Lemon Tea Lather

Group 23 ChE 180 Design Project Professor Marc Aucoin Fall 2019



Ingredients

- NaOH(Sodium Hydroxide or Lye)
- Distilled Water
- Coconut Oil
- Ghee
- Crisco
- Canola Oil
- Green Tea Flakes
- Lemongrass Essential Oil

Contributing Properties

- > Forms hard soap
- Mixed with NaOH to create lye solution
- > Hardness, bubbly lather, cleansing
- Hardness, creamy lather
- > Conditioning
- > Conditioning
- Green Tea Scent, exfoliating properties
- ➢ Lemongrass Scent

Context and Background

Saponification Reaction:

- The saponification reaction is essential to soap making. This is a reaction that takes place when oils/fats and lye (sodium hydroxide or potassium hydroxide) are mixed to create soap molecules.
- When making soap we have to look at the time it takes for the reaction to reach completion due to our reactants, specifically lye which can be harmful (look at Safe Design/Sustainability).
- There are two main processes in the industry when it comes to making soap with the saponification reaction. The processes are the hot process and cold process. It is self-evident from their names what each process is about. In the hot process, we allow the temperature to increase the rate of reaction whereas in the cold process heat may be applied to melt our oils/fats but afterwards the reaction might take place over days or weeks.

Design

Product Quality and Materials Selected:

- Quality is designed for utmost health benefits. Green tea is an antioxidant, antibacterial, and is beneficial for the prevention of UVB non-melanoma skin cancer.
- Materials selected are gentle on skin. Materials were selected such that the soap is hard, cleansing bubbly, creamy and conditioning.

Appearance:

- The natural appearance of the soap symbolizes the environment and demonstrates luxury. The incorporation of the green tea flakes allows the user to get a sensation of nature, and receive immense health benefits.
- The Lemon Tea Lather is delicately parcelled in clear wrap to let consumers see the details of the product. Furthermore, it was enclosed in a label which shows the unique brand name and logo, as well as the contents of the soap.

Process:

- Cold process is safe and requires less time for reaction than hot process.
- The procedure requires two batches. One batch is made with green tea as the solvent in the lye solution. This gives distinct colour, and infuses the green tea healing properties into the soap. The second batch is made with water as the solvent for the lye solution, and green tea flakes are added for texture difference. Both batches were mixed together in the mould.

Rationale for Soap Design

- Skin Revitalizing Properties
 - Tea contains anticarcinogenic, antibacterial, and antioxidant properties, as well as Vitamin A, Vitamin C, Magnesium and Zinc
 - o Natural dyes will not stain your skin, opposed to synthetic dyes like food colouring
 - Tea flakes allow gentle exfoliation and moisturization
- Unique Appearance
 - Marbled design increases aesthetic appeal
 - Roughened texture resembles the imperfections of nature
 - Multiple sizes available, to suit a wide variety of clients
- Aromatic Enhancement and Oil Usage
 - Lemongrass scent carries the allure of freshness
 - Specific oils used leave hands feeling clean and moisturized

Cancer Fighting Properties

Topical treatment of green tea has shown to prevent UVB-induced non-melanoma skin tumor development, through rapid repair of DNA (by the action of Green Tea Polyphenols). Green tea does not work as sunscreen, rather it repairs the damage done to the skin.

"In skin samples obtained at 24 h or 48 h after UVB exposure, the numbers of CPD-positive cells were significantly reduced (or repaired) in the EGCG-treated mouse skin compared to the control group of mice which were not treated with EGCG" (1)

- Non melanoma cancer: Rarely metastasizes, therefore is less fatal than melanoma cancer.
- CPD: 'Cyclobutane pyrimidine dimers' (Molecular triggers for the induction of immunosuppression and initiation of UV-caused carcinogenesis)
- EGCG: 'epigallocatechin-3-gallate' (A major polyphenol present in green tea)

Antibacterial and Antioxidant Properties

Green tea is approximately 30% polyphenols by weight. 50% of the polyphenols is the EGCG catechin. Catechins are natural antioxidants. (2)

Benefits of catechins: -Prevent cell damage -Reduce the formation of free radicals -Reduce inflammatory acne -Reducing inflammation reduces cancer risk, as inflammation is a precursor to cancer (4)

Green tea and purified EGCG compound have strong inhibitory effects against multi-drug-resistant pathogens. Thus, antibacterial properties of green tea are shown. (3)

1.4 1.2 1 Value (600 nm) 0.8 OD Value E. coli 0.6 0.4 OD Value S. aureus 0 0.2 0 8 10 6 -0.2 EGCG mg/mL

Chart: Minimum Inhibitory Concentration of EGCG on multi-drug-resistant E-coli and S-aureus. (3)

Antibacterial Effect of EGCG

Rationale for Packaging Design

- The soap is directly wrapped in plastic wrap to keep it protected and pure.
- The plastic wrap also allows the uniqueness of the soap to be observed while still in the package.
- A cardstock label is wrapped around the plastic. The prominent placement of the logo on the cardstock is expected to draw people in and to make the soap recognizable.
- A small hole is cut into the label and plastic wrap to allow people to smell the soap before purchasing.
- The unwrapped hole allows for people to feel the texture of the soap.

Procedure

Procedure:

Both the Green Tea-Infused Batch and the Natural Batch are to be cooked simultaneously. They will be mixed together in the soap mold at the same time, and layered to give an aesthetic appeal. Thus, both soaps must be done cooking at the same time.

Green Tea-Infused Batch:

Step 1: Preparing the Lye Solution

i) Bring water to 85F. Using the filter, steep the tea for 3 minutes. Let cool completely, by refrigerating for several hours. Note: It is normal for brown discolouration and a foul smell to be produced, so ensure the reaction occurs in a well-ventilated space.

ii) Once the mixture is completely cooled, add the lye slowly. Stir the mixture until all of the lye crystals are completely dissolved.

Step 2: Preparing the Oil Mixture

i) Add the solid oils to the cooking pot, heat set low. Stir periodically until the liquids have melted.

ii) Once the solid oils have melted, add the liquid oils to the cooking pot and stir to combine. Heat this mixture to 150F.

Step 3: Combining the Lye Solution and Oil Mixture

i) With caution, slowly pour the lye solution into the cooking pot. Continue to stir all areas of the pot. Stir until the mixture becomes a thick trace, much like the consistency of pudding.

ii) Cover the cooking container (ie, put the lid on) to retain moisture in the soap. Cook at low heat, watching the soap to ensure it does not bubble over. Stir periodically to even out the cooking process. The soap is done cooking when it has the consistency of Vaseline, and is mostly translucent. This will likely be around 210F.

ii) Test if the cook is finished by preparing a 100 mL beaker with 50mL of distilled water. Add one tablespoon (15mL) of soap. Stir the mixture and test the pH with a pH strip. If the pH is below 9, the soap is finished cooking and can be removed from heat. If not, continue to cook until this criteria is met.

Procedure

Step 4: Adding the Essential Oil

i) Once the soap has cooled to 150F, stir in the lemongrass oil. The flashpoint of lemongrass essential oil is 159F, so be careful not to add it when the soap mixture is above this temperature. However, work efficiently as the soap will cool quickly, decreasing fluidity.

Step 5: Transfering to the Mould

i) Transfer the soap to the desired mould. Make sure to level the top, and compact the soap to decrease the amount of air pockets. Layer with the Natural Batch.

Natural Batch:

Step 1: Preparing the Lye Solution

i) Repeat Step 1 of the Green Tea-Infused Batch, however use distilled water as the solvent in place of green tea.

Step 2: Preparing the Oil Mixture

i) Repeat Step 2 of the Green Tea-Infused Batch.

Step 3: Combining the Lye Solution and Oil Mixture

i) Repeat Step 3 of the Green Tea-Infused Batch.

Step 4: Adding the Essential Oil

i) Repeat Step 4 of the Green Tea-Infused Batch.

ii) Crush the green tea flakes to medium size, and stir in.

Step 5: Transferring to the Mould

i) In the same mould as used previously, layer the soap mixture with the Green Tea-Infused Batch.

ii) Note: The longer the soap has to set in the mould, the more pure it will be.

Rationale for Mold Selection

Shape:

- Resembles conventional soap
- Large size is easy to hold on to
- Easy for multiple sizes to be created, to satisfy the needs of customers

Plastic Container:

- Flexible container allows easy removal, by bending the container.
- High heat resistance

Clear:

• Since two batches of soap were made, aesthetic appeal is ideal. Transparent molds verify that the mixed batches are aesthetically appealing.

Soap Calculator

- The soap calculator efficiently calculates the correct amounts of oil, additives, and NaOH for the reaction to proceed.
- The properties of the different oils are based on the fatty oil composition of the soap
- The excel tool 'Solver' is used to calculate the quantity of oils required to meet design criteria (properties of the soap)
- Contains: Oil identity composition, cost per oil, cost composition, oil mass composition, water composition, lye consumption, overall properties of the soap.

• The soap calculator can be manipulated to create different variations of soap using different oils. Three variations will be shown

Soap Optimizer													
							Oil Prop	erties					
Oils	Percentage	Quantity (g)	SAP (NaOH) SA	AP (KOH)	Hardness	Clear	nsing E	ubbly Lather	Creamy Lather	Conditionning	Density		Cost
Coconut Oil, 76 deg	41%	202.6679128	0.183	0.257	7	79	67	67		12	10	0.92	1.63
Ghee, any bovine	19%	95.2299325	0.162	0.227	7	55	15	15		40	22	1.01	1.67
Crisco, old	15%	76.32097295	0.137	0.192	2	26	0	0		26	70	0.81	0.42
Avocado Oil	0%	0	0.133	0.186	5	22	0	0		22	70	0.92	1.86
Olive Oil	0%	0	0.135	0.19	9	17	0	0		17	82	0.92	0.6
Sesame Oil	0%	0	0.134	0.188	3	15	0	0		15	83	0.92	1.77
Corn Oil	0%	0.110794467	0.137	0.192	2	14	0	0		14	84	0.92	0.27
Grapeseed Oil	0%	0	0.129	0.181	L	12	0	0		12	88	0.92	0.86
Sunflower Oil	0%	0.762395446	0.135	0.189	9	11	0	0		11	87	0.92	0.28
Canola Oil	25%	124.9079905	0.133	0.186	5	6	0	0		6	91	0.92	0.21
Lemongrass Essential Oil	3%	14.99999996	0	C)	0	0	0		0	0	0.87	36.7
Total	103%	500											
		1				Contribut	ion to Overall	Soap Recipie and	Properties				
			SAP (Na	OH) SAP (K	(OH)	Hardness	Cleansing	Bubbly Lather	Creamy Lather	Conditionning	Cost		
			37.08	8822805 52	2.0856536	32.0215302	2 27.1575003	27.15750032	4.864029908	4.053358257	\$3.59		
1 A atus	VI Can	n	15.42	2724907 21.	61719468	10.4752926	5 2.85689798	2.856897975	7.6183946	4.19011703	\$1.57		
ALLUC	al JUd		10.45	597329 14.	65362681	3.96869059	9 0	0	3.968690594	10.68493621	\$0.40		
		•		0	0	0	0 0	0	0	0	\$0.00		
Color	Ilatar			0	0	0	0 0	0	0	0	\$0.00		
Laili	ιαιοι			0	0	0	0 0	0	0	0	\$0.00		
			0.015	5178842 0.0	21272538	0.00310225	5 0	0	0.003102245	0.01861347	\$0.00		
(Thic)	calau	latar		0	0	0) 0	0	0	0	\$0.00		
	Lailu	lalui	0.102	2923385 0.1	44092739	0.016//2/		0	0.016//2/	0.132656808	\$0.00		
		_	16.61	2/62/4 23.	23288624	1.49889589		0	1.498895886	22./3325428	\$0.29		
	icod ii	a tha		U	U	U	J U	U	U	U	\$0.33		
was u	IZEU II										\$0.64	(Additiv	e: Green Tea)
		\	Mass of Oils	(g)	500								
soan	made	ک) Mas	s of Water as a Percentage of C	Dils	38%								
Jup	induc	//	Mass of Water	(g)	190		-						-
				Mass of Na	OH (g) Ma	ss of KOH (g)	Hardness	Cleansing	Bubbly Lather	Creamy Lathe	r Conditio	ning	Cost

Totals 79.70231537 111.7547266 47.9842842

Recommended Ranges

Targets

Objective Function 86.8168811

12-22

17

29-54

48

18 30.01439829

14-46

30

60

52

44-69

\$12.82

35

32

16-48

Soap Optimizer											
						Oil Pro	perties				
Oils	Percentage	Quantity (g)	SAP (NaOH)	SAP (KOH)	Hardness	Cleansing	Bubbly Lather	Creamy Lather	Conditionning	Density	Cost
Coconut Oil, 76 deg	45%	223.720344	0.183	0.257	79	67	67	12	10	0.92	1.63
Ghee, any bovine	0%	0	0.162	0.227	55	15	15	40	22	1.01	1.67
Crisco, old	41%	202.6178384	0.137	0.192	26	0	0	26	70	0.81	0.42
Canola Oil	0%	0.004164123	0.133	0.186	6	0	0	6	91	0.92	0.21
Olive Oil	0%	0	0.135	0.19	17	0	0	17	82	0.92	0.6
Sesame Oil	0%	0	0.134	0.188	15	0	0	15	83	0.92	1.77
Corn Oil	15%	73.2930312	0.137	0.192	14	0	0	14	84	0.92	0.27
Grapeseed Oil	0%	0.033211977	0.129	0.181	12	0	0	12	88	0.92	0.86
Shea Butter	0%	0.331394896	0.128	0.179	45	0	0	45	59	0.91	2.9
Safflower Oil	0%	0	0.137	0.192	7	0	0	7	145	0.92	1.73
Lemongrass Essential Oil	3%	14.99999954	0	0	0	0	0	0	0	0.87	36.7
Total	100%	500									
Additive: Green Tea	3%	15									

First Variation

	Mass of Oils (g)	500	
Mass of Water as a	Percentage of Oils	38%	-
	Mass of Water (g)	190	

				roperties	oap Recipie and P	on to Overall S	Contributi		
		Cost	Conditionning	Creamy Lather	Bubbly Lather	Cleansing	Hardness	SAP (KOH)	SAP (NaOH)
		\$3.96	4.474406879	5.369288255	29.97852609	29.9785261	35.3478143	57.4961284	40.94082295
		\$0.00	0	0	0	0	0	0	0
		\$1.05	28.36649738	10.5361276	0	0	10.5361276	38.90262498	27.75864386
		\$0.00	0.00075787	4.99695E-05	0	0	4.9969E-05	0.000774527	0.000553828
		\$0.00	0	0	0	0	0	0	0
		\$0.00	0	0	0	0	0	0	0
		\$0.22	12.31322924	2.052204874	0	0	2.05220487	14.07226199	10.04114527
		\$0.00	0.005845308	0.000797087	0	0	0.00079709	0.006011368	0.004284345
		\$0.01	0.039104598	0.029825541	0	0	0.02982554	0.059319686	0.042418547
		\$0.00	0	0	0	0	0	0	0
		\$6.33	0	0	0	0	0	0	0
Green Tea)	(Additive: Gr	\$0.64							

	Mass of NaOH (g	Mass of KOH (g)	Hardness	Cleansing	Bubbly Lather	Creamy Lather	Conditioning	Cost
Totals	78.7878688	110.5371209	47.9668194	18	29.97852609	35	60	\$12.21
	Reco	mmended Ranges	29-54	12-22	14-46	16-48	44-69	
		Targets	48	17	30	32	52	
	(Objective Function	86.20948					

Soap Optimizer											
						Oil Pro	perties				
Oils	Percentage	Quantity (g)	SAP (NaOH)	SAP (KOH)	Hardness	Cleansing	Bubbly Lather	Creamy Lather	Conditionning	Density	Cost
Aloe Butter	48%	238.1997592	0.171	0.24	74	63	63	11	10	0.89	8.129
Ghee, any bovine	0%	0	0.162	0.227	55	15	15	40	22	1.01	1.67
Crisco, old	45%	222.8316782	0.137	0.192	26	0	0	26	70	0.81	0.42
Canola Oil	0%	0	0.133	0.186	6	0	0	6	91	0.92	0.21
Olive Oil	0%	0	0.135	0.19	17	0	0	17	82	0.92	0.6
Sesame Oil	0%	0	0.134	0.188	15	0	0	15	83	0.92	1.77
Corn Oil	8%	38.59124477	0.137	0.192	14	0	0	14	84	0.92	0.27
Grapeseed Oil	0%	0.033204646	0.129	0.181	12	0	0	12	88	0.92	0.86
Shea Butter	0%	0.344096483	0.128	0.179	45	0	0	45	59	0.91	2.9
Safflower Oil	0%	0	0.137	0.192	7	0	0	7	145	0.92	1.73
Lemongrass Essential Oil	3%	14.9999995	0	0	0	0	0	0	0	0.87	36.7
Total	100%	500									
Additive: Green Tea	3%	15									

Second	ł
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Variation

	Mass of Oils (g)	500
Mass of Water a	s a Percentage of Oils	38%
	Mass of Water (g)	190

		roperties	oap Recipie and P	on to Overall S	Contributi		
Cost	Conditionning	Creamy Lather	Bubbly Lather	Cleansing	Hardness	SAP (KOH)	SAP (NaOH)
\$21.76	4.763995184	5.240394702	30.01316966	30.0131697	35.2535644	57.1679422	40.73215882
\$0.00	0	0	0	0	0	0	0
\$1.16	31.19643494	11.58724726	0	0	11.5872473	42.78368221	30.52793991
\$0.00	0	0	0	0	0	0	0
\$0.00	0	0	0	0	0	0	0
\$0.00	0	0	0	0	0	0	0
\$0.11	6.483329122	1.080554854	0	0	1.08055485	7.409518996	5.287000534
\$0.00	0.005844018	0.000796912	0	0	0.00079691	0.006010041	0.004283399
\$0.01	0.040603385	0.030968683	0	0	0.03096868	0.06159327	0.04404435
\$0.00	0	0	0	0	0	0	0
\$6.33	0	0	0	0	0	0	0

\$0.64 (Additive: Green Tea)

	Mass of NaOH (g	Mass of KOH (g)	Hardness	Cleansing	Bubbly Lather	Creamy Lather	Conditioning	Cost
Totals	76.59542701	107.4287467	47.9531321	18	30.01316966	35	60	\$30.00
	Reco	mmended Ranges	29-54	12-22	14-46	16-48	44-69	
		Targets	48	17	30	32	52	
		Objective Function	104.006383					

Soap Optimizer											
						Oil Pro	perties				
Oils	Percentage	Quantity (g)	SAP (NaOH)	SAP (KOH)	Hardness	Cleansing	Bubbly Lather	Creamy Lather	Conditionning	Density	Cost
Aloe Butter	41%	206.9945314	0.171	0.24	74	63	63	11	10	0.89	8.129
Ghee, any bovine	26%	131.8189915	0.162	0.227	55	15	15	40	22	1.01	1.67
Coconut Oil, 76 deg	0%	0	0.183	0.257	79	67	67	12	10	0.92	1.63
Canola Oil	23%	112.8847911	0.133	0.186	6	0	0	6	91	0.92	0.21
Olive Oil	0%	0.502488505	0.135	0.19	17	0	0	17	82	0.92	0.6
Sesame Oil	0%	0	0.134	0.188	15	0	0	15	83	0.92	1.77
Corn Oil	9%	47.41526383	0.137	0.192	14	0	0	14	84	0.92	0.27
Grapeseed Oil	0%	0.033275142	0.129	0.181	12	0	0	12	88	0.92	0.86
Shea Butter	0%	0.350646004	0.128	0.179	45	0	0	45	59	0.91	2.9
Safflower Oil	0%	0	0.137	0.192	7	0	0	7	145	0.92	1.73
Lemongrass Essential Oil	3%	14.99999962	0	0	0	0	0	0	0	0.87	36.7
Total	100%	500									
Additive: Green Tea	3%	15									
(

			roperties	oap Recipie and P	ion to Overall S	Contribut		
	Cost	Conditionning	Creamy Lather	Bubbly Lather	Cleansing	Hardness	SAP (KOH)	SAP (NaOH)
	\$18.91	4.139890627	4.55387969	26.08131095	26.08131095	30.63519064	49.67868753	35.39606486
	\$2.18	5.800035625	10.54551932	3.954569744	3.954569744	14.50008906	29.92291107	21.35467662
	\$0.00	0	0	0	0	0	0	0
	\$0.26	20.54503198	1.354617493	0	0	1.354617493	20.99657114	15.01367721
	\$0.00	0.082408115	0.017084609	0	0	0.017084609	0.095472816	0.067835948
	\$0.00	0	0	0	0	0	0	0
	\$0.14	7.965764323	1.327627387	0	0	1.327627387	9.103730655	6.495891144
	\$0.00	0.005856425	0.000798603	0	0	0.000798603	0.006022801	0.004292493
	\$0.01	0.041376228	0.03155814	0	0	0.03155814	0.062765635	0.044882688
	\$0.00	0	0	0	0	0	0	0
	\$6.33	0	0	0	0	0	0	0
(Additive: Green Te	\$0.64							

Third Variation

Mass of Oils (g)		500
Mass of Water as a Percentage of Oils		38%
	Mass of Water (g)	190

	Mass of NaOH (g	Mass of KOH (g)	Hardness	Cleansing	Bubbly Lather	Creamy Lather	Conditioning	Cost
Totals	78.37732097	109.8661616	47.86696594	18	30.0358807	35	60	\$28.47
	Reco	mmended Ranges	29-54	12-22	14-46	16-48	44-69	
		Targets	48	17	30	32	52	
		Objective Function	102.4840165					

Designed vs As Made

As-Made Properties:

The actual masses of the oils and NaOH were inputted into the soap calculator, and 0.5 gram reduction accounting for residue on transfer containers. According to the table, a small deviation is found between the properties the designed and

	As Designed	As Made
Hardness	47.964	48.077
Cleansing	18.000	18.000
Bubbly Lather	30.014	30.253
Creamy Lather	35.000	35.000
Conditioning	60.000	60.000

Cost and Selling Price

	<u>Cost</u>	Price	
Oils:	\$5.85	Selling Price: \$0.045 per gram +\$ 0.10	
Additives:	\$7.15	Small Bar (75g): \$3.40	
NaOH :	\$2.38	Medium Bar (95 g): \$4.25	
Total : \$15.38		Large Bar (150 g): \$6.75	
Material cost	t/gram: \$0.03		
Packaging cost/bar: \$0.10		*Prices reflect 50% profit margin	

Total Cost: \$0.03 per gram + \$0.10

Options and Iterations of Design

	Variation 1	Variation 2	Variation 3
Oils Used	Coconut Oil (45%) Crisco (41%) Corn Oil (15%)	Aloe Butter (48%) Crisco (45%) Corn Oil (8%)	Aloe Butter (41%) Ghee (26%) Canola Oil (23%) Corn Oil (9%)
Distinguishing Values	-Inexpensive (\$12.21) -All ingredients are easily accessible and provided in the lab	-Expensive (\$30.00) -Vegan	-Expensive (\$28.47) -Large variety of ingredients required

Sustainability and Safe Design

- A cold process was chosen over a hot process. A hot process soap was not used due to the fact that if the soap mixture is left unattended when mixing, the hot soap can expand and flow completely out of the container and cause burns and stains.
- 5% Superfat was taken into account. Specifically since lye is corrosive, 95% of the mass of NaOH was used in order to ensure there was no NaOH left unreacted.
- Natural ingredients were used such as coconut oil, green tea and lemongrass essential oil.
- These natural ingredients do not stain hands like artificial colouring would.
- Using natural ingredients in soap is best as when they are washed down the drain, the natural ingredients do not bring harm to the environment.





Measuring the mass of ingredients

Oil mixture





Mixing the NaOH solution using a stir stick

Liquifying the oils



Mixing the lye solution and oil solution using immersion blenders

References

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