyl alcohol, black iron oxide, butylparaben, carboxymethylcellulose sodium, colloidal silicon dioxide, corn starch, D&C Red No. 28, D&C Yellow No. 10, edetate calcium disodium, FD&C Blue No. 1, FD&C Red No. 40, gelatin, hypromellose, methylparaben, microcrystalline cellulose, polyethylene glycol, polysorbate 80, powdered cellulose, pregelatinized starch, propylene glycol, propylparaben, red iron oxide, sodium lauryl sulfate, sodium propionate, sodium starch glycolate, stearic acid, titanium dioxide

79 Sesame Street Fizzy Tub Colors Sodium bicarbonate, pentasodium triphosphate, succinic acid, citric acid, PEG 8, glycerin, denatonium benzoate, fragrance, FD&C Yellow 5, FD&C Blue 1, D&C Red 33.

84	Wendy's mineral energy drink	Sodium citrate, magnesium hydroxide, sodium citrate, magnesium stearate, polyethylene glycol, pregelatinized starch, Red No. 27 Lake, sucrose
87	Raspberry coffee syrup	Cane sugar, glucose, raspberry juice concentrate, natural and artificial flavors, citric acid, less than 1/10 of 1% sodium benzoate/potassium sorbate as a preservative
88	Pez, cherry	Sugar, corn syrup, adipic acid, hydrogenated palm kernel and palm oils and soybean oil mono- and diglycerides, natural and artificial flavors, artificial colors FD&C Red 3
89	Mylicon infants' antigas, drops	Simethicone, carboxymethylcellulose sodium, citric acid, flavors, maltitol, microcrystalline cellulose, purified water, sodium benzoate, sodium citrate, xanthan gum
90	Suave Naturals conditioner, tropical coconut	Cetyl alcohol, cetrimonium chloride, potassium chloride, fragrance, distearyldimonium chloride, disodium EDTA, glycerin, 2-bromo-2-nitropropane-1,3-diol, methylchloroisothiazolinone, methylisothiazolinone, propylene glycol, silk amino acids, honey (Mel), nettle (<i>Urtica dioica</i>) extract, rosemary (<i>Rosmarinus officinalis</i>) extract, coconut (<i>Cocos nucifera</i>) extract
91	French's mustard, honey	Distilled vinegar, high-fructose corn syrup, No. 1 grade mustard seed, honey, salt, modified food starch (tapioca and corn), carrot extract (color), spices, garlic powder
92	Airborne hand lotion	Not available
93	Softsoap antibacterial hand soap	Triclosan water, sodium laureth sulfate, cocamidopropyl betaine, decyl glucoside, fragrance, DMDM hydantoin, sodium chloride, PEG 120 methyl glucose dioleate, tetrasodium EDTA, sodium sulfate, polyquaternium-7, citric acid, poloxamer 124, PEG 7 glyceryl cocoate, D&C Red No. 33, FD&C Blue No. 1
94	Nestle Good Start Supreme DHA and ARA soy infant formula	Corn maltodextrin, vegetable oil, enzymatic hydrolyzed soyprotein isolate, less than 1.5%: sucrose, corn starch, calcium phosphate, potassium citrate, sodium citrate, calcium citrate, <i>M. alpha</i> oil [source of arachidonic acid (ARA)], <i>C. cohnii</i> oil [source of docosahexaenoic acid (DHA)], magnesium chloride, calcium chloride, potassium chloride, ferrous sulfate, zinc sulfate, copper sulfate, potassium iodide, sodium selenate, soy lecithin, monoglycerides, sodium ascorbate, choline chloride, inositol, alpha-tocopherol phosphate, niacinamide, calcium pantothenate, vitamin A (acetate), riboflavin, thiamin mononitrate, pyridoxine hydrochloride, folic acid, biotin, phylloquinone, vitamin D3, vitamin B12, L-methionine, carrageenan, taurine, L-carnitine
95	Lipton orange herbal tea	Orange peel, hibiscus flowers, cinnamon, roasted chicory root, clove, licorice root, natural orange flavor (contains soy lecithin)
96	Mary Kay Timewise night solution	Not available



4. Perform the experiment

Perform the experiment

96 stock solutions were prepared by diluting the products with distilled deionized water.

Stock solutions were placed in a single 96 well, deep well plate, this plate was used as the mother plate.

Daughter plates were prepared by further diluting the mother plates with:

1. Water
2. Buffer (MES, HEPES, or Bis-Tris-Propane)
3. 25% PEG 3350

In total 8 unique 96 well source plates were prepared

Original 100% Pseudo Silver Bullet (PSB)

1:10 Diluted PSB

100% PSB:25% PEG 3350 pH 5.81

100% PSB:25% PEG 3350 pH 6.81

100% PSB:25% PEG 3350 pH 7.79

1:10 D-PSB:25% PEG 3350 pH 5.81

1:10 D-PSB:25% PEG 3350 pH 6.81

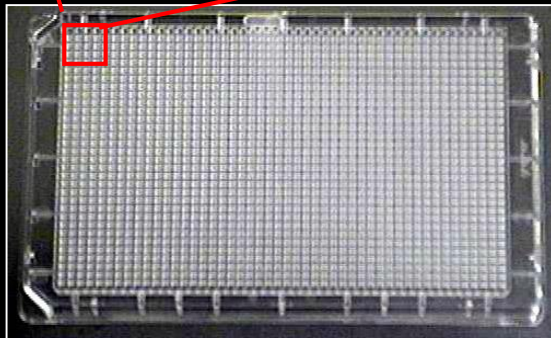
1:10 D-PSB:25% PEG 3350 pH 7.79



Crystallization Screening

The 20 proteins were set up against the eight different formulations of different solutions, two proteins in each 1536 well plate.

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16



Crystallization Screening

The plates were imaged 1 day after setup then weekly for 6 weeks.

Results were scored for crystals



5. Analyze the data

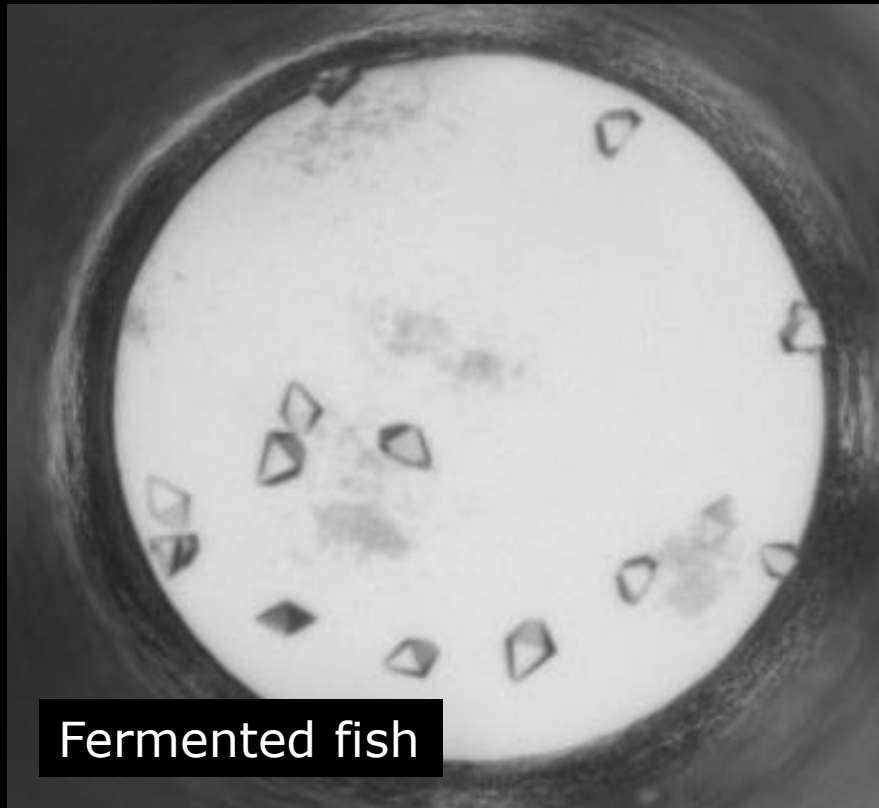
1	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	
	122	123	124	125	126	127	128	129	130	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	
2	O	V	A	H	J	L	P	B	C	D	E	F	U	V	M	N	R	T	Q	S	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	
3	1536-Plate Well	Deep Well Location	Pseudo Silver Bullet (PSB)	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	Pseudo Silver Bullet (PSB)	Total Hits Per PSB
4	1	A1	Bubbles	5	7			2	5												7	1				Bubbles	27
5	2	A2	Distilled White Vinegar	1	3			1	6												3					Distilled White Vinegar	14
6	3	A3	Clorox Disinfect Cleaner	4	1	7		1	3	4	1										5					Clorox Disinfect Cleaner	26
7	4	A4	Welch's White Grape Juice	1		5		1	3	2											5	1				Welch's White Grape Juice	18
8	5	A5	Dove Hairspray	3		4		1	3	2	1										3	1				Dove Hairspray	18
9	6	A6	Scoope Mint Mouthwash	1		7		1		6	1		1								5					Scoope Mint Mouthwash	22
10	7	A7	Nyquil Liquid- Cherry	2		1		4		5											5	1				Nyquil Liquid- Cherry	18
11	8	A8	Proactive Revitalize toner	2	1	4		1	1	4											3					Proactive Revitalize toner	16
12	9	A9	Sudafed PE Children's	5		5		5		6											5	1				Sudafed PE Children's	27
13	10	A10	Red Wine Vinegar			3		2		7											2					Red Wine Vinegar	14
14	11	A11	Coke Cola, Diet	1		6		2	1	6											8					Coke Cola, Diet	24
15	12	A12	Listerine Fluoride Rinse	2		6		3	3	3			1				1				5	1				Listerine Fluoride Rinse	25
16	13	B1	Dill Spears Juice	4		3		2	4	5							1				5					Dill Spears Juice	24
17	14	B2	Diet Peach Grapefruit	4		6				6											5					Diet Peach Grapefruit	21
18	15	B3	Heinz Cleaning Vinegar	1		3				5																Heinz Cleaning Vinegar	9
19	16	B4	Febreze Fabric Refresher			7			2	7											6					Febreze Fabric Refresher	22
20	17	B5	Contact Solution	3		5		2	1	8											5					Contact Solution	24
21	18	B6	Hydrogen Peroxide			7				6											6					Hydrogen Peroxide	19

1536-Plate Well	Deep Well Location	Pseudo Silver Bullet (PSB)	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks	4 Wks
1	A1	Bubbles	5	7			2	5	
2	A2	Distilled White Vinegar	1	3			1	6	
3	A3	Clorox Disinfect Cleaner	4	1	7		1	3	4
4	A4	Welch's White Grape Juice	1		5		1	3	2

36	36	C12	Baking Soda	2	1			1													1					Baking Soda	5
39	36	C12	Cranberry Pomegranate	2	1			1													1					Cranberry Pomegranate	5
40	37	D1	Tilex Mildew Remover	4	4			4													4	1				Tilex Mildew Remover	17
41	38	D2	Lemon Juice	2	3		2	2	4												2	1				Lemon Juice	16
42	39	D3	Maple Extract		1	2		1	1												3					Maple Extract	8
43	40	D4	Balsamic Vinegar	1	1		2	2													2					Balsamic Vinegar	8
44	41	D5	Afta Aftershave Lotion	2	1	4		4	2	5		1		1							4					Afta Aftershave Lotion	24
45	42	D6	Heinz Tomato Ketchup	1	4			5	3					1							4					Heinz Tomato Ketchup	18
46	43	D7	Raspberry Lemonade Mix	1	1				3												2					Raspberry Lemonade Mix	7
47	44	D8	Ground Black Pepper	1	6			5	6												5					Ground Black Pepper	23
48	45	D9	Powder Dish Detergent	3	2			1	3												3	2				Powder Dish Detergent	14
49	46	D10	Ground Cinnamon	1	6		2	3	4												5					Ground Cinnamon	21
50	47	D11	Wegmans Salt, Iodized	6	5		3	4													4	4				Wegmans Salt, Iodized	26
51	48	D12	Avon Loose Powder	3	8			1	7	1											6					Avon Loose Powder	26

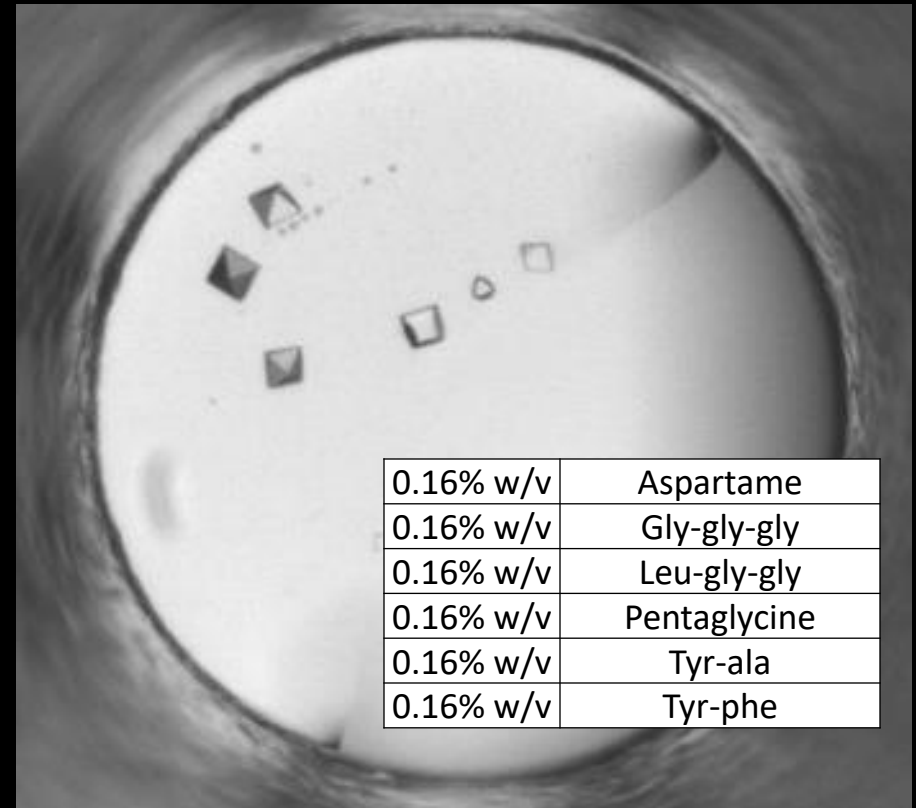
Proteinase K 4-Week Image

Pseudo-Silver Bullet



Fish Sauce
12.5% PEG 3350
HEPES pH 6.81

Original Silver Bullet



Silver Bullet H12
12.5% PEG 3350
HEPES pH 6.8

Concanavalin A 4-Week Image

Pseudo-Silver Bullet

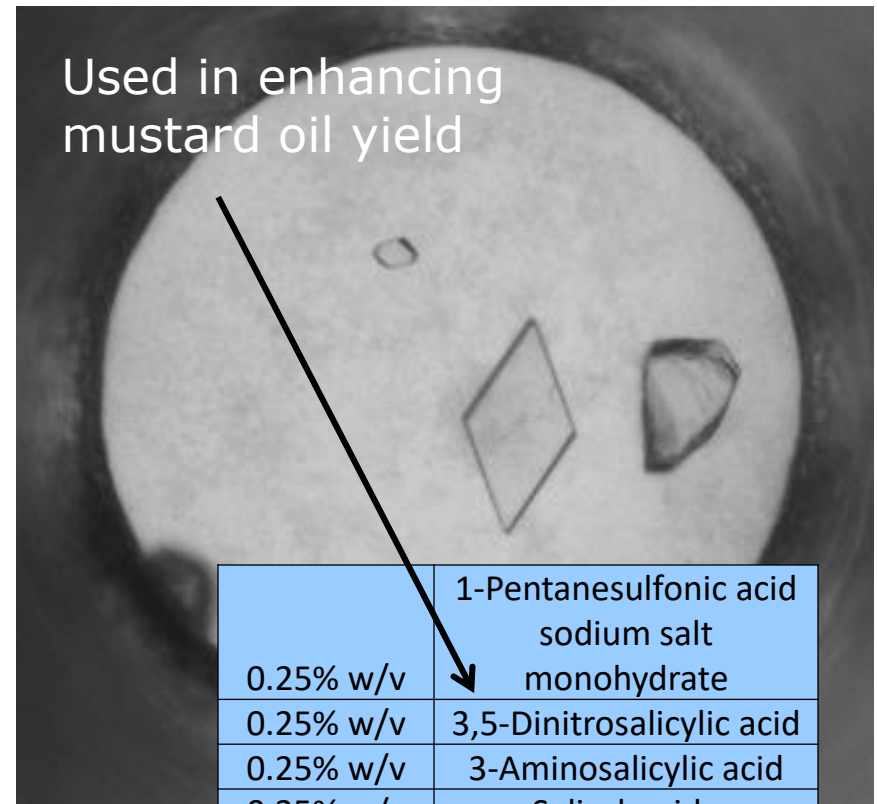
Distilled Vinegar, Water, High Fructose Corn Syrup, #1 Grade Mustard Seed, Sugar, Corn Syrup, Salt, Carrot Oleoresin (color), Honey, Spices, and Garlic Powder.



French's Honey Mustard
12.5% PEG 3350
HEPES pH 6.81

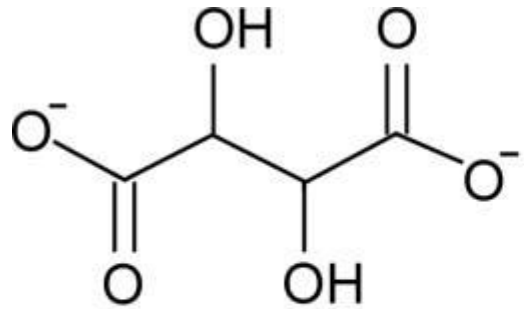
Original Silver Bullet

Used in enhancing mustard oil yield

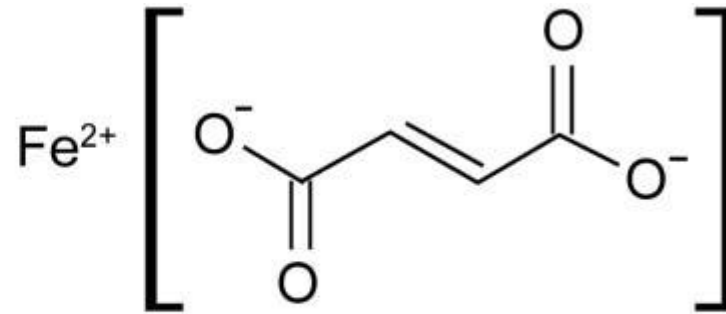


0.25% w/v	1-Pentanesulfonic acid sodium salt monohydrate
0.25% w/v	3,5-Dinitrosalicylic acid
0.25% w/v	3-Aminosalicylic acid
0.25% w/v	Salicylamide

Silver Bullet A8
12.5% PEG 3350
HEPES pH 6.8



(a)



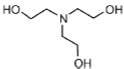
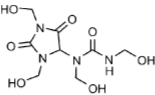
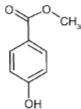
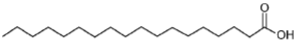
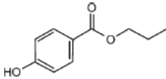
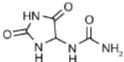
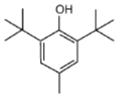
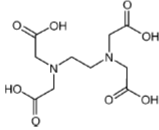
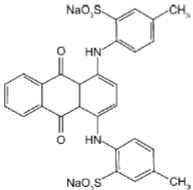
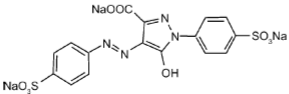
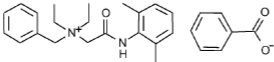
(b)

Chemical diagrams for (a) tartrate used for crystallization of thaumatin and (b) ferrous fumarate found as an ingredient in prenatal vitamins, showing obvious chemical similarities.

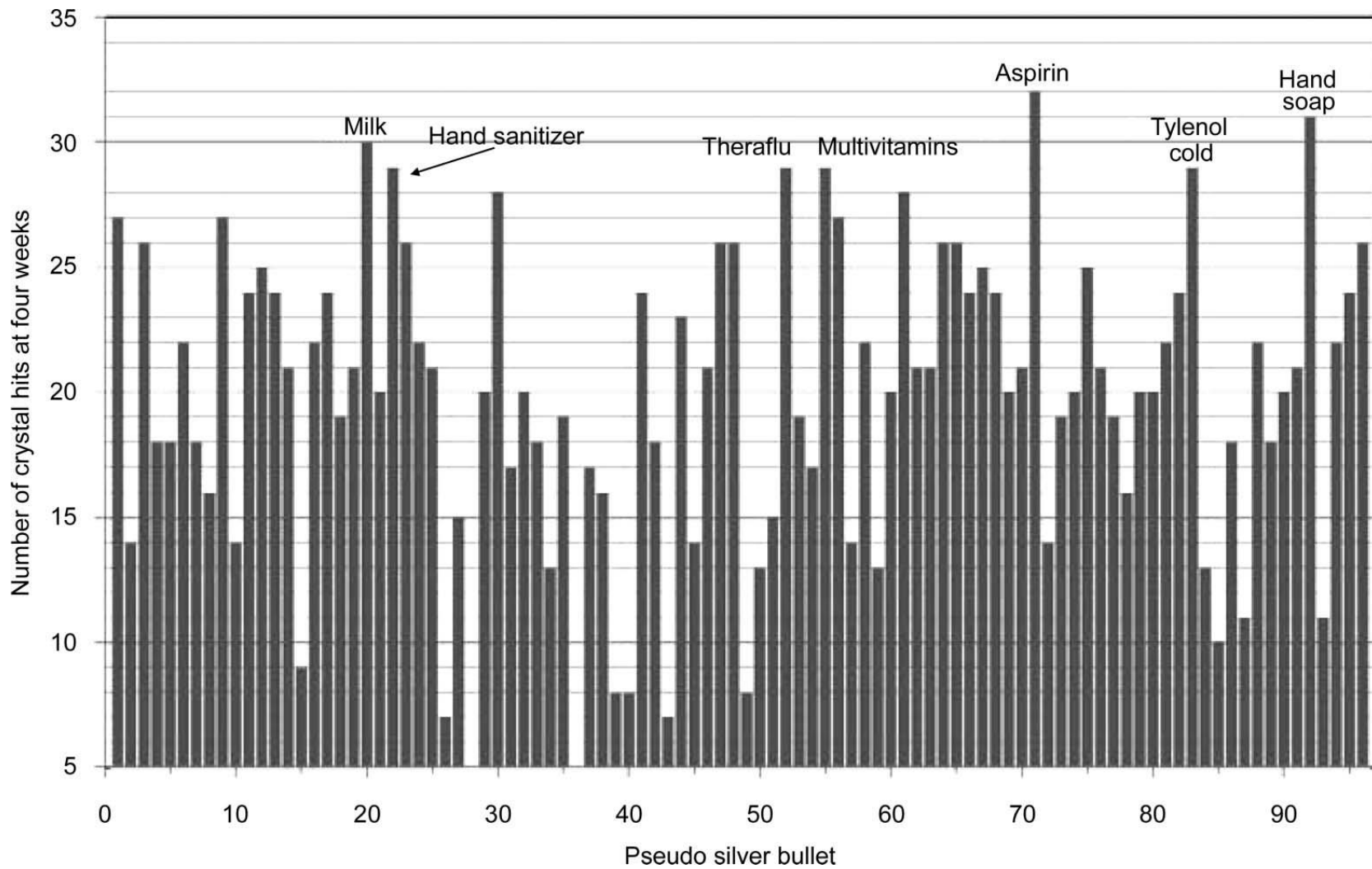
The chemicals found in one Pseudo Silver Bullet

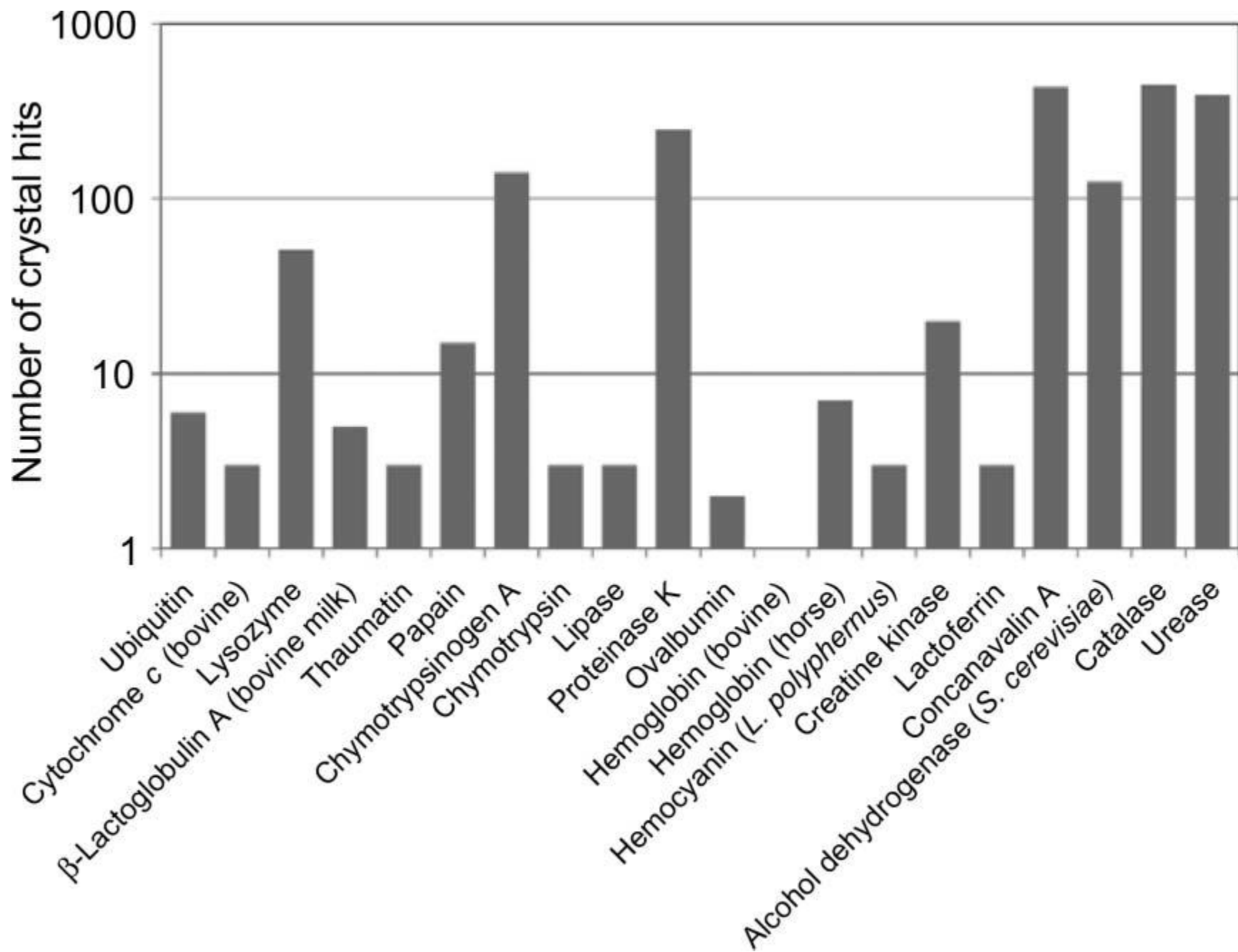
Aftershave lotion

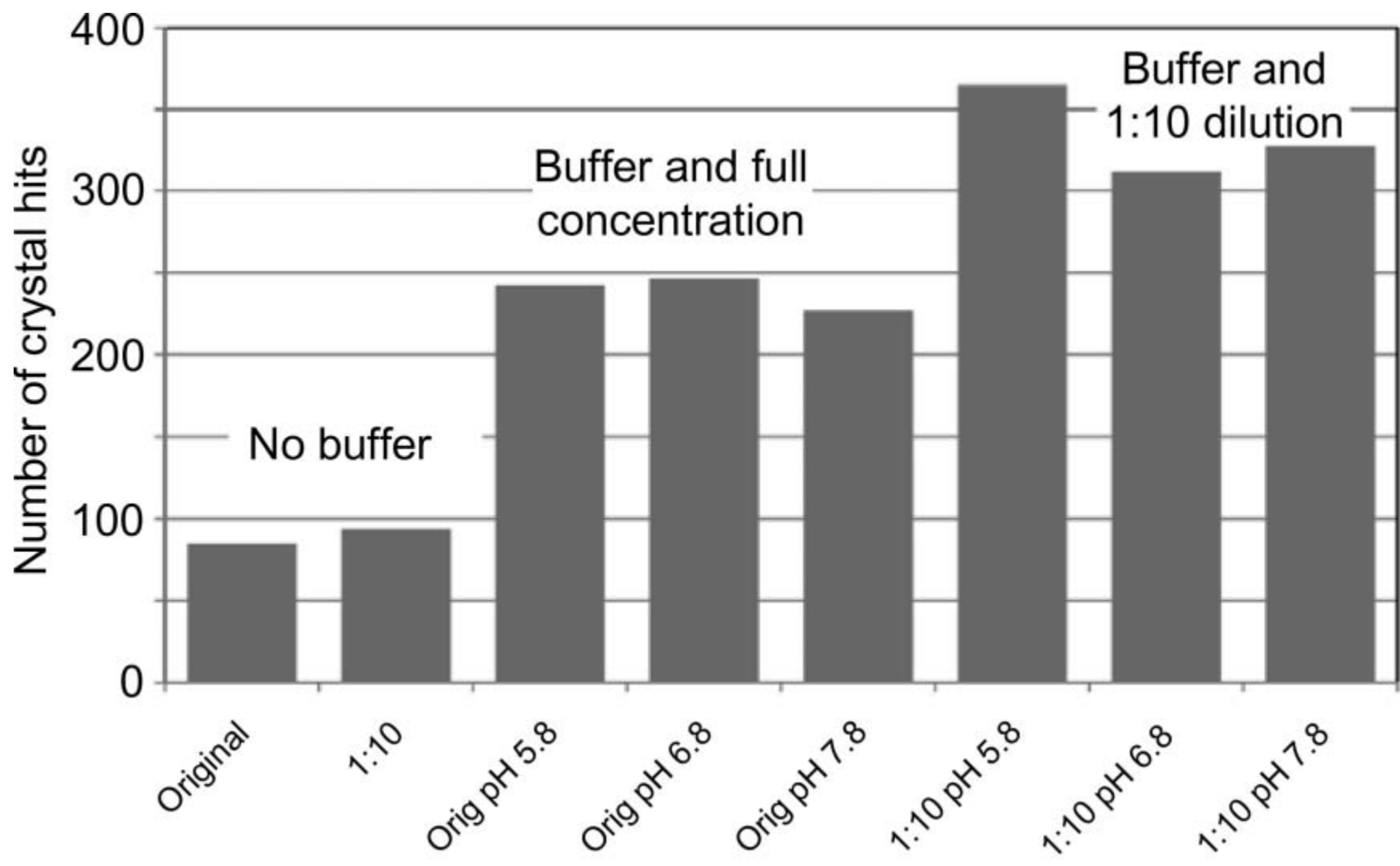
The name, chemical structure and probable use of the non-PEG ingredients in PSB 41, aftershave lotion.

Name	Structure	Use if known
Triethanolamine		pH balancer
Carbomer	A product class consisting of high molecular weight polymers of acrylic acid	Thickening, dispersing, suspending and emulsifying agents
Diazolidinyl urea		Antimicrobial preservative
Methylparaben		Anti-fungal agent
Stearic acid		Possibly used to produce a pearlescent effect
Propylparaben		Preservative
Allantoin		Moisturizer
BHT (butylhydroxytoluene)		Antioxidant additive
Disodium EDTA (shown without the two sodium ions)		Improves stability towards air, chelating agent
D&C Green No. 5		Coloring agent
FD&C Yellow No. 5		Coloring agent
Denatonium benzoate†		Agent to denature ethanol

† Denatonium benzoate is listed somewhat cryptically on the ingredients as part of the ingredient SD alcohol 40, used to denature the ethanol.



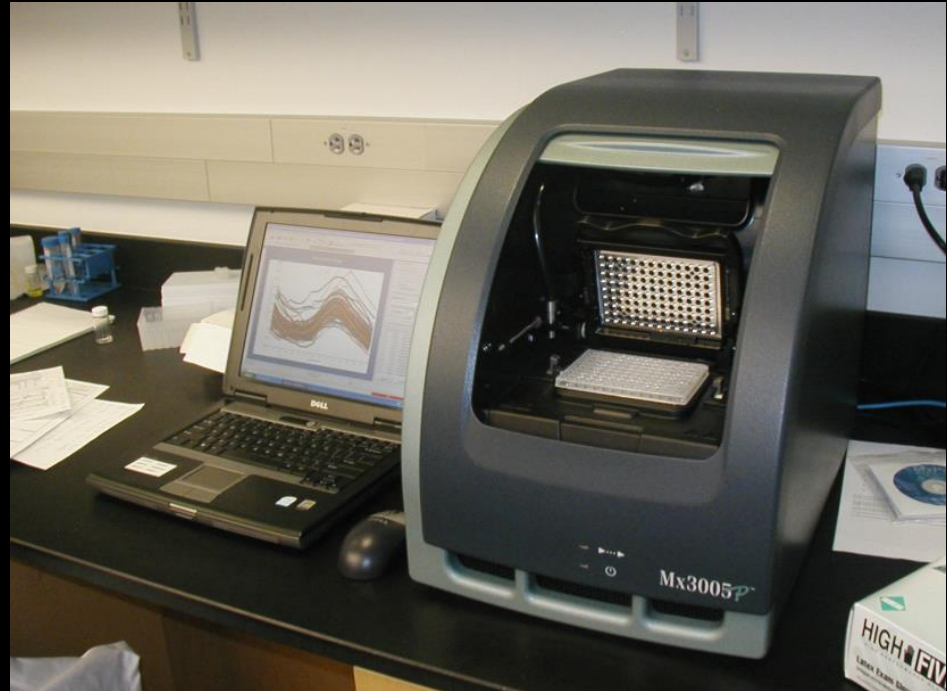




5. Supporting data

Differential Scanning Fluorimetry

- We ran the PSB from the mother plate deep well through the Thermofluor with 20 different proteins to check for stabilization/destabilization
- 20 proteins x 96 stock PSB's
- Twelve of the proteins run with the PSB gave distinct T_m values; some of the PSB stabilized the protein (the protein denatured at a higher temperature than the control)
- These twelve proteins were then run through Thermofluor with real SB to compare to the PSB



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
1				122	123	124	125	126	127	128	129	130	131															
2				O	V	A	H	J	L	P	B	C	D	E	F	U	V	M	N	R	T	Q	S					
3			Pseudo Silver Bullet (PSB)	Shift	Shift	Shift	Shift	Shift		Shift	Shift	Shift	Shift	Shift	Shift	Shift	Shift	Shift	Shift	Shift	Shift	Shift	Shift					
4	1	A1	Bubbles	-	N	N	D	-	N	U	N	D	U	D	N	-	-	N	-	-	U	D			U	D	N	-
5	2	A2	Distilled White Vinegar	-	U	U	-	-	D	-	-	-	D	U	D	-	-	N	-	-	N	D			U	D	N	-
6	3	A3	Clorox Disinfect Cleaner	-	-	U	-	-	D	-	D	-	U	-	-	-	-	D	-	-	D	D			U	D	N	-
7	4	A4	Welch's White Grape Juice	-	-	U	D	D	N	-	-	-	U	U	D	-	-	U	-	-	U	D			U	D	N	-
8	5	A5	Dove Hairspray	-	-	U	D	-	-	D	D	-	U	D	D	-	-	D	-	-	-	-			U	D	N	-
9	6	A6	Scope Mint Mouthwash	-	-	U	D	D	N	N	N	-	U	D	D	-	-	N	-	-	U	D			U	D	N	-
10	7	A7	Nyquil Liquid-Cherry	-	-	-	-	U	-	U	N	-	U	D	N	-	U	D	-	-	U	D			U	D	N	-
11	8	A8	Proactive Revitalize toner	-	U	U	D	-	D	-	-	-	U	U	D	D	-	U	U	-	-	D			U	D	N	-
12	9	A9	Sudafed PE Children's	-	-	U	-	U	N	U	D	U	U	U	N	-	-	U	-	-	U	D			U	D	N	-
13	10	A10	Red Wine Vinegar	-	U	U	-	-	D	-	-	-	-	U	D	-	-	U	-	-	N	-			U	D	N	-
14	11	A11	Coke Cola Diet	-	-	U	-	U	N	U	N	-	U	U	N	-	U	U	-	-	U	D			U	D	N	-

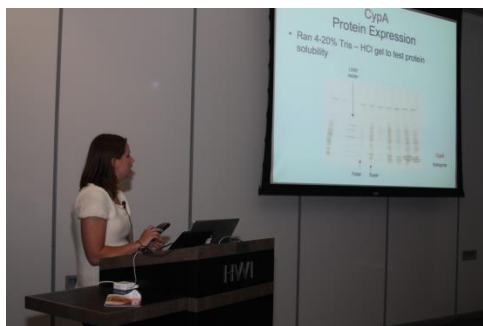
	O	V	A	H	J	L	P	B	C	D	E	F	U	W	M	N	R	T	Q	S								
Pseudo Silver Bullet (PSB)	Shift	Shift	Shift	Shift	Shift		Shift	Shift	Shift	Shift	Shift	Shift	Shift	Shift	Shift	Shift	Shift	Shift	Shift	Shift	Shift							
Bubbles	-	N	N	D	-	N	U	N	D	U	D	N	-	-	N	-	-	U	D					U	D	N	-	
Distilled White Vinegar	-	U	U	-	-	D	-	-	-	D	U	D	-	-	N	-	-	N	D					U	D	N	-	
Clorox Disinfect Cleaner	-	-	U	-	-	D	-	D	-	U	-	-	-	-	D	-	-	D	D					U	D	N	-	
Welch's White Grape Juice	-	-	U	D	D	N	-	-	-	U	U	D	-	-	U	-	-	U	D					U	D	N	-	

27	24	B12	Bathroom Cleaner	-	U	U	D	-	D	-	-	-	D	-	D	-	-	N	-	-	D	D			U	D	N	-
28	25	C1	Polish Remover, Regular	-	D	D	D	N	N	N	N	D	U	D	N	-	U	N	-	-	N	D			U	D	N	-
29	26	C2	Red Food Coloring	-	-	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				U	D	N	-
30	27	C3	2-in-1 Body Shampoo	-	N	D	D	-	-	-	-	D	-	-	-	-	-	-	-	-	-				U	D	N	-
31	28	C4	Gel Dishwash Detergent	-	U	U	-	-	-	-	-	-	-	-	-	-	-	D	-	-	-				U	D	N	-
32	29	C5	Purell Hand Sanitizer	-	U	U	D	N	N	U	U	-	U	U	N	D	U	N	-	-	D	D			U	D	N	-
33	30	C6	Airborne Baby Wash	-	-	U	-	-	-	-	-	-	-	D	-	-	-	-	-	-	-				U	D	N	-
34	31	C7	Dawn Dishwash Liquid	-	-	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				U	D	N	-
35	32	C8	Excedrin	-	U	N	-	-	U	U	-	-	U	U	D	-	-	U	-	-	N	D			U	D	N	-
36	33	C9	Cinnamon Mint	-	-	U	N	U	N	U	N	D	U	U	N	-	-	N	-	-	N	N			U	D	N	-
37	34	C10	Wegmans Dish Detergent	-	-	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				U	D	N	-
38	35	C11	Baking Soda	-	U	U	D	D	U	D	D	D	U	D	D	-	D	N	U	-	D	D			U	D	N	-
39	36	C12	Cranberry Pomegranate	-	-	U	-	-	-	-	-	-	-	-	-	-	N	-	-	-	-				U	D	N	-
40	37	D1	Tilex Mildew Remover	-	N	U	D	-	D	D	D	D	-	D	-	U	U	D	-	-	D	D			U	D	N	-
41	38	D2	Lemon Juice	U	U	U	D	-	D	N	-	-	D	-	D	D	U	U	-	-	D	D			U	D	N	-
42	39	D3	Maple Extract	-	-	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				U	D	N	-
43	40	D4	Balsamic Vinegar	-	-	U	-	-	D	-	-	-	D	-	-	-	-	-	-	-	D				U	D	N	-
44	41	D5	Afta Aftershave Lotion	U	D	U	D	U	N	D	N	-	U	D	N	D	U	N	D	D	D	D			U	D	N	-
45	42	D6	Heinz Tomato Ketchup	U	-	U	D	U	D	D	D	-	U	U	D	-	U	U	-	U	U	D			U	D	N	-
46	43	D7	Raspberry Lemonade Mix	U	-	U	D	-	D	U	-	-	-	-	D	-	-	D	-	-	D	D			U	D	N	-

No.	Pseudo silver bullet (PSB)	C	G	E	H	K	O	P	Q	R	S	T
1	Bubbles	-0.5	-0.1	-0.2		-1.0	-0.1	-2.6	-8.4		-0.7	-1.4
2	Distilled white vinegar		-2.0	-0.1		-10.5		-20.4	4.7		-10.8	
3	Clorox disinfect cleaner	-6.0	-11.2	-10.2			-2.3	-3.8	10.3			-9.5
4	Welch's white grape juice	2.9	-0.9	5.5	0.5	-4.7		-0.2	1.2	10.4	-10.4	-12.4
5	Dove hairspray							-1.3	2.8	-2.6		
6	Scope mint mouthwash	1.6	0.0	0.1		-1.2	0.2	-0.3	14.1	-1.9	1.0	-1.8
7	Nyquil Liquid- cherry					-0.4	0.6	5.2	-19.6	-1.0	2.7	1.7
8	Proactive Revitalize toner				-8.0	-11.1		-21.2	0.1			-10.6
9	Sudafed PE children	4.5	0.5	3.2		0.1	-2.3	3.6	2.4	-1.2	-0.3	1.1
10	Red wine vinegar		1.5	0.8	-0.3	-10.5		-16.3	7.7			-16.4
11	Coke Cola, diet	4.9	0.5	-3.3		0.5	-0.1	3.2	11.3	0.3	-3.3	-1.0
12	Listerine fluoride rinse		-12.1	-2.5		-0.8	0.0	-1.0	24.8	-6.3	-2.1	-2.5
13	Dill spears juice	4.6	0.1	5.4	0.9	-4.4		-3.8	2.0	6.1	-7.0	1.3
14	Diet peach grapefruit	4.6	0.1	4.0		0.0	-0.3	4.4	1.4	-1.1	0.5	0.6
15	Heinz cleaning vinegar	3.9	-2.3	-0.1	-1.0	-12.0		-22.2	2.5		-10.4	
16	Febreze fabric refresher	-5.0	-0.4	-7.1		0.2	1.0	5.8	9.7	-0.3	0.8	0.9
17	Contact solution	2.4	-0.1	0.1		-0.8	-0.2	0.2	-0.2	-0.2	-0.7	0.3
18	Hydrogen peroxide	0.2	0.0	0.3		-0.8	-1.7	0.8	-33.2	-2.9	-0.6	-0.5
19	Tops fat-free milk	-3.2	1.5	5.5		-0.2	0.2	2.2	2.9	0.2	-3.3	-0.2
20	Deep-cleaning astringent					-1.2	-5.7	4.0	5.9	-3.3	-5.1	
21	Margarita mix	0.9	-11.7	-13.4		-12.2		-11.8	1.9		-15.6	-11.1
22	Tiparos fish sauce	3.5	1.9	1.5		0.2	-1.0	5.5	-2.1	-0.4	-1.1	-1.2
23	Body spray, vanilla					0.3	0.9	-0.4	-3.2	-2.9		
24	Bathroom cleaner				-1.5	-14.4		-22.7	2.6		-9.1	
25	Polish remover, regular	0.3	-0.1	0.3		-0.8	0.2	-0.5	-1.0	-0.2	0.3	-0.2
26	Red food coloring	2.8								-0.7		
27	2-in-1 body shampoo									-0.9		
28	Gel dishwash detergent	5.5								1.0		
29	Purell hand sanitizer	-7.9	-0.1	-9.3		0.0	0.4	2.0	2.1	-2.5	-0.2	-6.1
30	Airborne baby wash									-0.4		
31	Dawn dishwash liquid									-1.2		
32	Excedrin	-8.6	-2.7	0.3	0.0	-8.5		-14.1	-2.3		-17.7	1.9
33	Cinnamon mint	1.6	0.4	0.3		0.1	0.7	1.3	4.2	-3.1	0.9	-0.8
34	Wegmans dish detergent								-4.0			
35	Baking soda	2.2	-5.0	-13.9		-2.7	-16.6	3.7	11.2	-8.5	-14.2	-15.8
36	Cranberry pomegranate								3.0			
37	Tilex mildew remover		-9.4	-13.6			-5.9		8.7		-15.3	-14.3
38	Lemon juice		-4.2	-7.2	0.2	-14.4		-20.0	13.1		-25.5	-9.0
39	Maple extract								15.0			
40	Balsamic vinegar		-2.2					-12.5	4.1		-14.6	
41	Afta aftershave lotion		-2.5	-27.4		0.1	-6.8		12.2	13.5	-20.8	0.9
42	Heinz tomato ketchup	2.9	-4.4	2.5	0.4	-4.4	-20.9	-0.2	-0.5	4.1	-4.9	-4.8
43	Raspberry lemonade mix		-7.8	-11.8	-6.0	-15.6			6.7			1.8
44	Ground black pepper	2.8	0.7	-1.4		-0.2	1.1	2.7	12.1	-0.1	1.2	5.8
45	Powder dish detergent	-2.5	-8.5	-28.7		-7.9		-3.2	11.6			-29.4
46	Ground cinnamon	-2.8	-0.2	1.7		0.4	1.3	2.0	-1.9	15.3	6.3	0.0
47	Wegmans salt, iodized	1.1	0.0	0.8		0.1	0.5	4.5	2.7	12.1	-1.1	-3.1
48	Avon loose powder	0.0	0.4	0.1		0.3	0.8	0.8		-0.6	-0.4	-0.9

No.	Pseudo silver bullet (PSB)	C	G	E	H	K	O	P	Q	R	S	T
49	Cascade dish detergent	-4.3	-7.9	-21.9		-8.3		-4.5	2.0			-22.8
50	Equal sweetener	2.3	0.4	1.1		-0.2	-0.3	0.2	0.2	-0.6	0.8	1.5
51	Severe cold, daytime		-3.2	-1.6	-1.0	-10.3		-10.0	7.7			-16.0
52	Centrum multivitamin	2.6	1.1	2.6		-1.4	-1.5	28.2		-3.9	1.0	-1.2
53	Folgers roast coffee		-2.5			-0.2	0.4	8.6	7.9	-1.4	6.3	
54	Gerber cherry puffs	0.3	0.2			-0.1	0.5	0.7	-5.9	0.1	0.0	-0.7
55	Ibuprofen	-8.0	0.1	-3.5		0.0	0.7	-0.2	2.8	-0.8	0.8	0.6
56	Prenatal vitamins	1.6	0.3			-1.0	-0.4	23.7	5.2	10.4	5.2	-0.3
57	Halls defense				0.0	-7.4		-3.0	11.1			-11.6
58	Women's vitamins	0.7	-0.2	3.3		-1.1	-1.9	30.2		4.6	1.4	2.1
59	Wegman's honey	-4.8	0.2	4.7		0.3	0.4	2.5	-5.6	0.1	2.9	2.0
60	Spices	2.9	-2.2	1.6		0.2	0.1	4.5	-25.5	-0.5	0.9	8.5
61	Children's Thin Strips	-1.4	0.5	0.8		-1.0	0.5	0.5		-0.5	-4.3	-1.8
62	MK Timewise day	-6.7	-5.2	-10.2	5.2	-4.8	-0.3	5.2		1.6	-5.0	-2.8
63	MK Timewise 3-in-1			-7.7		0.2	0.2	0.9		-0.4	-1.6	-3.2
64	MK TW step 2: replenish	-3.2	-16.4	-7.6	5.0	0.0	-1.9	0.5	2.3	0.0	-0.1	1.1
65	Rubbing alcohol	-0.4	-1.7	-0.3		-3.3	-0.5	-1.4	-4.4	-1.4	-0.7	-0.9
66	Clorox sanitizing spray	-2.0	-0.1	0.2		0.2	-0.2	0.3		-0.2	0.2	-0.1
67	Ron Bacardi rum	-0.3	-0.3	-0.2		-1.2	-0.4	-0.4		-0.6	-0.2	0.2
68	Golden Fields fiber	2.2	-2.8	-0.7		-0.1	-0.1	2.5	-4.2	0.2	0.1	0.0
69	Windshield washer fluid	0.0	0.0	-0.1		-0.6	0.2	-0.6		0.8	0.3	-1.2
70	Lemon Lime Gatorade		-1.3	3.6		-5.2		1.8		1.5	-9.7	1.7
71	Rite-Aid aspirin	-4.2	-2.0	1.9		-4.4		-3.5		5.8	-11.1	2.7
72	Chiavetta marinade BBQ	-1.5	-4.1	-3.8	-0.7	-12.2		-16.7	7.0			-21.1
73	Splenda sweetener	0.5	0.3	0.1		0.3	0.0	2.2	-3.6	-0.8	0.2	-0.4
74	Sugarfree Redbull		-0.9		0.3	-4.0		3.5	3.5	6.6	-6.4	3.0
75	Monster Energy		-0.3		-1.4			5.0	11.3	1.2	-6.0	0.7
76	Tums cool relief	-0.7	0.6	-0.3		-0.1	1.1	3.3	-6.3	-0.1	-1.5	-1.7
77	Sugar, white, granulated	0.4	0.2	0.1		0.0	0.2	1.2	-4.3	-0.1	0.2	0.1
78	Nesquik strawberry	0.0	0.4	0.1		-0.1	0.6	4.5	10.7	0.7	3.0	0.4
79	Fizzy Tub Colors	11.7	-2.4	-8.0		-0.4	-2.4	11.2	-5.0	-3.1	-9.3	-8.7
80	L'Oreal mineral blush	0.5	0.2	-0.5		0.1	1.4	1.6	-0.8	0.4	-0.8	-2.5
81	Tums antacid	-1.5	1.1	-0.3		-0.4	0.9	2.6	-4.4	0.3	-0.6	-3.4
82	Cake Mate sprinkles	1.2	0.2	0.9		0.2	0.8	0.6	-4.8	0.1	1.0	-0.1
83	Tylenol cold, daytime	0.2	0.2	0.4		-0.9	0.5	0.2	-5.5	-1.3	-1.2	-0.5
84	Omega 3 fish oil	-0.6	-0.2	0.2		0.0	0.0	0.0	0.0	-0.1	-0.6	-0.9
85	Cold-Eeze lozenges		0.3	5.2	0.6	-6.0	-16.2	-1.5	-1.2			
86	Rolaids antacid, cherry	-0.4	1.2	0.1		-0.4	0.1	3.2	4.1	-0.2	-1.7	-4.6
87	Raspberry coffee syrup		-0.2	4.9		-0.3	-2.6	6.1	-4.6	-1.9	4.6	1.9
88	Pez, cherry	3.2	0.3	0.4		0.0	-0.1	1.1	-11.2	-0.2	0.0	0.0
89	Infants' antigas, drops	1.8	-7.7	-2.3	-15.5	-0.2	0.9	3.4	-4.7	-0.2	0.1	-0.6
90	Coconut conditioner	-11.7	-0.3	-1.8	6.7		-0.1	-3.8	0.2		-8.6	-3.3
91	French's mustard, honey	-1.0	-4.4	3.7	0.1	-4.2		-5.1	-4.9	3.4	-6.9	3.3
92	Airborne hand lotion	-4.6	-0.3	0.1		0.0	0.2	0.4		-0.5	0.3	0.0
	Control point	0.0	0.0			0.0	0.0		0.0	0.0	0.0	0.0
94	Good Start supreme	2.0	0.9	1.8		-0.3	0.1	3.3	-16.4	0.4	3.7	-0.4
95	Lipton orange tea	-0.9	-3.5	-1.2		-0.1	-1.2	2.5	-5.5	-0.5	-6.3	0.8
96	MK Timewise night	-5.5	-4.4	-9.8	5.9	0.3	-0.5	0.8	0.9	-4.2		-0.8

Communicate Results



Each of the students presents to an audience of scientist and peers.

Crystal cookery – using high-throughput technologies and the grocery store as a teaching tool

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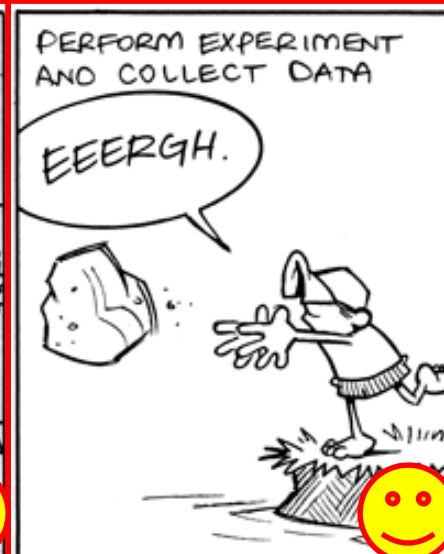
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Crystallography is a multidisciplinary field that links divergent areas of mathematics, science and engineering to provide knowledge of life on an atomic scale. Crystal growth, a key component of the field, is an ideal vehicle for education. Crystallization has been used with a 'grocery store chemistry' approach and linked to high-throughput remote-access screening technologies. This approach provides an educational opportunity that can effectively teach the scientific method, readily accommodate different levels of educational experience, and reach any student with access to a grocery store, a post office and the internet. This paper describes the formation of the program through the students who helped develop and prototype the procedures. A summary is presented of the analysis and preliminary results and a description given of how the program could be linked with other aspects of crystallography. This approach has the potential to bridge the gap between students in remote locations and with limited funding, and access to scientific resources, providing students with an international-level research experience.

Also - Goes on resume for college application!

Where appropriate they help write up the results and receive authorship for their work. This has one of the biggest impacts in encouragement and motivation.

THE SCIENTIFIC METHOD... FOR TEN-YEAR OLDS



* THIS IS SURPRISINGLY CLOSE TO HOW REAL SCIENTISTS ACT AT CONFERENCES.

6. The future

In progress – this years students

Do grocery store items mimic silver bullets?

Crystallize a subset of proteins with silver bullets and identified pseudo silver bullets.

Collect diffraction data.

Process the data.

Refine the structure and determine the ligand if any.

Where we would like to take it

Crystallization screening is virtual – results are seen over the internet

Identify a school or schools that can simply do the experiment of selecting a number of different compounds

Run the screening over the internet with the school simply sending a 96 well plate filled with solutions.

Monitor results.

Send one of our scientist to the school to go over the analysis of results.

In the process teach the scientific method and get children to discover discovery.

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