

# Deliciousness of Ice-Cream: The Saga of the Ingredients

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## Introduction

The sensory characteristics and rheological properties of ice cream sample have a strong correlation to the recipe's ingredients. Changes in cream, sugar and starch content affect food qualities including the body, texture, melt qualities and flavor of the ice cream. Ingredients also affect rheological properties such as viscosity and elasticity.

## Materials and Methods

Design of Experiments (DOE) was used to make nine recipes. Salt and vanilla contents were kept constant in all recipes at 3 tsp each. Analysis of Variance (ANOVA) elucidated correlations linking sensory properties and ingredients.

Table 1: Recipes for Samples 1-8

Recipe	Levels [X <sub>D</sub> ,X <sub>3</sub> ,X <sub>4</sub> ]	Heavy Cream (cups)	Whole Milk (cups)	Sugar (cups)	Corn Starch (tablespoon)
0	[0,0,0]	6	6	3	3
1	[-1,-1,-1]	4	8	2	2
2	[-1,-1,+1]	4	8	2	4
3	[-1,+1,-1]	4	8	4	2
4	[-1,+1,+1]	4	8	4	4
5	[+1,-1,-1]	8	4	2	2
6	[+1,-1,+1]	8	4	2	4
7	[+1,+1,-1]	8	4	4	2
8	[+1,+1,+1]	8	4	4	4

ANSCI 3010 students made the ice-cream samples and completed a sensory survey. Samples and surveys were given to the students by a double-blind method.

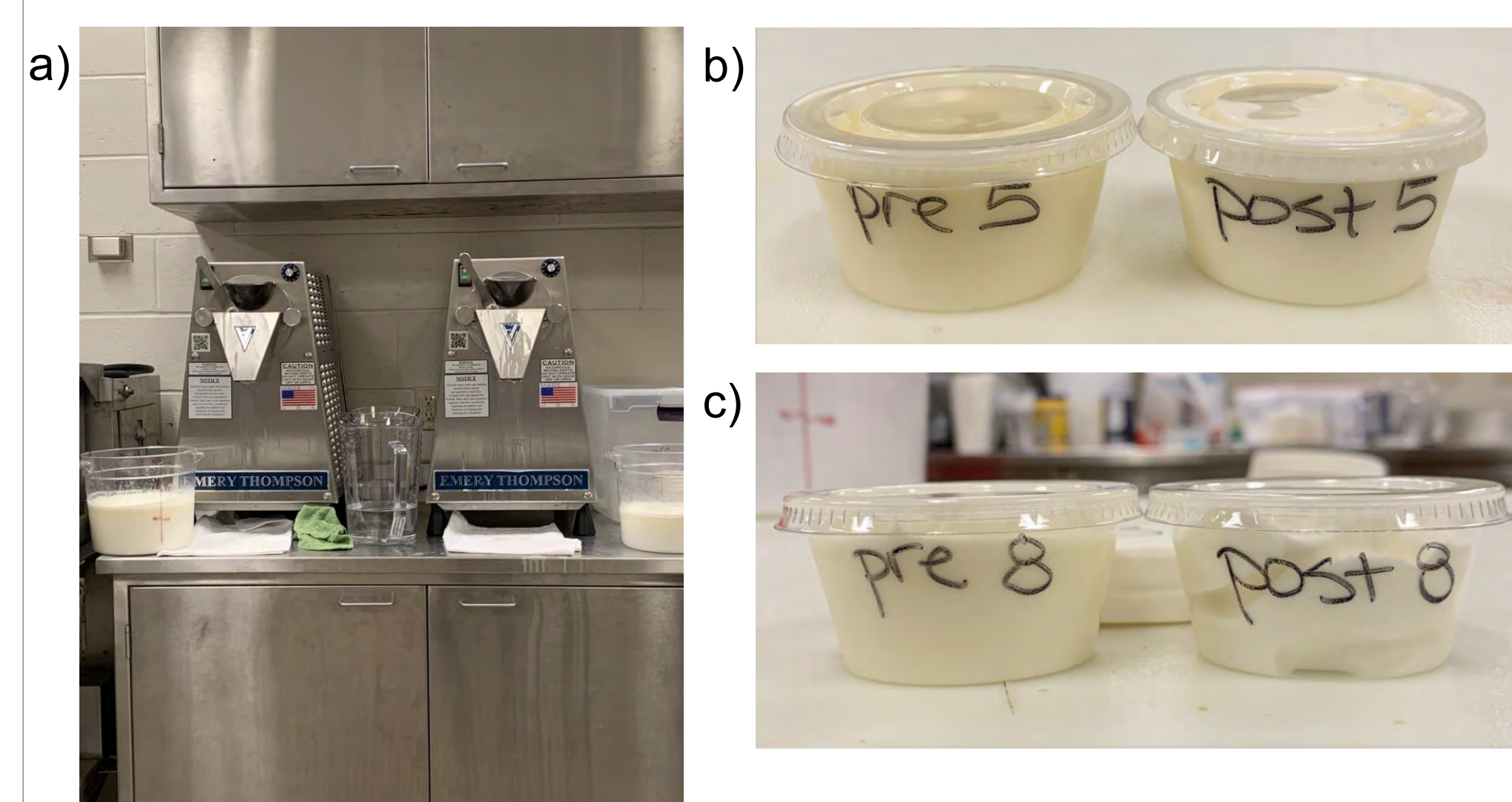


Figure 1: Ice cream samples were created on campus using an a) ice cream machine. Samples were taken b) before aeration and c) after aeration for comparison.

## Sensory Results: Student Tasters

Body, texture, melt rate and flavor were affected by changes in cream, sugar and starch content.

Correlation for cream, sugar and starch:

- Body: adhesiveness, gumminess
- Texture: viscosity, creamy, aeration

Flavor Anomalies

- Salt and sugar content was not changed
- Perception of vanilla was affected by different ingredients.

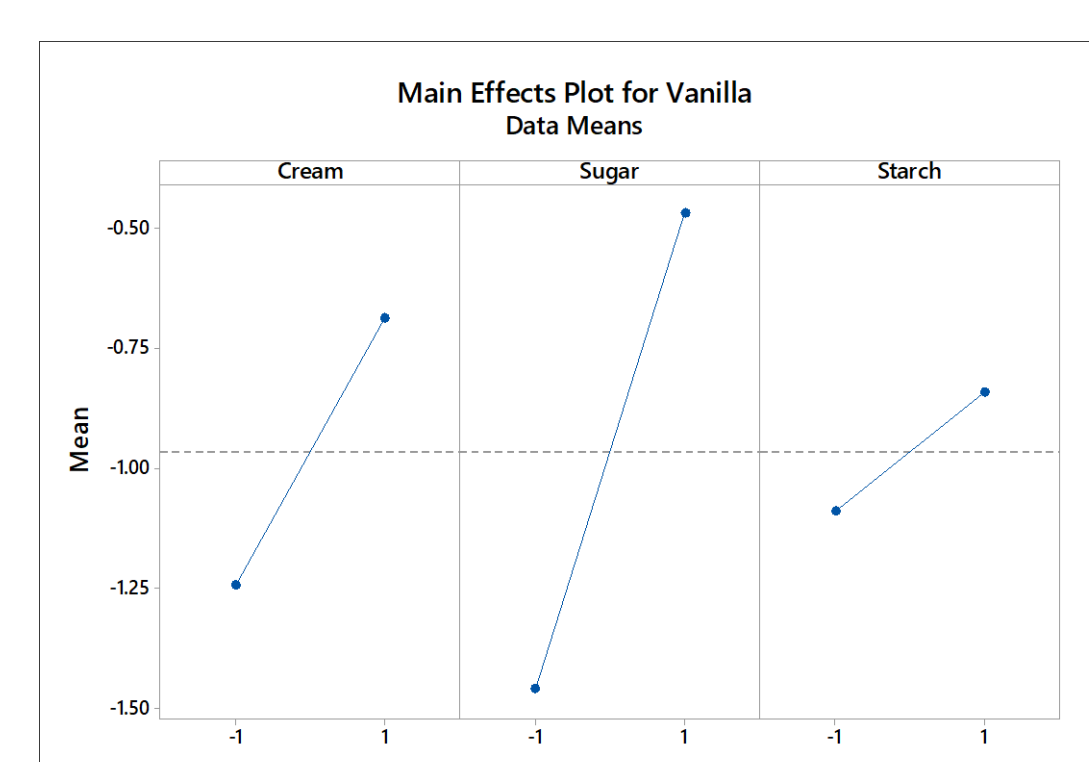


Figure 2: Sugar was the main reason for an increase in vanilla flavor.

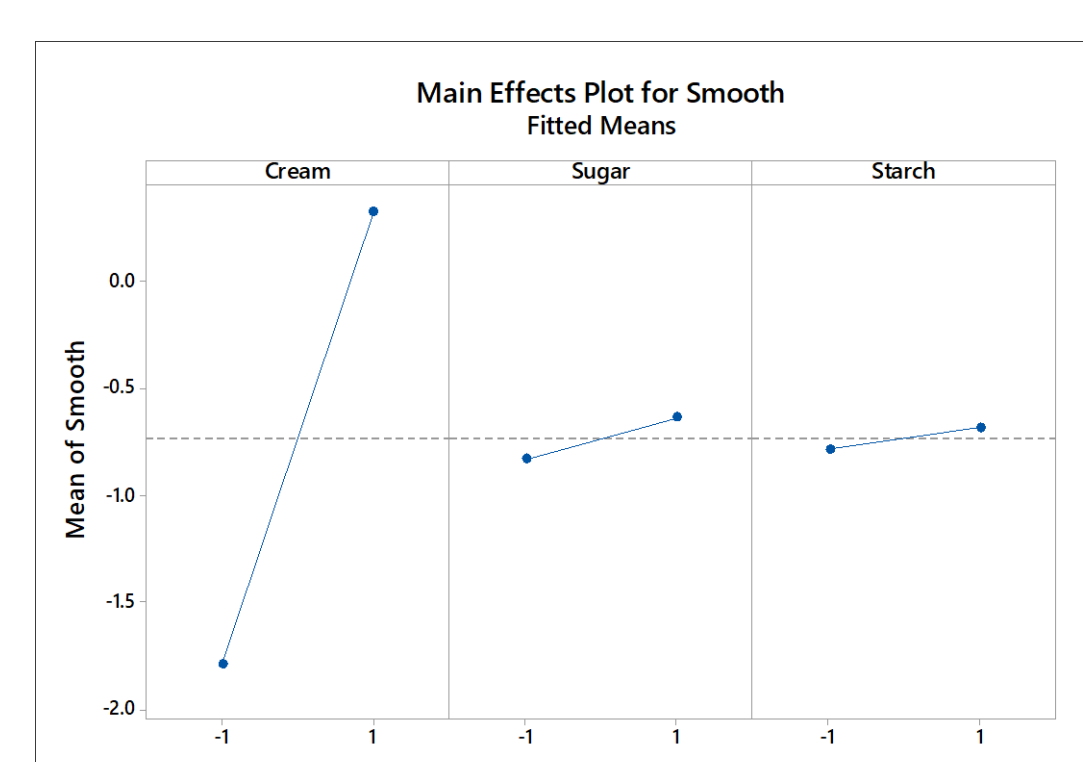


Figure 3: Smoothness was most affected by cream content.

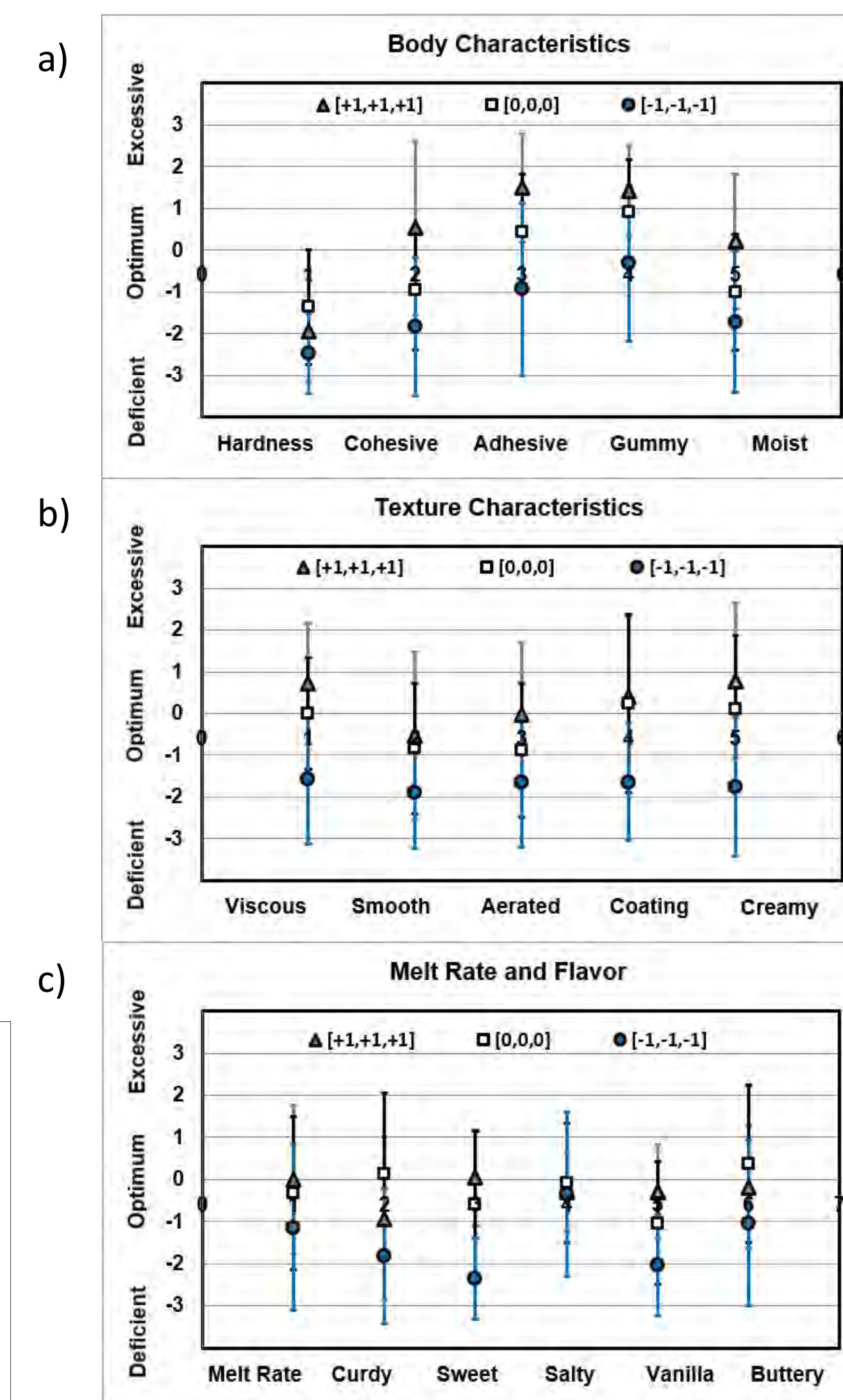


Figure 4: a) Body characteristics, b) texture characteristics and c) melt and flavor sensory survey results. [+1,+1,+1]: high cream, high sugar, high starch, [0,0,0]: original recipe, [-1,-1,-1]: low cream, low sugar, low starch

## Rheological Results: Anton-Paar Modular Rheometer

Ingredients affect properties

- Viscosity
- Adhesiveness
- Cohesiveness
- Elasticity
- Melt Rate
- Hardness

Table 2: Non-Newtonian behavior of melted samples was fit to Bingham, Casson, and Hershel Bulkley viscosity models.

Sample #	Sample Code	Temperature (°C)	Bingham		Casson		Hershel Bulkley		
			$\tau$	$\eta^{\infty}$	$\tau$	$\eta^{\infty}$	$\tau$	$b$	$p$
1	[-1,-1,-1]	10	0.010932	9.628	0.001799	8.4513	2	0.001453	0.90281
		15	0.00693	7.7568	0.000905	7.0039	2	0.004428	0.93791
2	[-1,-1,+1]	10	0.24624	5.3337	0.18875	1.4306	2	0.23137	0.015258
		15	0.26789	4.7959	0.213	1.1298	2	0.3139	0.001226
3	[-1,+1,-1]	10	0.23921	10.449	0.1565	4.319	2	0.25348	0.0148
		15	0.3487	8.9513	0.25937	2.6187	2	0.33628	0.0094
4	[-1,+1,+1]	10	0.20609	10.15	0.12962	4.2709	2	0.18085	0.021481
		15	0.20953	9.5923	0.13455	3.916	2	-	0.13067
5	[+1,-1,-1]	10	0.17373	65.914	0.056716	49.971	2	-	0.1809
		15	0.14032	53.466	0.03814	42.036	2	0.008248	0.11951
6	[+1,-1,+1]	10	0.055393	54.158	0.008376	48.063	2	-	0.094373
		15	0.040371	43.283	0.005132	39.09	2	0.064841	0.037358
7	[+1,+1,-1]	10	0.3437	31.529	0.17647	17.152	2	0.45927	0.017426
		15	0.34683	29.819	0.1862	15.683	2	0.44342	0.027725
8	[+1,+1,+1]	10	0.13055	74.936	0.025976	63.271	2	-	0.16954
		15	0.090617	58.741	0.018906	49.525	2	-	0.09819

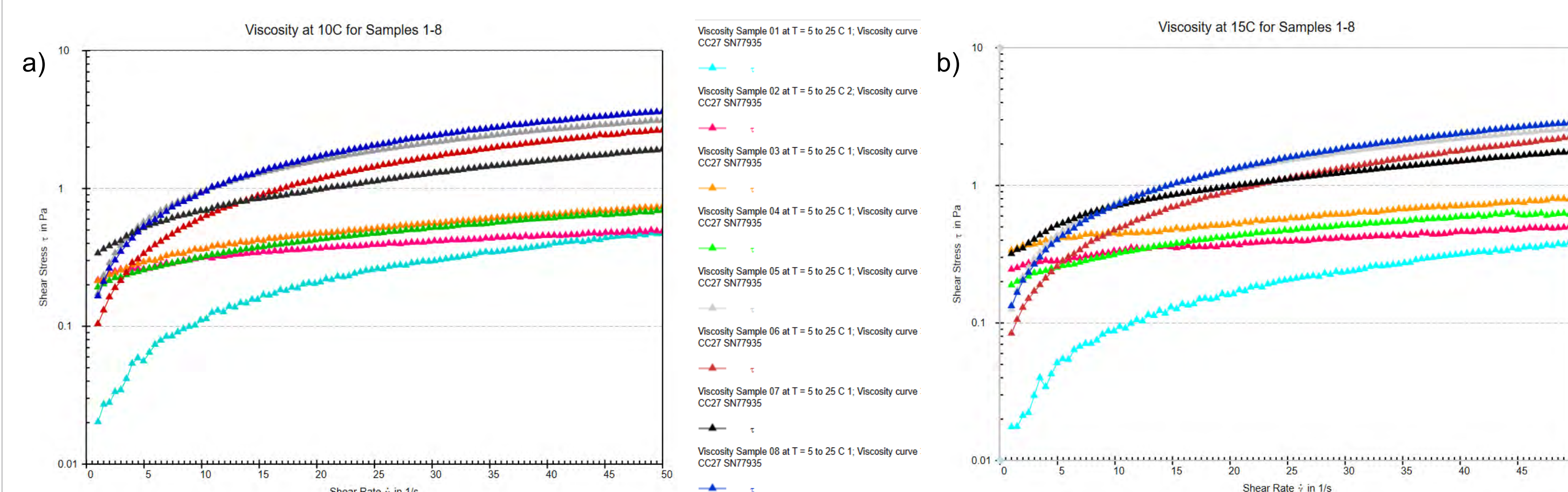


Figure 5: Viscosity of each sample was plotted at a) 10°C and b) 15°C

## Conclusion and Future Direction

The sensory characteristics of dairy products can be quantified through organoleptic and rheological measurements:

- Direct and inverse correlations between levels of ingredients
- 16 Sensory Characteristics
- 18 Rheological Properties

### Future Direction

- Extract correlations between rheological properties and sensory characteristics
- Optimize base recipe
- Generalize method

## Literature Cited

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## Acknowledgements

Financial support for this project was provided by the Dairy Innovation Hub from the state of Wisconsin. The authors would like to thank the student participants in the UWP courses ANSCI 3010 and ME 4720.

Please contact Dr. Thomas Zolper for more information regarding further research on measuring the rheological properties of ice-cream to predict its mouth-feel sensations.