ISIK UNIVERSITY

Faculty of Engineering

Department of Industrial Engineering

"Factors Affecting the Thickness of Hot Chocolate"

Progress Report

INDE4141.1

Design and Analysis of Experiments

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1) Introduction

Around the world, hot chocolate is a popular beverage, especially in the winter months. Despite its apparent ease of preparation, the final texture, thickness, and richness can vary significantly according on the ingredients and techniques of preparation. One important factor that affects how creamy and fulfilling the drink feels is thickness, also known as viscosity.

The thickness of hot chocolate can vary depending on a number of factors. These consist of the kind of milk (almond, skim, or whole), The amount of Sugar in a Spoon (0 spoon, 1.5 spoon, 3 spoon), and the kind of chocolate (cocoa powder, chocolate bars, chocolate cream). The final output may be influenced by the many ways in which these components interact. In order to identify the ideal mix for a rich, enjoyable beverage, this study intends to investigate how these factors affect the thickness and flavour of hot chocolate.

Finding out how milk type, Sugar amount, and chocolate type impact the viscosity and general quality of hot chocolate is the aim of this study. Find the best mixture to get a thick, creamy, and rich texture.

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2) Experiment Setup Design

We will use a full factorial experimental design with 3 factors, each having 3 levels, resulting in 27 unique combinations. Each combination will be replicated twice, yielding a total of 54 experimental runs ((3 * 3 * 3) * 2) = 54, will measure the outcome.

By using Drip Time Method (DTM) for Viscosity.

We make sure that the hot chocolate is well mixed. Then, we use a spoon to scoop up some of the hot chocolate. then, We Hold the spoon above the cup and let the chocolate drip back into the cup. We will calculate the time, how long it takes for the drip to break off completely. and we are going to do it three times for each sample, and then we will calculate the average time **in second**.

Factors and Levels

1) Chocolate Type (Cocoa Powder, Chocolate Bar, Chocolate Cream).
2) Sugar Amount (0 spoon, 1.5 spoon, 3 spoon).
3) Milk Type (Whole Milk, Skim Milk, Almond Milk)

Preparation of Samples

- Each sample of hot chocolate was prepared freshly for each run using the exact combination of the three factors.

- All ingredients were measured accurately using standard kitchen scales and spoons to ensure consistency.
- The mixture was heated to the same temperature (83 °) for each sample.

Measurement of the Response Variable

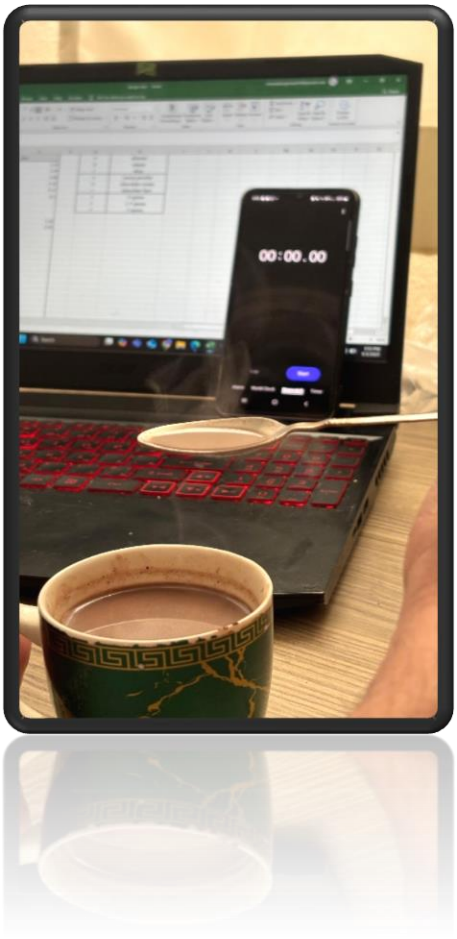
- A spoonful of the prepared hot chocolate was held above the cup.
- The time taken for the chocolate to completely drip off the spoon was measured using a stopwatch.
- This process was repeated two time for each test and every factor has 9 test ,3 for each level.

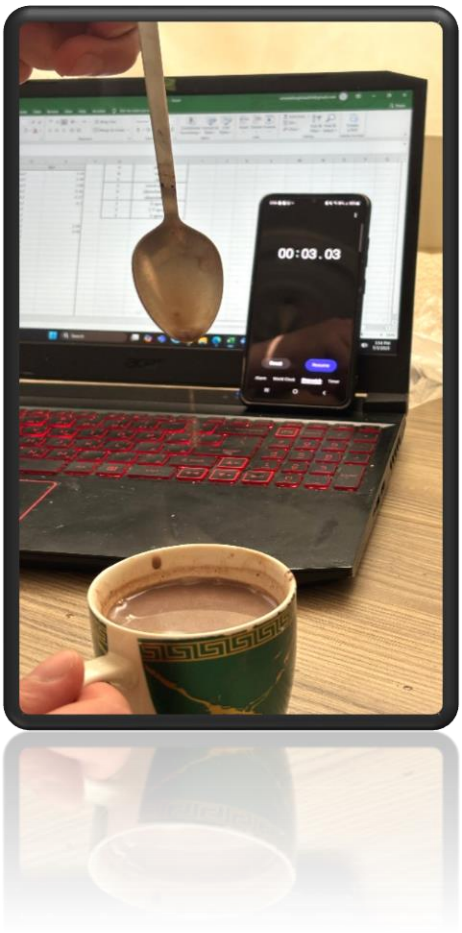
Randomization in Experimental Run and Replications

We conducted a full factorial experiment with 27 treatment combinations, each replicated once, totalling 54 runs. To ensure randomization, we assigned random numbers to all runs and randomized the order of both the first and second replications separately. This prevented consecutive repetitions and reduced environmental or timing bias. Samples were prepared consistently using standardized methods. Were assigned a random number using a random number generator in Minitab.

↓	C1	C2	C3	C4	C5-T	C6-T	C7	C8
	StdOrder	RunOrder	PtType	Blocks	Milk	Chocolate	sugar	Response
1	46	1	1	1	skim	powder	0.0	2.71
2	28	2	1	1	Almond	powder	0.0	3.76
3	29	3	1	1	Almond	powder	1.5	3.06
4	17	4	1	1	Whole	bar	1.5	6.02
5	35	5	1	1	Almond	bar	1.5	5.12
6	20	6	1	1	skim	powder	1.5	2.95
7	32	7	1	1	Almond	cream	1.5	4.87
8	47	8	1	1	skim	powder	1.5	2.89
9	10	9	1	1	Whole	powder	0.0	2.99
10	22	10	1	1	skim	cream	0.0	3.85
11	45	11	1	1	Whole	bar	3.0	6.54
12	5	12	1	1	Almond	cream	1.5	4.17
13	9	13	1	1	Almond	bar	3.0	5.63
14	50	14	1	1	skim	cream	1.5	4.11
15	31	15	1	1	Almond	cream	0.0	4.75
16	6	16	1	1	Almond	cream	3.0	5.37
17	3	17	1	1	Almond	powder	3.0	1.58
18	7	18	1	1	Almond	bar	0.0	4.65
19	41	19	1	1	Whole	cream	1.5	5.35
20	37	20	1	1	Whole	powder	0.0	1.69
21	12	21	1	1	Whole	powder	3.0	4.02
22	49	22	1	1	skim	cream	0.0	3.74
23	34	23	1	1	Almond	bar	0.0	4.52
24	2	24	1	1	Almond	powder	1.5	2.49
25	21	25	1	1	skim	powder	3.0	3.24
26	24	26	1	1	skim	cream	3.0	4.58
27	16	27	1	1	Whole	bar	0.0	5.63
28	42	28	1	1	Whole	cream	3.0	5.92
29	13	29	1	1	Whole	cream	0.0	5.06
30	38	30	1	1	Whole	powder	1.5	3.06
31	33	31	1	1	Almond	cream	3.0	6.18
32	4	32	1	1	Almond	cream	0.0	5.36

❖ **Here there are a few photos of our experiment environment while conducting the experiment.**





3) Analysis Plan

To analyse our results, we will use a statistical method **ANOVA** (Analysis of Variance) and will use (Minitab 17) to find out the ANOVA result.

By applying ANOVA, we can

- ✓ See which factors have a significant effect on viscosity.
- ✓ Find out if there are any interactions between factors.
- ✓ Compare the average results from each group in a scientific way.

➢ Data Table

The Left number of Observation it's the first time test and the Right number of Observation it is a replication

0 Spoon Sugar

Chocolate	Milk: Aalmond	Milk: Whole	Milk: Skim
powder	3.76 | 3.35	2.99 | 1.69	2.71 | 2.55
cream	4.75 | 5.36	5.06 | 5.17	3.85 | 3.74
bars	4.65 | 4.52	5.63 | 5.66	4.05 | 3.96

1.5 Spoon Sugar

Chocolate	Milk: Aalmond	Milk: Whole	Milk: Skim
powder	3.06 | 2.49	3.06 | 4.44	2.95 | 2.89
cream	4.87 | 4.17	5.35 | 5.61	4.11 | 4.02
bars	5.12 | 4.97	6.02 | 6.11	4.53 | 4.49

3 Spoon Sugar

Chocolate	Milk: Aalmond	Milk: Whole	Milk: Skim
powder	1.58 | 1.88	4.02 | 4.54	3.24 | 3.32
cream	5.37 | 6.18	5.92 | 6.15	4.58 | 4.81
bars	5.63 | 5.89	6.54 | 6.73	5.01 | 5.14

In this experiment Table, we examined the effects of three independent factors on the thickness of hot chocolate: chocolate type**,** milk type, and sugar amount. Since each factor consists of three levels, the total number of treatment combinations is 3^3=27. To clearly present our findings, we structured the data into a single comprehensive table, logically divided into three sections based on sugar amount (0 spoon, 1.5 spoons, and 3 spoons). Within each section, the rows represent the different types of chocolate, and the columns represent the various milk types. This format allows for an organized and detailed comparison of how each combination affects viscosity. Each cell in the table contains two values: the left value represents the initial experimental run, and the right value corresponds to the replication of that specific treatment. This layout ensures clarity in data presentation and helps to distinguish between the original measurement and its repeated observation, which is critical for conducting accurate statistical analysis and verifying the consistency of results

4) ANOVA Analysis

Multilevel Factorial Design

```
Factors:       3     Replicates:     2
Base runs:    27     Total runs:    54
Base blocks:   1     Total blocks:   1

Number of levels: 3, 3, 3
```

General Factorial Regression: Response versus Milk, Chocolate, sugar

Factor Information

Factor	Levels	Values
Milk	3	Almond, Whole, skim
Chocolate	3	powder, cream, bar
sugar	3	0.0, 1.5, 3.0

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	26	82.458	3.1715	26.82	0.000
Linear	6	69.591	11.5984	98.08	0.000
Milk	2	12.223	6.1113	51.68	0.000
Chocolate	2	52.505	26.2524	221.99	0.000
sugar	2	4.863	2.4316	20.56	0.000
2-Way Interactions	12	7.607	0.6339	5.36	0.000
Milk*Chocolate	4	3.097	0.7743	6.55	0.001
Milk*sugar	4	2.778	0.6946	5.87	0.002
Chocolate*sugar	4	1.732	0.4329	3.66	0.017
3-Way Interactions	8	5.261	0.6576	5.56	0.000
Milk*Chocolate*sugar	8	5.261	0.6576	5.56	0.000
Error	27	3.193	0.1183		
Total	53	85.651			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.343888	96.27%	92.68%	85.09%

ANOVA results show that the p-values for all main factors (Milk, Chocolate, and Sugar) are less than 0.05 p-value, which means they are statistically significant. This indicates that each of these factors individually affects the viscosity (thickness) of hot chocolate. For example, different types of chocolate had the strongest effect, as seen by the highest **F-value (221.99**).

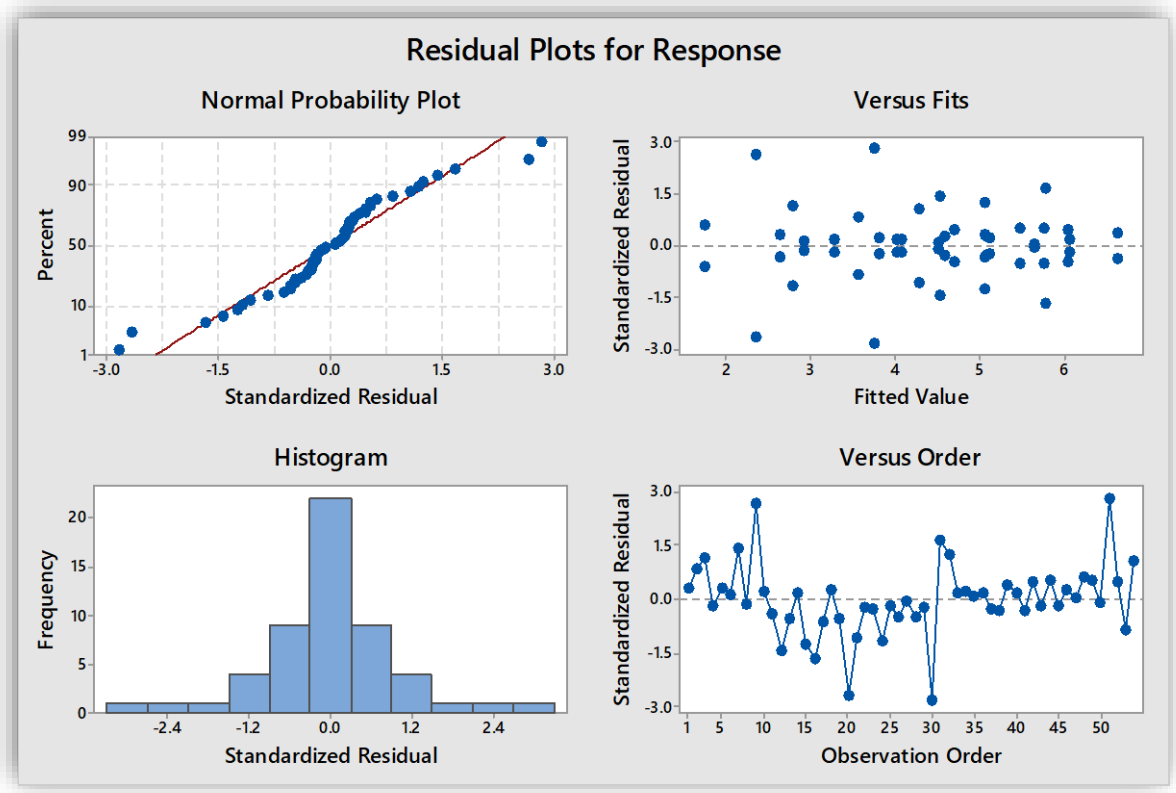
- **The two-way interactions**

  All combinations (Milk*Chocolate**,** Milk*Sugar, and Chocolate*Sugar) also have p-values below 0.05. This means the effect of one factor depends on the level of another. For instance, the influence of chocolate type on thickness can change depending on the milk type used

➢ The three-way interaction

among Milk, Chocolate, and Sugar is significant (p = 0.000), which suggests that all three variables together have a complex, combined effect on thickness. This highlights that the best or worst thickness outcomes result from specific combinations of all three factors, not just individual ones.

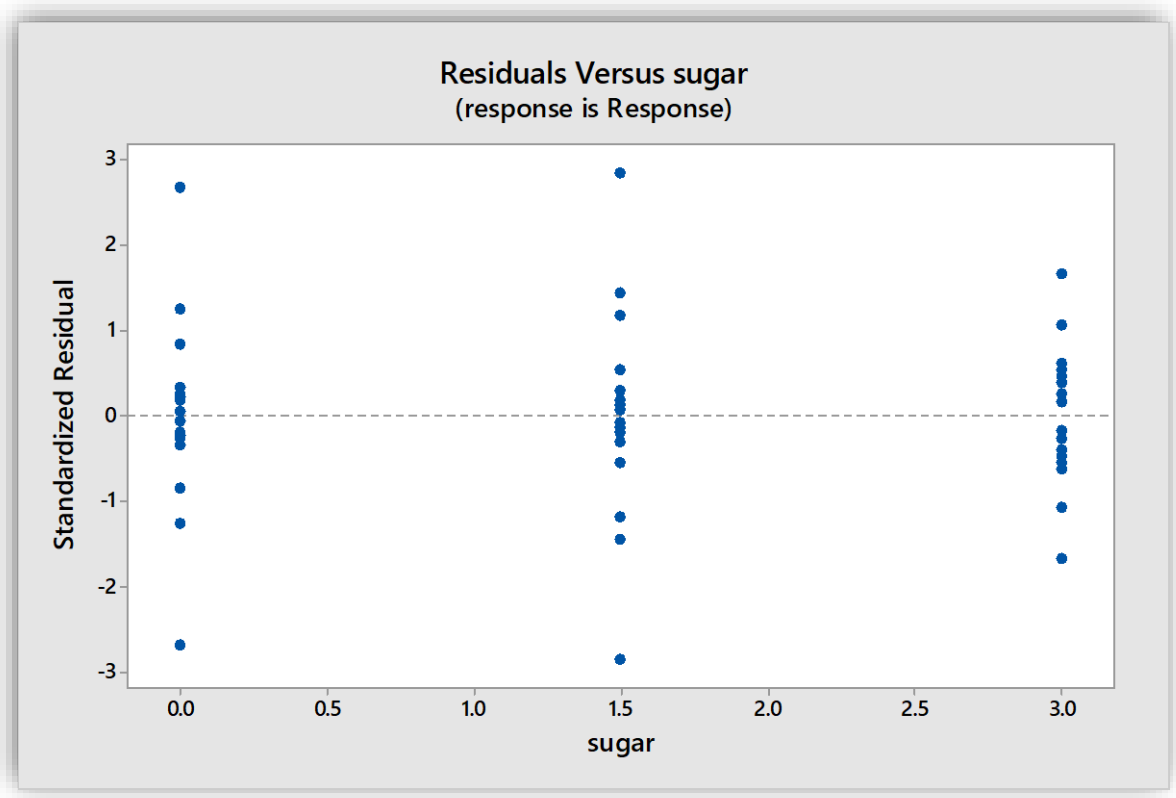
❖ Model adequacy



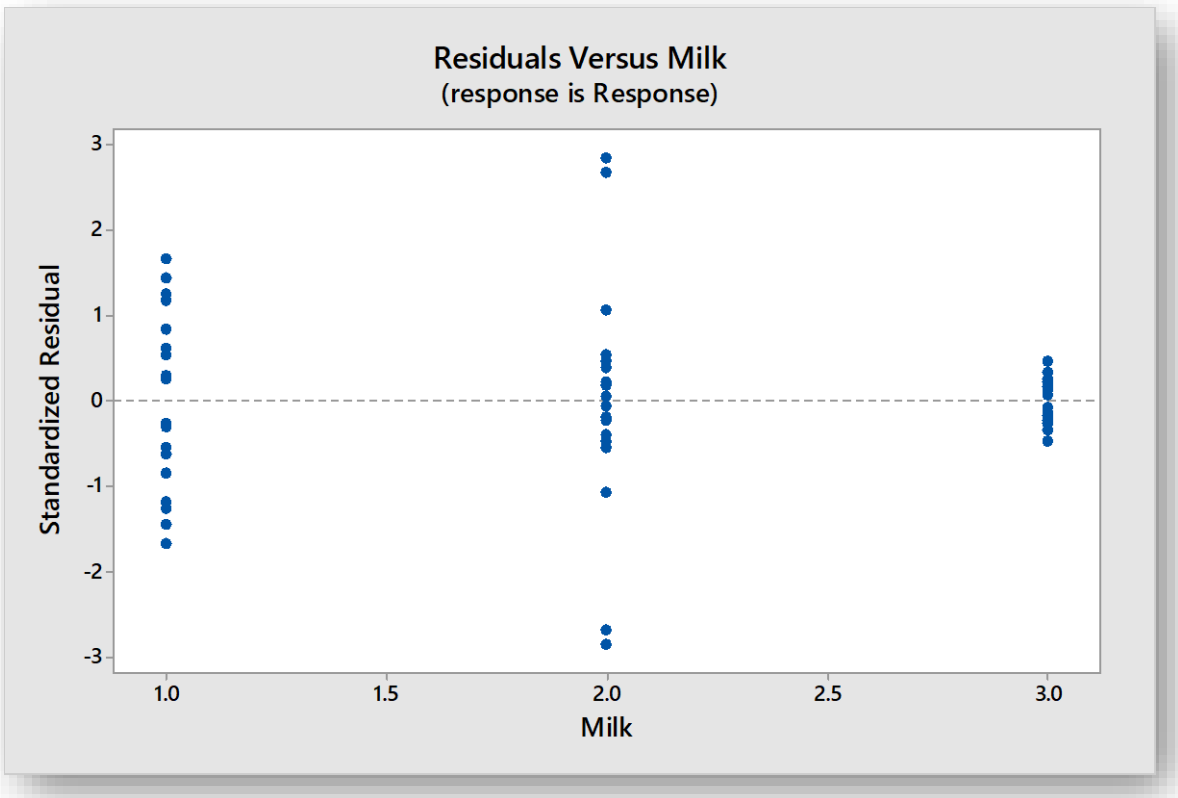
- **Normal Probability Plot**: The Residuals is normal distribution the Result Passed
- **Versus Fits**: No clear pattern or changing spread so that's why the result Passed
- **Histogram**: shows a bell-shaped distribution (Normal distribution).
- **Versus Order**: Residuals are independent; no time trend

Based on the results of the model adequacy checks, we can confidently conclude that our ANOVA model is both statistically significant and reliable. The residuals passed the

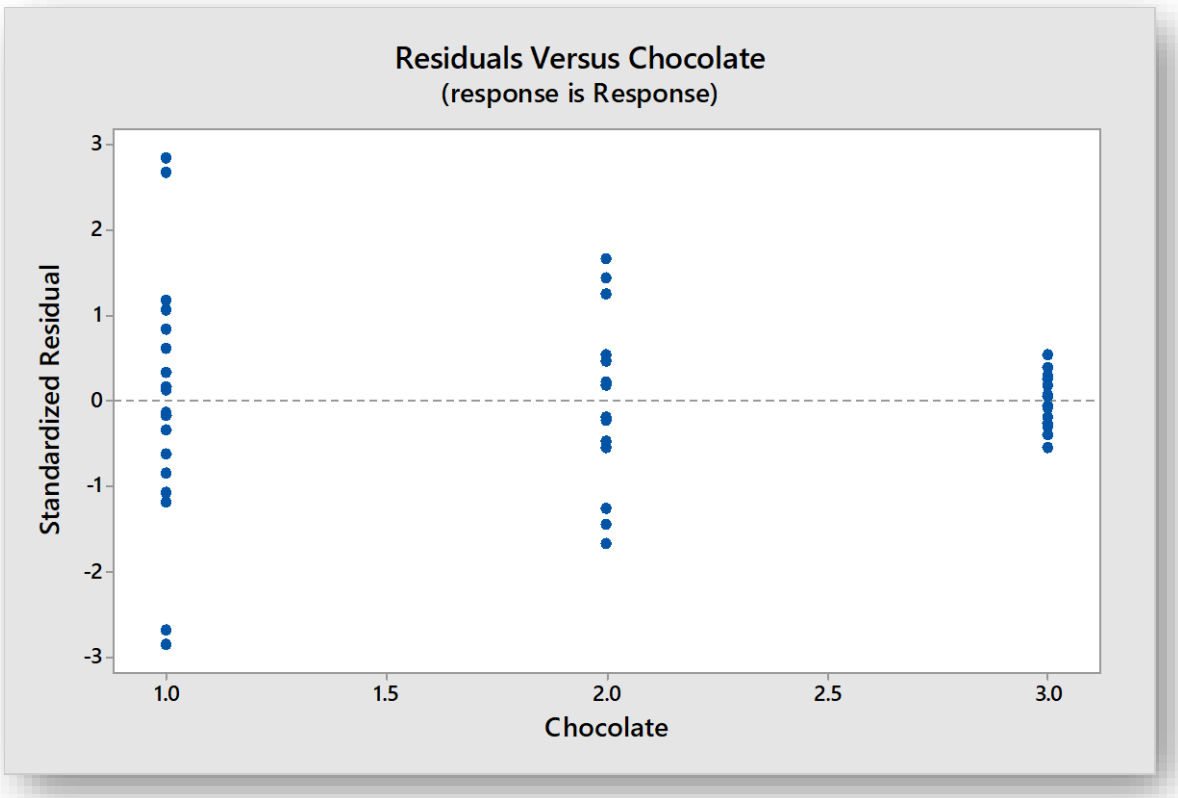
normality checks through both the normal probability plot and histogram, indicating that the assumption of normally distributed errors holds. The plot of residuals versus fitted values showed constant variance, suggesting homoscedasticity. Furthermore, the residuals versus order plot confirmed that the observations were independent and not affected by time-related trends. Since all key assumptions of ANOVA have been met, we can trust the validity of our results and proceed with further analysis in the final report.



There is a 3 level of the sugar amount which shows in the plot 0 spoon and 1.5 spoon and 3 spoon This suggests that the relationship between sugar and the response is properly captured by our model, no big problems like missing terms or nonlinearity related to sugar. The residuals are randomly scattered across sugar levels, meaning the model treats sugar correctly without serious issues.



There are 3 levels of the milk factor shown in the plot (Whole, Skim, Almond). The residuals are randomly scattered across these milk types without any clear pattern or trend. This indicates that the relationship between milk and the response variable is well modelled. There are no signs of missing terms, nonlinearity, or unequal variance, meaning the model handles the milk factor appropriately and without serious issues.



There are 3 levels of the chocolate factor shown in the plot (e.g., Cocoa Powder, Chocolate Bar, Chocolate Cream). The residuals are randomly scattered across these chocolate types, with no visible pattern or trend. This suggests that the model has successfully captured the effect of chocolate type on the response. There are no serious issues such as nonlinearity or missing terms, meaning the model handles chocolate appropriately and reliably.

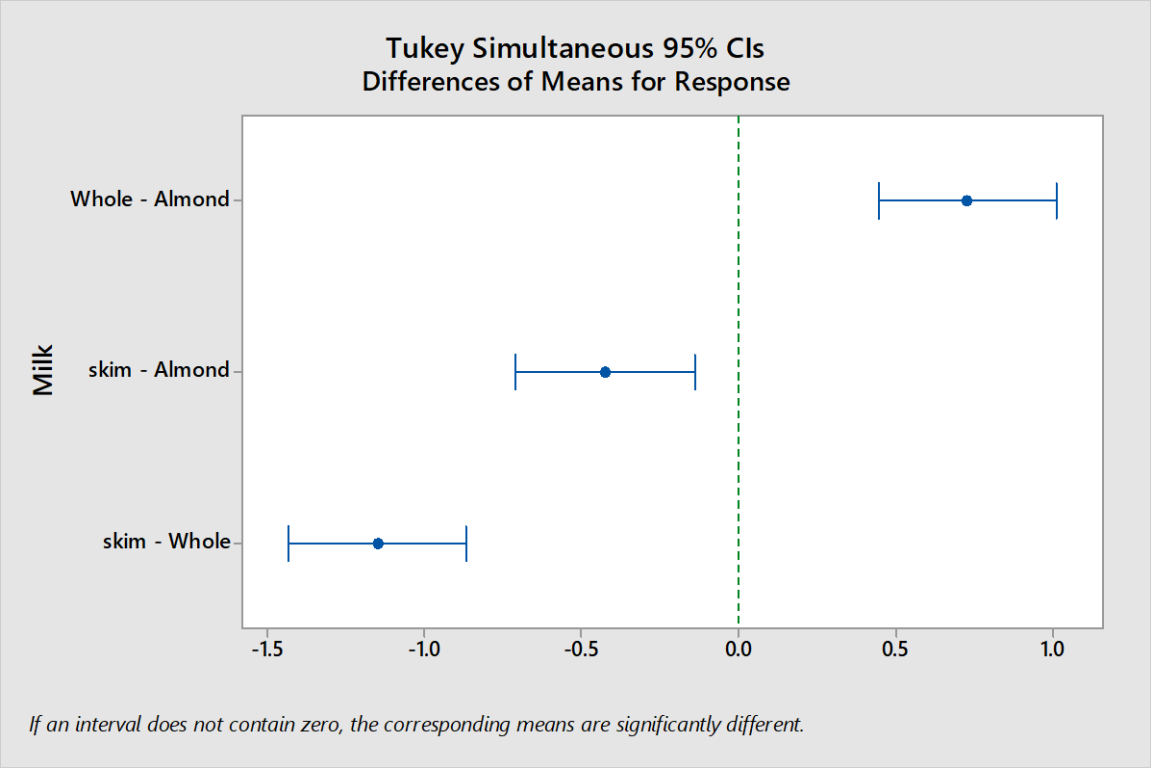
5) contributions

The successful execution of this project was the result of effective teamwork and clear role distribution among the team members.

- Feras Mohammad took responsibility for organizing the experimental data and meticulously entering and formatting the results in Microsoft Excel after conducting the experiment.
- Abdulrahman Sallam was in charge of accurately timing the dripping process using a stopwatch, ensuring precise measurements of viscosity during each trial. He communicated the recorded times to Feras Mohammad for proper documentation. Meanwhile,
- Emadeden Albaghdadi played a critical role in physically conducting the Drip Time Method. He prepared each hot chocolate sample by carefully mixing the specified ingredients (milk, sugar, and chocolate) and holding the spoon to measure the drip in coordination with Abdulrahman's timing.

This synchronized effort ensured consistent experimental procedures and reliable data collection. Beyond the practical phase, all three members collaborated closely on data analysis, using Minitab to perform the ANOVA and interpret the results. The team also worked collectively on preparing the final report and developing the presentation. Face-to-face discussions played a significant role in aligning interpretations and verifying statistical conclusions, particularly when reviewing interactions and main effects in the factorial design. This collaborative approach allowed for a comprehensive understanding of the experiment and ensured the accuracy and integrity of the project. The strong communication, division of tasks, and mutual support among the team members significantly contributed to the high quality and success of the final project report.

6) Tukey Test



Tukey Pairwise Comparisons: Response = Response, Term = Milk

Grouping Information Using the Tukey Method and 95% Confidence

Milk	N	Mean	Grouping
Whole	18	5.03833	A
Almond	18	4.31111	B
skim	18	3.88611	C

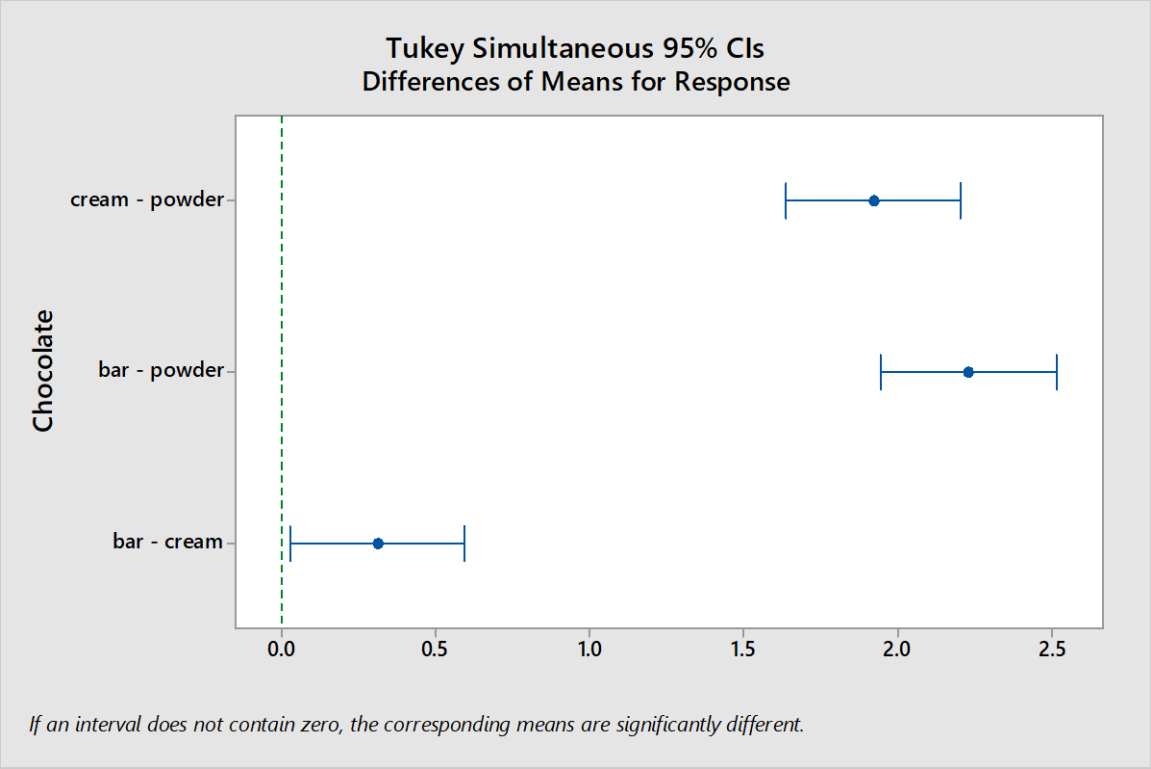
Means that do not share a letter are significantly different.

Tukey Simultaneous Tests for Differences of Means

Difference of Milk Levels	Difference of Means	SE of Difference	Simultaneous 95% CI	T-Value	Adjusted P-Value
Whole - Almond	0.727	0.115	(0.443, 1.012)	6.34	0.000
skim - Almond	-0.425	0.115	(-0.710, -0.140)	-3.71	0.003
skim - Whole	-1.152	0.115	(-1.437, -0.868)	-10.05	0.000

Individual confidence level = 98.04%

Tukey's test and confidence interval plot reveal significant differences among Whole, Almond, and Skim milk. Whole milk has the highest mean, significantly higher than both Almond and Skim. All confidence intervals exclude zero, confirming statistical significance. Each milk type belongs to a distinct group with different response levels.



Tukey Pairwise Comparisons: Response = Response, Term = Chocolate

Grouping Information Using the Tukey Method and 95% Confidence

Chocolate	N	Mean	Grouping
bar	18	5.25833	A
cream	18	4.94833	B
powder	18	3.02889	C

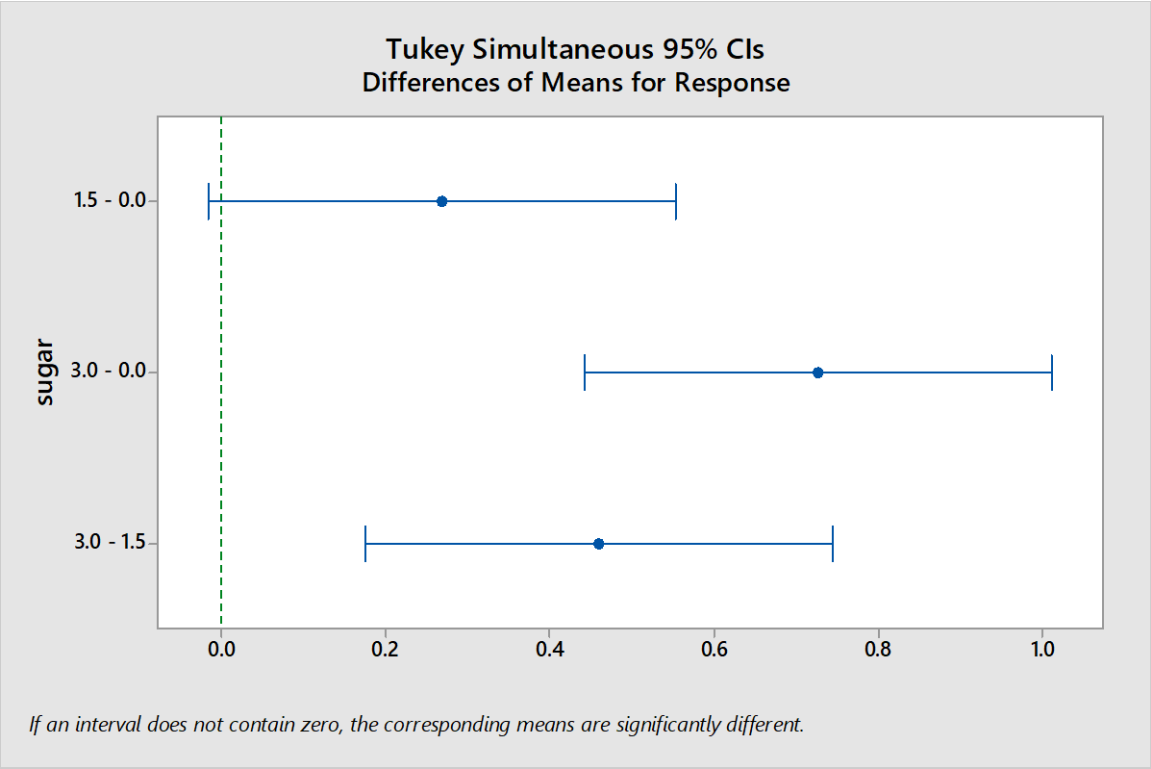
Means that do not share a letter are significantly different.

Tukey Simultaneous Tests for Differences of Means

Difference of Chocolate Levels	Difference of Means	SE of Difference	Simultaneous 95% CI	T-Value	Adjusted P-Value
cream - powder	1.919	0.115	(1.635, 2.204)	16.74	0.000
bar - powder	2.229	0.115	(1.945, 2.514)	19.45	0.000
bar - cream	0.310	0.115	(0.025, 0.595)	2.70	0.030

Individual confidence level = 98.04%

Tukey's test shows all chocolate types differ significantly. Bar chocolate has the highest mean, followed by cream and powder. Confidence intervals confirm significant differences among all pairs. Each type belongs to a distinct group, indicating statistically meaningful variation in responses between bar, cream, and powder chocolates.



Tukey Pairwise Comparisons: Response = Response, Term = sugar

Grouping Information Using the Tukey Method and 95% Confidence

sugar	N	Mean	Grouping
3.0	18	4.80722	A
1.5	18	4.34778	B
0.0	18	4.08056	B

Means that do not share a letter are significantly different.

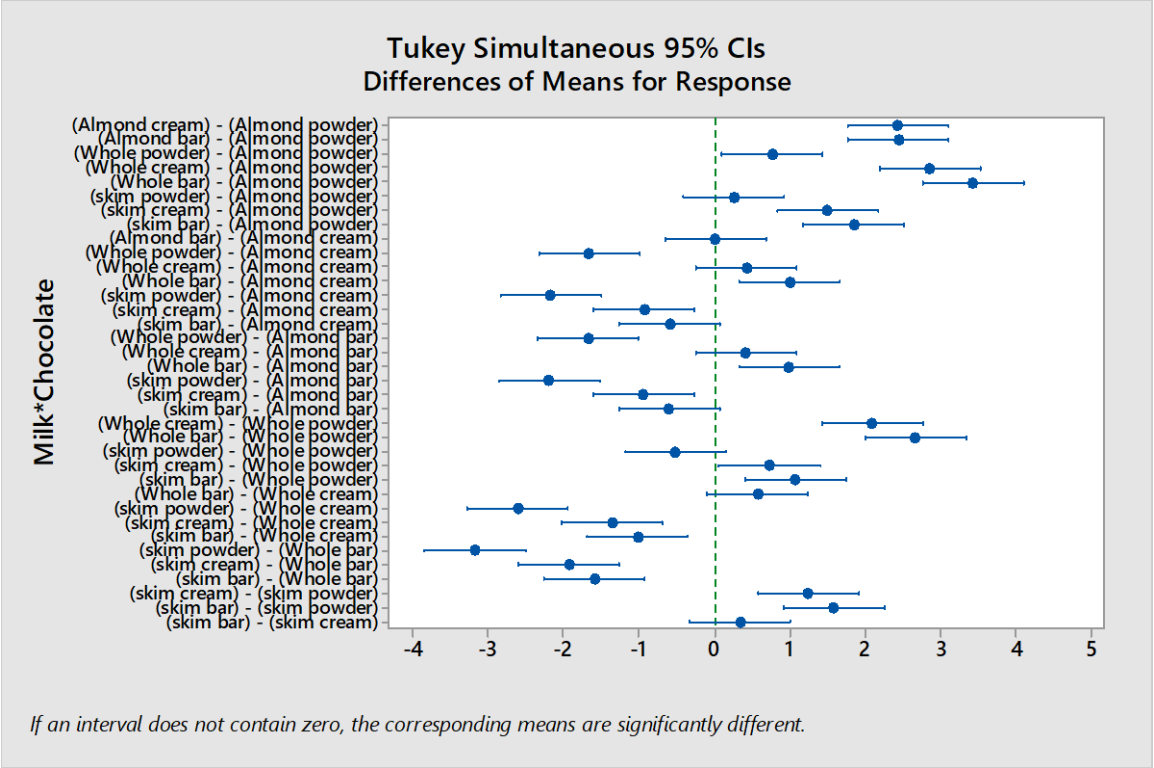
Tukey Simultaneous Tests for Differences of Means

Difference of sugar Levels	Difference of Means	SE of Difference	Simultaneous 95% CI	T-Value	Adjusted P-Value
1.5 - 0.0	0.267	0.115	(-0.017, 0.552)	2.33	0.068
3.0 - 0.0	0.727	0.115	(0.442, 1.011)	6.34	0.000
3.0 - 1.5	0.459	0.115	(0.175, 0.744)	4.01	0.001

Individual confidence level = 98.04%

The Tukey confidence interval plot for sugar levels shows that all pairwise differences between groups (1.5-0.0, 3.0-0.0, and 3.0-1.5) are **statistically** significant, as none of the

intervals include zero. This indicates that sugar levels significantly differ across all compared groups, with increasing values from 0.0 to 3.0.



Tukey Pairwise Comparisons: Response = Response, Term = Milk*Chocolate

Grouping Information Using the Tukey Method and 95% Confidence

Milk*Chocolate	N	Mean	Grouping				
Whole bar	6	6.11500	A				
Whole cream	6	5.54333	A	B			
Almond bar	6	5.13000		B	C		
Almond cream	6	5.11667		B	C		
skim bar	6	4.53000			C	D	
skim cream	6	4.18500				D	
Whole powder	6	3.45667					E
skim powder	6	2.94333					E F
Almond powder	6	2.68667					F

Means that do not share a letter are significantly different.

Whole bar has the highest mean response, significantly different from most combinations. Almond powder and skim powder show the lowest means. Grouping letters confirm distinct statistical differences across combinations. Confidence intervals further validate significant differences between nearly all pairs, especially between whole bar and lower-ranked milk-chocolate types.

Difference of Milk*Chocolate Levels	Adjusted P-Value
(Almond cream) - (Almond powder)	0.000
(Almond bar) - (Almond powder)	0.000
(Whole powder) - (Almond powder)	0.015
(Whole cream) - (Almond powder)	0.000
(Whole bar) - (Almond powder)	0.000
(skim powder) - (Almond powder)	0.925
(skim cream) - (Almond powder)	0.000
(skim bar) - (Almond powder)	0.000
(Almond bar) - (Almond cream)	1.000
(Whole powder) - (Almond cream)	0.000
(Whole cream) - (Almond cream)	0.464
(Whole bar) - (Almond cream)	0.001
(skim powder) - (Almond cream)	0.000
(skim cream) - (Almond cream)	0.002
(skim bar) - (Almond cream)	0.119
(Whole powder) - (Almond bar)	0.000
(Whole cream) - (Almond bar)	0.505
(Whole bar) - (Almond bar)	0.001
(skim powder) - (Almond bar)	0.000
(skim cream) - (Almond bar)	0.002
(skim bar) - (Almond bar)	0.104
(Whole cream) - (Whole powder)	0.000
(Whole bar) - (Whole powder)	0.000
(skim powder) - (Whole powder)	0.238
(skim cream) - (Whole powder)	0.025
(skim bar) - (Whole powder)	0.000
(Whole bar) - (Whole cream)	0.139
(skim powder) - (Whole cream)	0.000
(skim cream) - (Whole cream)	0.000
(skim bar) - (Whole cream)	0.001
(skim powder) - (Whole bar)	0.000
(skim cream) - (Whole bar)	0.000
(skim bar) - (Whole bar)	0.000
(skim cream) - (skim powder)	0.000
(skim bar) - (skim powder)	0.000
(skim bar) - (skim cream)	0.719

Individual confidence level = 99.77%

(skim powder) – (Almond powder) → 0.925

(Whole cream) – (Almond cream) → 0.464

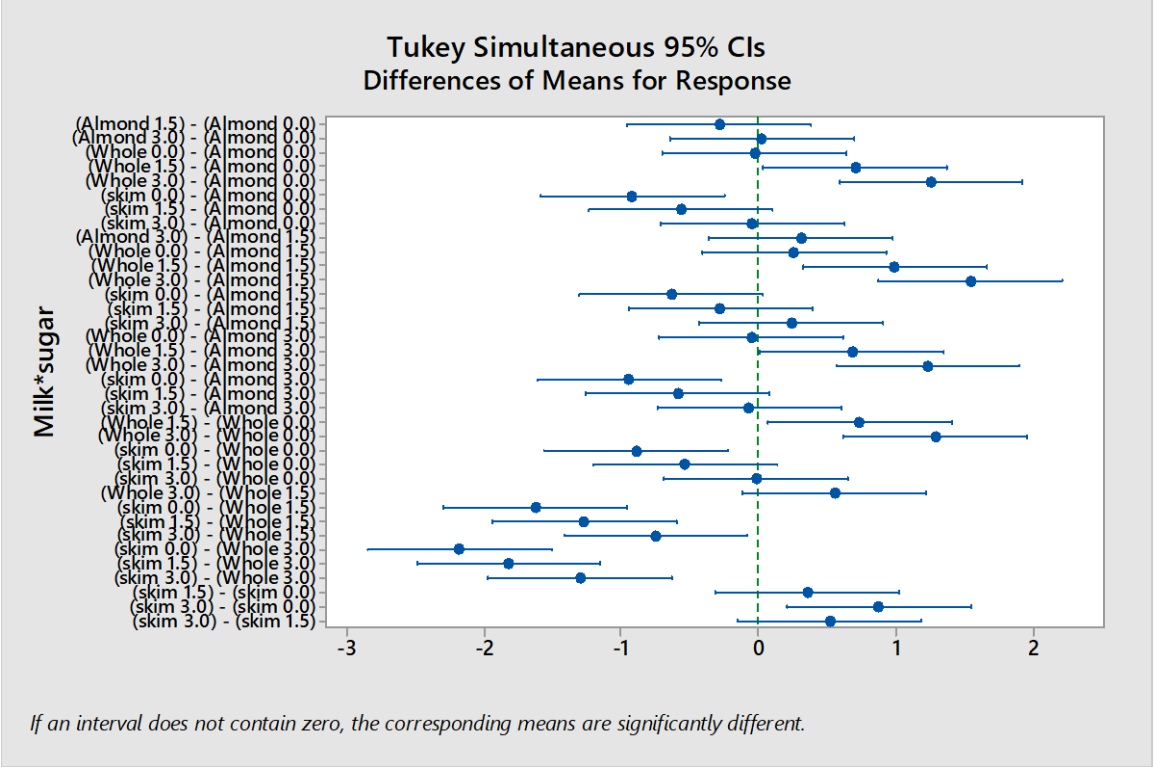
(skim bar) – (Almond cream) → 0.119

(skim cream) – (Almond bar) → 0.505

(Whole bar) – (Whole cream) → 0.139

(skim bar) – (skim cream) → 0.719

These comparisons are not statistically significant, meaning the differences in means between these pairs are likely due to chance.



Tukey Pairwise Comparisons: Response = Response, Term = Milk*sugar

Grouping Information Using the Tukey Method and 95% Confidence

Milk*sugar	N	Mean	Grouping		
Whole 3.0	6	5.65000	A		
Whole 1.5	6	5.09833	A		
Almond 3.0	6	4.42167		B	
Almond 0.0	6	4.39833		B	
Whole 0.0	6	4.36667		B	
skim 3.0	6	4.35000		B	
Almond 1.5	6	4.11333		B	C
skim 1.5	6	3.83167		B	C
skim 0.0	6	3.47667			C

Means that do not share a letter are significantly different.

Whole milk with higher sugar (3.0, 1.5) shows the highest mean responses and forms group A. Skim milk combinations have the lowest means. Most other combinations fall in intermediate groups. Significant differences exist, especially between whole and skim milk types, as confirmed by non-overlapping confidence intervals.

Difference of Milk*sugar Levels	Difference of Means	SE of Difference	Simultaneous 95% CI		T-Value	Adjusted P-Value
(Almond 1.5) - (Almond 0.0)	-0.285	0.199	(-0.953,	0.383)	-1.44	0.874
(Almond 3.0) - (Almond 0.0)	0.023	0.199	(-0.645,	0.692)	0.12	1.000
(Whole 0.0) - (Almond 0.0)	-0.032	0.199	(-0.700,	0.637)	-0.16	1.000
(Whole 1.5) - (Almond 0.0)	0.700	0.199	(0.032,	1.368)	3.53	0.035
(Whole 3.0) - (Almond 0.0)	1.252	0.199	(0.583,	1.920)	6.30	0.000
(skim 0.0) - (Almond 0.0)	-0.922	0.199	(-1.590,	-0.253)	-4.64	0.002
(skim 1.5) - (Almond 0.0)	-0.567	0.199	(-1.235,	0.102)	-2.85	0.146
(skim 3.0) - (Almond 0.0)	-0.048	0.199	(-0.717,	0.620)	-0.24	1.000
(Almond 3.0) - (Almond 1.5)	0.308	0.199	(-0.360,	0.977)	1.55	0.821
(Whole 0.0) - (Almond 1.5)	0.253	0.199	(-0.415,	0.922)	1.28	0.930
(Whole 1.5) - (Almond 1.5)	0.985	0.199	(0.317,	1.653)	4.96	0.001
(Whole 3.0) - (Almond 1.5)	1.537	0.199	(0.868,	2.205)	7.74	0.000
(skim 0.0) - (Almond 1.5)	-0.637	0.199	(-1.305,	0.032)	-3.21	0.071
(skim 1.5) - (Almond 1.5)	-0.282	0.199	(-0.950,	0.387)	-1.42	0.881
(skim 3.0) - (Almond 1.5)	0.237	0.199	(-0.432,	0.905)	1.19	0.951
(Whole 0.0) - (Almond 3.0)	-0.055	0.199	(-0.723,	0.613)	-0.28	1.000
(Whole 1.5) - (Almond 3.0)	0.677	0.199	(0.008,	1.345)	3.41	0.045
(Whole 3.0) - (Almond 3.0)	1.228	0.199	(0.560,	1.897)	6.19	0.000
(skim 0.0) - (Almond 3.0)	-0.945	0.199	(-1.613,	-0.277)	-4.76	0.002
(skim 1.5) - (Almond 3.0)	-0.590	0.199	(-1.258,	0.078)	-2.97	0.116
(skim 3.0) - (Almond 3.0)	-0.072	0.199	(-0.740,	0.597)	-0.36	1.000
(Whole 1.5) - (Whole 0.0)	0.732	0.199	(0.063,	1.400)	3.69	0.024
(Whole 3.0) - (Whole 0.0)	1.283	0.199	(0.615,	1.952)	6.46	0.000
(skim 0.0) - (Whole 0.0)	-0.890	0.199	(-1.558,	-0.222)	-4.48	0.003
(skim 1.5) - (Whole 0.0)	-0.535	0.199	(-1.203,	0.133)	-2.69	0.197
(skim 3.0) - (Whole 0.0)	-0.017	0.199	(-0.685,	0.652)	-0.08	1.000
(Whole 3.0) - (Whole 1.5)	0.552	0.199	(-0.117,	1.220)	2.78	0.168
(skim 0.0) - (Whole 1.5)	-1.622	0.199	(-2.290,	-0.953)	-8.17	0.000
(skim 1.5) - (Whole 1.5)	-1.267	0.199	(-1.935,	-0.598)	-6.38	0.000
(skim 3.0) - (Whole 1.5)	-0.748	0.199	(-1.417,	-0.080)	-3.77	0.020
(skim 0.0) - (Whole 3.0)	-2.173	0.199	(-2.842,	-1.505)	-10.95	0.000
(skim 1.5) - (Whole 3.0)	-1.818	0.199	(-2.487,	-1.150)	-9.16	0.000
(skim 3.0) - (Whole 3.0)	-1.300	0.199	(-1.968,	-0.632)	-6.55	0.000
(skim 1.5) - (skim 0.0)	0.355	0.199	(-0.313,	1.023)	1.79	0.689
(skim 3.0) - (skim 0.0)	0.873	0.199	(0.205,	1.542)	4.40	0.004
(skim 3.0) - (skim 1.5)	0.518	0.199	(-0.150,	1.187)	2.61	0.228

Individual confidence level = 99.77%

(Almond 1.5) – (Almond 0.0) → p = 0.874 (Almond 3.0) – (Almond 0.0) → p = 1.000

(Whole 0.0) – (Almond 0.0) → p = 1.000 (skim 1.5) – (Almond 0.0) → p = 0.146

(Almond 3.0) – (Almond 1.5) → p = 0.82 (skim 0.0) – (Almond 1.5) → p = 0.071

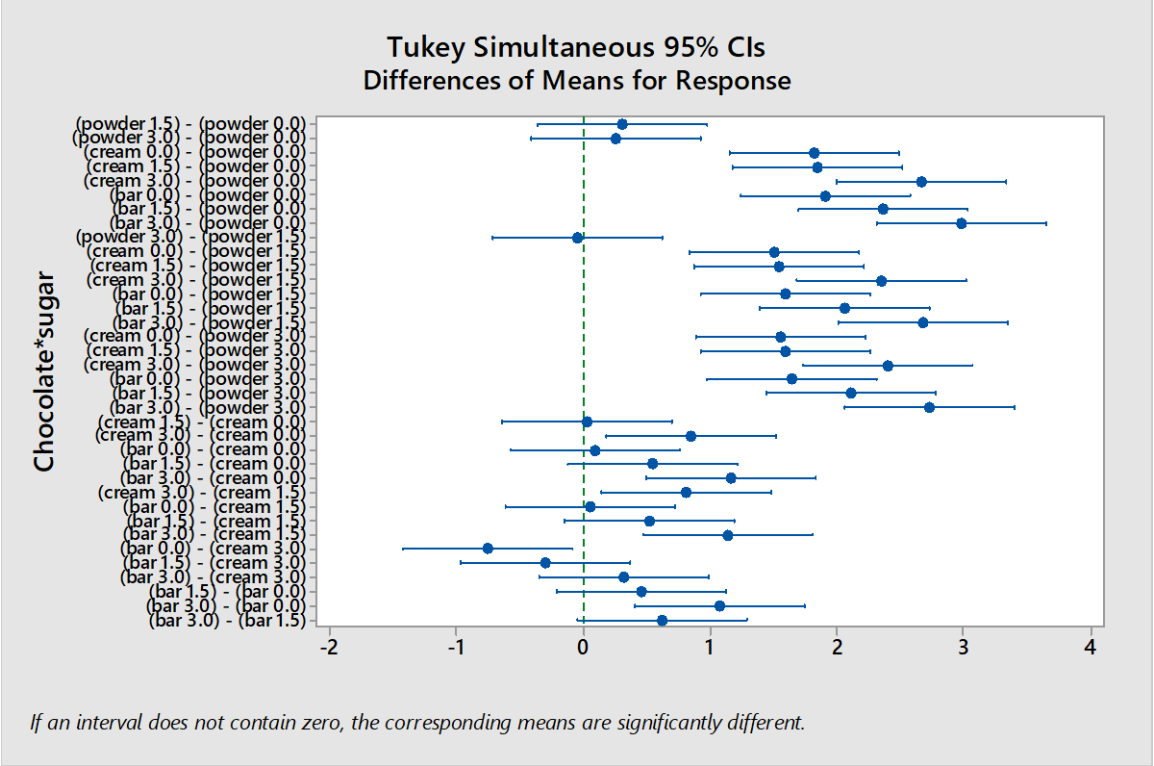
(skim 1.5) – (Almond 1.5) → p = 0.881 (skim 3.0) – (Almond 1.5) → p = 0.197

(Whole 0.0) – (Almond 3.0) → p = 1.000 (skim 3.0) – (Almond 3.0) → p = 1.000

(skim 1.5) – (Whole 0.0) → p = 0.197 (skim 1.5) – (skim 0.0) → p = 0.689

(skim 3.0) – (skim 1.5) → p = 0.228

These rows show comparisons where the mean differences are not statistically significant at the 99.77% individual confidence level.



Tukey Pairwise Comparisons: Response = Response, Term = Chocolate*sugar

Grouping Information Using the Tukey Method and 95% Confidence

Chocolate*sugar	N	Mean	Grouping		
bar 3.0	6	5.82333	A		
cream 3.0	6	5.50167	A		
bar 1.5	6	5.20667	A	B	
bar 0.0	6	4.74500		B	
cream 1.5	6	4.68833		B	
cream 0.0	6	4.65500		B	
powder 1.5	6	3.14833			C
powder 3.0	6	3.09667			C
powder 0.0	6	2.84167			C

Means that do not share a letter are significantly different.

Bar chocolate with sugar level 3.0 shows the highest mean and forms its own group. Powder chocolate, regardless of sugar level, consistently yields the lowest responses. The confidence intervals confirm significant differences among most combinations, particularly between bar/powder chocolates, while cream chocolate ranks in between.

Difference of Chocolate*sugar Levels	Difference of Means	SE of Difference	Simultaneous 95% CI	T-Value	Adjusted P-Value
(powder 1.5) - (powder 0.0)	0.307	0.199	(-0.362, 0.975)	1.54	0.825
(powder 3.0) - (powder 0.0)	0.255	0.199	(-0.413, 0.923)	1.28	0.927
(cream 0.0) - (powder 0.0)	1.813	0.199	(1.145, 2.482)	9.13	0.000
(cream 1.5) - (powder 0.0)	1.847	0.199	(1.178, 2.515)	9.30	0.000
(cream 3.0) - (powder 0.0)	2.660	0.199	(1.992, 3.328)	13.40	0.000
(bar 0.0) - (powder 0.0)	1.903	0.199	(1.235, 2.572)	9.59	0.000
(bar 1.5) - (powder 0.0)	2.365	0.199	(1.697, 3.033)	11.91	0.000
(bar 3.0) - (powder 0.0)	2.982	0.199	(2.313, 3.650)	15.02	0.000
(powder 3.0) - (powder 1.5)	-0.052	0.199	(-0.720, 0.617)	-0.26	1.000
(cream 0.0) - (powder 1.5)	1.507	0.199	(0.838, 2.175)	7.59	0.000
(cream 1.5) - (powder 1.5)	1.540	0.199	(0.872, 2.208)	7.76	0.000
(cream 3.0) - (powder 1.5)	2.353	0.199	(1.685, 3.022)	11.85	0.000
(bar 0.0) - (powder 1.5)	1.597	0.199	(0.928, 2.265)	8.04	0.000
(bar 1.5) - (powder 1.5)	2.058	0.199	(1.390, 2.727)	10.37	0.000
(bar 3.0) - (powder 1.5)	2.675	0.199	(2.007, 3.343)	13.47	0.000
(cream 0.0) - (powder 3.0)	1.558	0.199	(0.890, 2.227)	7.85	0.000
(cream 1.5) - (powder 3.0)	1.592	0.199	(0.923, 2.260)	8.02	0.000
(cream 3.0) - (powder 3.0)	2.405	0.199	(1.737, 3.073)	12.11	0.000
(bar 0.0) - (powder 3.0)	1.648	0.199	(0.980, 2.317)	8.30	0.000
(bar 1.5) - (powder 3.0)	2.110	0.199	(1.442, 2.778)	10.63	0.000
(bar 3.0) - (powder 3.0)	2.727	0.199	(2.058, 3.395)	13.73	0.000
(cream 1.5) - (cream 0.0)	0.033	0.199	(-0.635, 0.702)	0.17	1.000
(cream 3.0) - (cream 0.0)	0.847	0.199	(0.178, 1.515)	4.26	0.006
(bar 0.0) - (cream 0.0)	0.090	0.199	(-0.578, 0.758)	0.45	1.000
(bar 1.5) - (cream 0.0)	0.552	0.199	(-0.117, 1.220)	2.78	0.168
(bar 3.0) - (cream 0.0)	1.168	0.199	(0.500, 1.837)	5.88	0.000
(cream 3.0) - (cream 1.5)	0.813	0.199	(0.145, 1.482)	4.10	0.009
(bar 0.0) - (cream 1.5)	0.057	0.199	(-0.612, 0.725)	0.29	1.000
(bar 1.5) - (cream 1.5)	0.518	0.199	(-0.150, 1.187)	2.61	0.228
(bar 3.0) - (cream 1.5)	1.135	0.199	(0.467, 1.803)	5.72	0.000
(bar 0.0) - (cream 3.0)	-0.757	0.199	(-1.425, -0.088)	-3.81	0.018
(bar 1.5) - (cream 3.0)	-0.295	0.199	(-0.963, 0.373)	-1.49	0.852
(bar 3.0) - (cream 3.0)	0.322	0.199	(-0.347, 0.990)	1.62	0.786
(bar 1.5) - (bar 0.0)	0.462	0.199	(-0.207, 1.130)	2.33	0.363
(bar 3.0) - (bar 0.0)	1.078	0.199	(0.410, 1.747)	5.43	0.000
(bar 3.0) - (bar 1.5)	0.617	0.199	(-0.052, 1.285)	3.11	0.088

Individual confidence level = 99.77%

(powder 1.5) – (powder 0.0) → 0.825 (powder 3.0) – (powder 0.0) → 0.927

(powder 3.0) – (powder 1.5) → 1.000 (cream 1.5) – (cream 0.0) → 1.000

(bar 0.0) – (cream 0.0) → 1.000 (bar 1.5) – (cream 0.0) → 0.168

(bar 1.5) – (cream 3.0) → 0.852 (bar 0.0) – (cream 3.0) → 0.786

(bar 1.5) – (bar 0.0) → 0.363 (bar 3.0) – (bar 1.5) → 0.088

These rows represent non-significant differences, meaning the observed differences are not statistically meaningful at the 99.77% individual confidence level.

Milk*Chocolate*Sugar

Tukey Pairwise Comparisons: Response = Response, Term = Milk*Chocolate*sugar

Grouping Information Using the Tukey Method and 95% Confidence

Milk*Chocolate*sugar	N	Mean	Grouping										
Whole bar 3.0	2	6.635	A										
Whole bar 1.5	2	6.065	A	B									
Whole cream 3.0	2	6.035	A	B									
Almond cream 3.0	2	5.775	A	B	C								
Almond bar 3.0	2	5.760	A	B	C								
Whole bar 0.0	2	5.645	A	B	C	D							
Whole cream 1.5	2	5.480	A	B	C	D							
Whole cream 0.0	2	5.115		B	C	D	E						
skim bar 3.0	2	5.075		B	C	D	E						
Almond cream 0.0	2	5.055		B	C	D	E						
Almond bar 1.5	2	5.045		B	C	D	E						
skim cream 3.0	2	4.695		B	C	D	E	F					
Almond bar 0.0	2	4.585			C	D	E	F	G				
Almond cream 1.5	2	4.520			C	D	E	F	G				
skim bar 1.5	2	4.510			C	D	E	F	G				
Whole powder 3.0	2	4.280				D	E	F	G	H			
skim cream 1.5	2	4.065					E	F	G	H	I		
skim bar 0.0	2	4.005					E	F	G	H	I	J	
skim cream 0.0	2	3.795					E	F	G	H	I	J	
Whole powder 1.5	2	3.750					E	F	G	H	I	J	K
Almond powder 0.0	2	3.555						F	G	H	I	J	K
skim powder 3.0	2	3.280							G	H	I	J	K
skim powder 1.5	2	2.920								H	I	J	K	L
Almond powder 1.5	2	2.775									I	J	K	L
skim powder 0.0	2	2.630										J	K	L
Whole powder 0.0	2	2.340											K	L
Almond powder 3.0	2	1.730												L

Means that do not share a letter are significantly different.

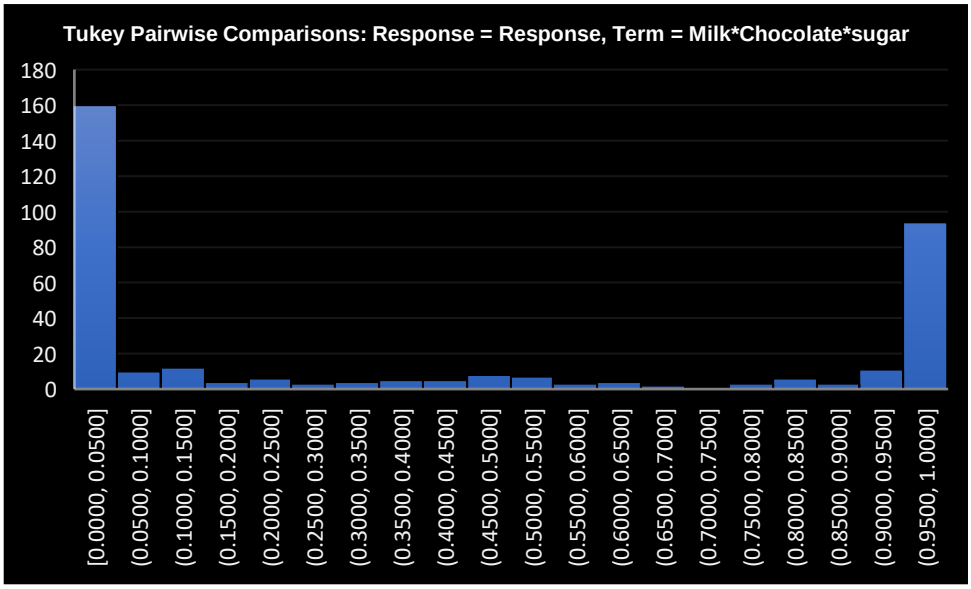
The analysis shows significant differences among Milk*_Chocolate_*Sugar combinations. Whole milk with bar chocolate and high sugar (3.0) has the highest mean response. In contrast, almond and skim milk with powder chocolate and low sugar show the lowest scores. Groupings from A to L confirm that all three factors, milk type, chocolate form, and sugar level, interact to influence response, with bar chocolate and higher sugar levels consistently performing better.

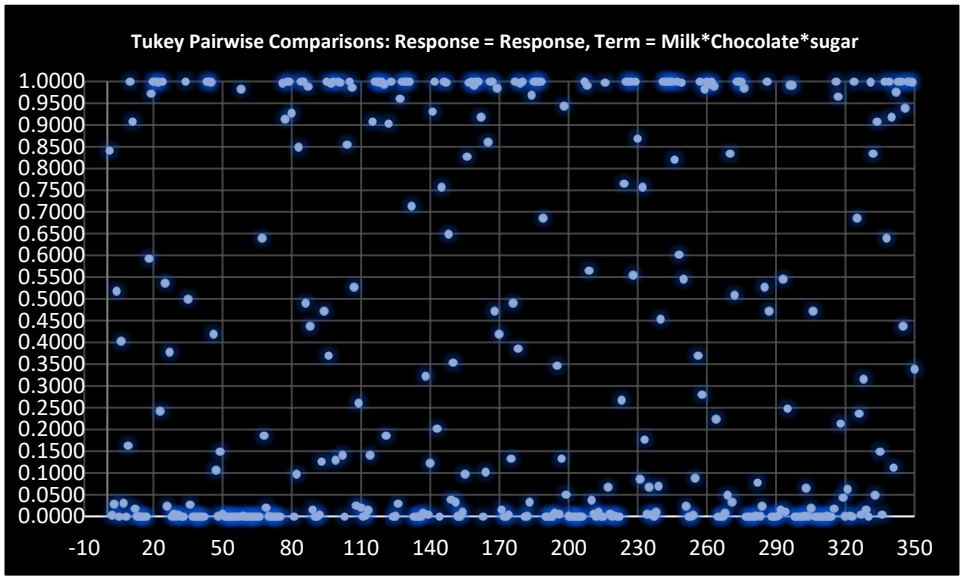
Milk*Chocolate*sugar

difference of Milk*Chocolate*sugar Levels	P-Value
(Almond powder 1.5) - (Almond powder 0.0)	0.841
(Almond powder 3.0) - (Almond powder 0.0)	0.003
(Almond cream 0.0) - (Almond powder 0.0)	0.028
(Almond cream 1.5) - (Almond powder 0.0)	0.518
(Almond cream 3.0) - (Almond powder 0.0)	0.000
(Almond bar 0.0) - (Almond powder 0.0)	0.402
(Almond bar 1.5) - (Almond powder 0.0)	0.030
(Almond bar 3.0) - (Almond powder 0.0)	0.000
(Whole powder 0.0) - (Almond powder 0.0)	0.162
(Whole powder 1.5) - (Almond powder 0.0)	1.000
(Whole powder 3.0) - (Almond powder 0.0)	0.908
(Whole cream 0.0) - (Almond powder 0.0)	0.018
(Whole cream 1.5) - (Almond powder 0.0)	0.001
(Whole cream 3.0) - (Almond powder 0.0)	0.000
(Whole bar 0.0) - (Almond powder 0.0)	0.000
(Whole bar 1.5) - (Almond powder 0.0)	0.000
(Whole bar 3.0) - (Almond powder 0.0)	0.000
(skim powder 0.0) - (Almond powder 0.0)	0.593
(skim powder 1.5) - (Almond powder 0.0)	0.972
(skim powder 3.0) - (Almond powder 0.0)	1.000
(skim cream 0.0) - (Almond powder 0.0)	1.000
(skim cream 1.5) - (Almond powder 0.0)	0.998
(skim cream 3.0) - (Almond powder 0.0)	0.242
(skim bar 0.0) - (Almond powder 0.0)	1.000
(skim bar 1.5) - (Almond powder 0.0)	0.537
(skim bar 3.0) - (Almond powder 0.0)	0.024
(Almond powder 3.0) - (Almond powder 1.5)	0.378
(Almond cream 0.0) - (Almond powder 1.5)	0.000
(Almond cream 1.5) - (Almond powder 1.5)	0.005
(Almond cream 3.0) - (Almond powder 1.5)	0.000
(Almond bar 0.0) - (Almond powder 1.5)	0.003
(Almond bar 1.5) - (Almond powder 1.5)	0.000
(Almond bar 3.0) - (Almond powder 1.5)	0.000
(Whole powder 0.0) - (Almond powder 1.5)	1.000
(Whole powder 1.5) - (Almond powder 1.5)	0.500
(Whole powder 3.0) - (Almond powder 1.5)	0.027
(Whole cream 0.0) - (Almond powder 1.5)	0.000
(Whole cream 1.5) - (Almond powder 1.5)	0.000
(Whole cream 3.0) - (Almond powder 1.5)	0.000
(Whole bar 0.0) - (Almond powder 1.5)	0.000
(Whole bar 1.5) - (Almond powder 1.5)	0.000
(Whole bar 3.0) - (Almond powder 1.5)	0.000
(skim powder 0.0) - (Almond powder 1.5)	1.000
(skim powder 1.5) - (Almond powder 1.5)	1.000
(skim powder 3.0) - (Almond powder 1.5)	0.998
(skim cream 0.0) - (Almond powder 1.5)	0.419
(skim cream 1.5) - (Almond powder 1.5)	0.106
(skim cream 3.0) - (Almond powder 1.5)	0.001
(skim bar 0.0) - (Almond powder 1.5)	0.149
(skim bar 1.5) - (Almond powder 1.5)	0.005
(skim bar 3.0) - (Almond powder 1.5)	0.000
(Almond cream 0.0) - (Almond powder 3.0)	0.000
(Almond cream 1.5) - (Almond powder 3.0)	0.000
(Almond cream 3.0) - (Almond powder 3.0)	0.000
(Almond bar 0.0) - (Almond powder 3.0)	0.000
(Almond bar 1.5) - (Almond powder 3.0)	0.000
(Almond bar 3.0) - (Almond powder 3.0)	0.000
(Whole powder 0.0) - (Almond powder 3.0)	0.982
(Whole powder 1.5) - (Almond powder 3.0)	0.001
(Whole powder 3.0) - (Almond powder 3.0)	0.000
(Whole cream 0.0) - (Almond powder 3.0)	0.000
(Whole cream 1.5) - (Almond powder 3.0)	0.000
(Whole cream 3.0) - (Almond powder 3.0)	0.000
(Whole bar 0.0) - (Almond powder 3.0)	0.000
(Whole bar 1.5) - (Almond powder 3.0)	0.000
(Whole bar 3.0) - (Almond powder 3.0)	0.000
(skim powder 0.0) - (Almond powder 3.0)	0.640
(skim powder 1.5) - (Almond powder 3.0)	0.186
(skim powder 3.0) - (Almond powder 3.0)	0.020
(skim cream 0.0) - (Almond powder 3.0)	0.001
(skim cream 1.5) - (Almond powder 3.0)	0.000
(skim cream 3.0) - (Almond powder 3.0)	0.000
(skim bar 0.0) - (Almond powder 3.0)	0.000
(skim bar 1.5) - (Almond powder 3.0)	0.000
(skim bar 3.0) - (Almond powder 3.0)	0.000
(Almond cream 1.5) - (Almond cream 0.0)	0.996
(Almond cream 3.0) - (Almond cream 0.0)	0.913
(Almond bar 0.0) - (Almond cream 0.0)	0.999
(Almond bar 1.5) - (Almond cream 0.0)	1.000
(Almond bar 3.0) - (Almond cream 0.0)	0.927
(Whole powder 0.0) - (Almond cream 0.0)	0.000
(Whole powder 1.5) - (Almond cream 0.0)	0.097
(Whole powder 3.0) - (Almond cream 0.0)	0.848
(Whole cream 0.0) - (Almond cream 0.0)	1.000
(Whole cream 1.5) - (Almond cream 0.0)	1.000
(Whole cream 3.0) - (Almond cream 0.0)	0.490
(Whole bar 0.0) - (Almond cream 0.0)	0.988
(Whole bar 1.5) - (Almond cream 0.0)	0.437
(Whole bar 3.0) - (Almond cream 0.0)	0.016
(skim powder 0.0) - (Almond cream 0.0)	0.000
(skim powder 1.5) - (Almond cream 0.0)	0.000
(skim powder 3.0) - (Almond cream 0.0)	0.004
(skim cream 0.0) - (Almond cream 0.0)	0.126
(skim cream 1.5) - (Almond cream 0.0)	0.472
(skim cream 3.0) - (Almond cream 0.0)	1.000
(skim bar 0.0) - (Almond cream 0.0)	0.370
(skim bar 1.5) - (Almond cream 0.0)	0.995
(skim bar 3.0) - (Almond cream 0.0)	1.000
(Almond cream 3.0) - (Almond cream 1.5)	0.130
(Almond bar 0.0) - (Almond cream 1.5)	1.000
(Almond bar 1.5) - (Almond cream 1.5)	0.997
(Almond bar 3.0) - (Almond cream 1.5)	0.141
(Whole powder 0.0) - (Almond cream 1.5)	0.000
(Whole powder 1.5) - (Almond cream 1.5)	0.855
(Whole powder 3.0) - (Almond cream 1.5)	1.000
(Whole cream 0.0) - (Almond cream 1.5)	0.986
(Whole cream 1.5) - (Almond cream 1.5)	0.527
(Whole cream 3.0) - (Almond cream 1.5)	0.025
(Whole bar 0.0) - (Almond cream 1.5)	0.261
(Whole bar 1.5) - (Almond cream 1.5)	0.020
(Whole bar 3.0) - (Almond cream 1.5)	0.000
(skim powder 0.0) - (Almond cream 1.5)	0.002
(skim powder 1.5) - (Almond cream 1.5)	0.014
(skim powder 3.0) - (Almond cream 1.5)	0.141
(skim cream 0.0) - (Almond cream 1.5)	0.908
(skim cream 1.5) - (Almond cream 1.5)	1.000
(skim cream 3.0) - (Almond cream 1.5)	1.000
(skim bar 0.0) - (Almond cream 1.5)	0.998
(skim bar 1.5) - (Almond cream 1.5)	1.000
(skim bar 3.0) - (Almond cream 1.5)	0.994
(Almond bar 0.0) - (Almond cream 3.0)	0.186
(Almond bar 1.5) - (Almond cream 3.0)	0.903
(Almond bar 3.0) - (Almond cream 3.0)	1.000
(Whole powder 0.0) - (Almond cream 3.0)	0.000
(Whole powder 1.5) - (Almond cream 3.0)	0.001
(Whole powder 3.0) - (Almond cream 3.0)	0.029
(Whole cream 0.0) - (Almond cream 3.0)	0.960
(Whole cream 1.5) - (Almond cream 3.0)	1.000
(Whole cream 3.0) - (Almond cream 3.0)	1.000
(Whole bar 0.0) - (Almond cream 3.0)	1.000
(Whole bar 1.5) - (Almond cream 3.0)	1.000
(Whole bar 3.0) - (Almond cream 3.0)	0.713
(skim powder 0.0) - (Almond cream 3.0)	0.000
(skim powder 1.5) - (Almond cream 3.0)	0.000
(skim powder 3.0) - (Almond cream 3.0)	0.000
(skim cream 0.0) - (Almond cream 3.0)	0.001
(skim cream 1.5) - (Almond cream 3.0)	0.007
(skim cream 3.0) - (Almond cream 3.0)	0.323
(skim bar 0.0) - (Almond cream 3.0)	0.004
(skim bar 1.5) - (Almond cream 3.0)	0.122
(skim bar 3.0) - (Almond cream 3.0)	0.931
(Almond bar 1.5) - (Almond bar 0.0)	1.000
(Almond bar 3.0) - (Almond bar 0.0)	0.202
(Whole powder 0.0) - (Almond bar 0.0)	0.000
(Whole powder 1.5) - (Almond bar 0.0)	0.756
(Whole powder 3.0) - (Almond bar 0.0)	1.000
(Whole cream 0.0) - (Almond bar 0.0)	0.997
(Whole cream 1.5) - (Almond bar 0.0)	0.649
(Whole cream 3.0) - (Almond bar 0.0)	0.039
(Whole bar 0.0) - (Almond bar 0.0)	0.354
(Whole bar 1.5) - (Almond bar 0.0)	0.032
(Whole bar 3.0) - (Almond bar 0.0)	0.001
(skim powder 0.0) - (Almond bar 0.0)	0.001
(skim powder 1.5) - (Almond bar 0.0)	0.009
(skim powder 3.0) - (Almond bar 0.0)	0.097
(skim cream 0.0) - (Almond bar 0.0)	0.827
(skim cream 1.5) - (Almond bar 0.0)	0.997
(skim cream 3.0) - (Almond bar 0.0)	1.000
(skim bar 0.0) - (Almond bar 0.0)	0.990
(skim bar 1.5) - (Almond bar 0.0)	1.000
(skim bar 3.0) - (Almond bar 0.0)	0.999
(Almond bar 3.0) - (Almond bar 1.5)	0.918
(Whole powder 0.0) - (Almond bar 1.5)	0.000
(Whole powder 1.5) - (Almond bar 1.5)	0.102
(Whole powder 3.0) - (Almond bar 1.5)	0.861
(Whole cream 0.0) - (Almond bar 1.5)	1.000
(Whole cream 1.5) - (Almond bar 1.5)	1.000
(Whole cream 3.0) - (Almond bar 1.5)	0.472
(Whole bar 0.0) - (Almond bar 1.5)	0.985
(Whole bar 1.5) - (Almond bar 1.5)	0.419
(Whole bar 3.0) - (Almond bar 1.5)	0.015
(skim powder 0.0) - (Almond bar 1.5)	0.000
(skim powder 1.5) - (Almond bar 1.5)	0.000
(skim powder 3.0) - (Almond bar 1.5)	0.004
(skim cream 0.0) - (Almond bar 1.5)	0.133
(skim cream 1.5) - (Almond bar 1.5)	0.490
(skim cream 3.0) - (Almond bar 1.5)	1.000
(skim bar 0.0) - (Almond bar 1.5)	0.386
(skim bar 1.5) - (Almond bar 1.5)	0.996
(skim bar 3.0) - (Almond bar 1.5)	1.000
(Whole powder 0.0) - (Almond bar 3.0)	0.000
(Whole powder 1.5) - (Almond bar 3.0)	0.001
(Whole powder 3.0) - (Almond bar 3.0)	0.032
(Whole cream 0.0) - (Almond bar 3.0)	0.968
(Whole cream 1.5) - (Almond bar 3.0)	1.000
(Whole cream 3.0) - (Almond bar 3.0)	1.000
(Whole bar 0.0) - (Almond bar 3.0)	1.000
(Whole bar 1.5) - (Almond bar 3.0)	1.000
(Whole bar 3.0) - (Almond bar 3.0)	0.686
(skim powder 0.0) - (Almond bar 3.0)	0.000
(skim powder 1.5) - (Almond bar 3.0)	0.000
(skim powder 3.0) - (Almond bar 3.0)	0.000
(skim cream 0.0) - (Almond bar 3.0)	0.001
(skim cream 1.5) - (Almond bar 3.0)	0.007
(skim cream 3.0) - (Almond bar 3.0)	0.346
(skim bar 0.0) - (Almond bar 3.0)	0.005
(skim bar 1.5) - (Almond bar 3.0)	0.133
(skim bar 3.0) - (Almond bar 3.0)	0.943
(Whole powder 1.5) - (Whole powder 0.0)	0.050
(Whole powder 3.0) - (Whole powder 0.0)	0.001
(Whole cream 0.0) - (Whole powder 0.0)	0.000
(Whole cream 1.5) - (Whole powder 0.0)	0.000
(Whole cream 3.0) - (Whole powder 0.0)	0.000
(Whole bar 0.0) - (Whole powder 0.0)	0.000
(Whole bar 1.5) - (Whole powder 0.0)	0.000
(Whole bar 3.0) - (Whole powder 0.0)	0.000
(skim powder 0.0) - (Whole powder 0.0)	1.000
(skim powder 1.5) - (Whole powder 0.0)	0.990
(skim powder 3.0) - (Whole powder 0.0)	0.565
(skim cream 0.0) - (Whole powder 0.0)	0.037
(skim cream 1.5) - (Whole powder 0.0)	0.006
(skim cream 3.0) - (Whole powder 0.0)	0.000
(skim bar 0.0) - (Whole powder 0.0)	0.009
(skim bar 1.5) - (Whole powder 0.0)	0.000
(skim bar 3.0) - (Whole powder 0.0)	0.000
(Whole powder 3.0) - (Whole powder 1.5)	0.997
(Whole cream 0.0) - (Whole powder 1.5)	0.067
(Whole cream 1.5) - (Whole powder 1.5)	0.006
(Whole cream 3.0) - (Whole powder 1.5)	0.000
(Whole bar 0.0) - (Whole powder 1.5)	0.002
(Whole bar 1.5) - (Whole powder 1.5)	0.000
(Whole bar 3.0) - (Whole powder 1.5)	0.000
(skim powder 0.0) - (Whole powder 1.5)	0.267
(skim powder 1.5) - (Whole powder 1.5)	0.765
(skim powder 3.0) - (Whole powder 1.5)	0.999
(skim cream 0.0) - (Whole powder 1.5)	1.000
(skim cream 1.5) - (Whole powder 1.5)	1.000
(skim cream 3.0) - (Whole powder 1.5)	0.555
(skim bar 0.0) - (Whole powder 1.5)	1.000
(skim bar 1.5) - (Whole powder 1.5)	0.868
(skim bar 3.0) - (Whole powder 1.5)	0.086
(Whole cream 0.0) - (Whole powder 3.0)	0.756
(Whole cream 1.5) - (Whole powder 3.0)	0.176
(Whole cream 3.0) - (Whole powder 3.0)	0.005
(Whole bar 0.0) - (Whole powder 3.0)	0.067
(Whole bar 1.5) - (Whole powder 3.0)	0.004
(Whole bar 3.0) - (Whole powder 3.0)	0.000
(skim powder 0.0) - (Whole powder 3.0)	0.010
(skim powder 1.5) - (Whole powder 3.0)	0.069
(skim powder 3.0) - (Whole powder 3.0)	0.454
(skim cream 0.0) - (Whole powder 3.0)	0.999
(skim cream 1.5) - (Whole powder 3.0)	1.000
(skim cream 3.0) - (Whole powder 3.0)	1.000
(skim bar 0.0) - (Whole powder 3.0)	1.000
(skim bar 1.5) - (Whole powder 3.0)	1.000
(skim bar 3.0) - (Whole powder 3.0)	0.820
(Whole cream 1.5) - (Whole cream 0.0)	1.000
(Whole cream 3.0) - (Whole cream 0.0)	0.602
(Whole bar 0.0) - (Whole cream 0.0)	0.997
(Whole bar 1.5) - (Whole cream 0.0)	0.546
(Whole bar 3.0) - (Whole cream 0.0)	0.024
(skim powder 0.0) - (Whole cream 0.0)	0.000

(skim powder 1.5) - (Whole cream 0.0)	0.000
(skim powder 3.0) - (Whole cream 0.0)	0.003
(skim cream 0.0) - (Whole cream 0.0)	0.088
(skim cream 1.5) - (Whole cream 0.0)	0.370
(skim cream 3.0) - (Whole cream 0.0)	1.000
(skim bar 0.0) - (Whole cream 0.0)	0.280
(skim bar 1.5) - (Whole cream 0.0)	0.983
(skim bar 3.0) - (Whole cream 0.0)	1.000
(Whole cream 3.0) - (Whole cream 1.5)	0.994
(Whole bar 0.0) - (Whole cream 1.5)	1.000
(Whole bar 1.5) - (Whole cream 1.5)	0.989
(Whole bar 3.0) - (Whole cream 1.5)	0.224
(skim powder 0.0) - (Whole cream 1.5)	0.000
(skim powder 1.5) - (Whole cream 1.5)	0.000
(skim powder 3.0) - (Whole cream 1.5)	0.000
(skim cream 0.0) - (Whole cream 1.5)	0.008
(skim cream 1.5) - (Whole cream 1.5)	0.049
(skim cream 3.0) - (Whole cream 1.5)	0.834
(skim bar 0.0) - (Whole cream 1.5)	0.033
(skim bar 1.5) - (Whole cream 1.5)	0.509
(skim bar 3.0) - (Whole cream 1.5)	1.000
(Whole bar 0.0) - (Whole cream 3.0)	1.000
(Whole bar 1.5) - (Whole cream 3.0)	1.000
(Whole bar 3.0) - (Whole cream 3.0)	0.985
(skim powder 0.0) - (Whole cream 3.0)	0.000
(skim powder 1.5) - (Whole cream 3.0)	0.000
(skim powder 3.0) - (Whole cream 3.0)	0.000
(skim cream 0.0) - (Whole cream 3.0)	0.000
(skim cream 1.5) - (Whole cream 3.0)	0.001
(skim cream 3.0) - (Whole cream 3.0)	0.078
(skim bar 0.0) - (Whole cream 3.0)	0.001
(skim bar 1.5) - (Whole cream 3.0)	0.023
(skim bar 3.0) - (Whole cream 3.0)	0.527
(Whole bar 1.5) - (Whole bar 0.0)	1.000
(Whole bar 3.0) - (Whole bar 0.0)	0.472
(skim powder 0.0) - (Whole bar 0.0)	0.000
(skim powder 1.5) - (Whole bar 0.0)	0.000
(skim powder 3.0) - (Whole bar 0.0)	0.000
(skim cream 0.0) - (Whole bar 0.0)	0.002
(skim cream 1.5) - (Whole bar 0.0)	0.016
(skim cream 3.0) - (Whole bar 0.0)	0.546
(skim bar 0.0) - (Whole bar 0.0)	0.011
(skim cream 1.5) - (skim cream 0.0)	1.000
(skim cream 3.0) - (skim cream 0.0)	0.640
(skim bar 0.0) - (skim cream 0.0)	1.000
(skim bar 1.5) - (skim cream 0.0)	0.918
(skim bar 3.0) - (skim cream 0.0)	0.112
(skim cream 3.0) - (skim cream 1.5)	0.975
(skim bar 0.0) - (skim cream 1.5)	1.000
(skim bar 1.5) - (skim cream 1.5)	1.000
(skim bar 3.0) - (skim cream 1.5)	0.437
(skim bar 0.0) - (skim cream 3.0)	0.939
(skim bar 1.5) - (skim cream 3.0)	1.000
(skim bar 3.0) - (skim cream 3.0)	1.000
(skim bar 1.5) - (skim bar 0.0)	0.998
(skim bar 3.0) - (skim bar 0.0)	0.338
(skim bar 3.0) - (skim bar 1.5)	0.992

(skim bar 1.5) - (Whole bar 0.0)	0.248
(skim bar 3.0) - (Whole bar 0.0)	0.992
(Whole bar 3.0) - (Whole bar 1.5)	0.992
(skim powder 0.0) - (Whole bar 1.5)	0.000
(skim powder 1.5) - (Whole bar 1.5)	0.000
(skim powder 3.0) - (Whole bar 1.5)	0.000
(skim cream 0.0) - (Whole bar 1.5)	0.000
(skim cream 1.5) - (Whole bar 1.5)	0.001
(skim cream 3.0) - (Whole bar 1.5)	0.065
(skim bar 0.0) - (Whole bar 1.5)	0.001
(skim bar 1.5) - (Whole bar 1.5)	0.019
(skim bar 3.0) - (Whole bar 1.5)	0.472
(skim powder 0.0) - (Whole bar 3.0)	0.000
(skim powder 1.5) - (Whole bar 3.0)	0.000
(skim powder 3.0) - (Whole bar 3.0)	0.000
(skim cream 0.0) - (Whole bar 3.0)	0.000
(skim cream 1.5) - (Whole bar 3.0)	0.000
(skim cream 3.0) - (Whole bar 3.0)	0.001
(skim bar 0.0) - (Whole bar 3.0)	0.000
(skim bar 1.5) - (Whole bar 3.0)	0.000
(skim bar 3.0) - (Whole bar 3.0)	0.018
(skim powder 1.5) - (skim powder 0.0)	1.000
(skim powder 3.0) - (skim powder 0.0)	0.965
(skim cream 0.0) - (skim powder 0.0)	0.213
(skim cream 1.5) - (skim powder 0.0)	0.043
(skim cream 3.0) - (skim powder 0.0)	0.001
(skim bar 0.0) - (skim powder 0.0)	0.063
(skim bar 1.5) - (skim powder 0.0)	0.002
(skim bar 3.0) - (skim powder 0.0)	0.000
(skim powder 3.0) - (skim powder 1.5)	1.000
(skim cream 0.0) - (skim powder 1.5)	0.686
(skim cream 1.5) - (skim powder 1.5)	0.236
(skim cream 3.0) - (skim powder 1.5)	0.004
(skim bar 0.0) - (skim powder 1.5)	0.316
(skim bar 1.5) - (skim powder 1.5)	0.015
(skim bar 3.0) - (skim powder 1.5)	0.000
(skim cream 0.0) - (skim powder 3.0)	0.998
(skim cream 1.5) - (skim powder 3.0)	0.834
(skim cream 3.0) - (skim powder 3.0)	0.049
(skim bar 0.0) - (skim powder 3.0)	0.908
(skim bar 1.5) - (skim powder 3.0)	0.149
(skim bar 3.0) - (skim powder 3.0)	0.004

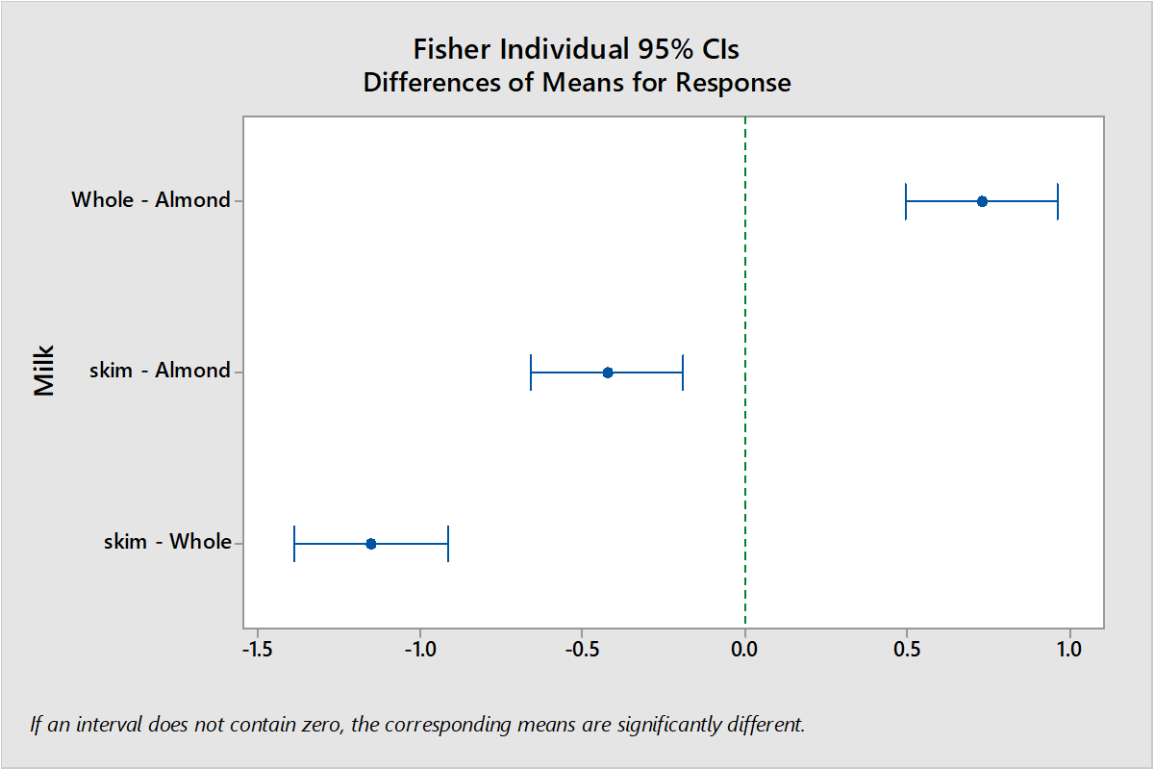




Our Tukey test revealed numerous statistically significant comparisons ($p < 0.05$), confirming the validity and sensitivity of our experimental design. Based on these results, we offer specific product recommendations by sugar preference. For individuals avoiding sugar (0.0), whole bar, whole powder, and skim powder varieties showed significant differences from almond formulations. For those who enjoy moderate sweetness (1.5), almond bar, whole cream, and skim powder at the same sugar level are highly distinguishable and suitable. Lastly, for sweet lovers (3.0), almond and whole creams are distinct from each other and from skim powder, offering clear options for selection.

Comparison	P-Value
(Whole bar 0.0) - (Almond powder 0.0)	0.0000
(Whole powder 0.0) - (Almond cream 0.0)	0.0000
(skim powder 0.0) - (Almond cream 0.0)	0.0000
(Almond bar 1.5) - (Almond powder 1.5)	0.0000
(Whole cream 1.5) - (Almond powder 1.5)	0.0000
(skim powder 1.5) - (Almond bar 1.5)	0.0000
(Almond cream 3.0) - (Almond powder 3.0)	0.0000
(Whole cream 3.0) - (Almond powder 3.0)	0.0000
(skim powder 3.0) - (Almond cream 3.0)	0.0000

7) Fisher Test



Fisher Pairwise Comparisons: Response = Response, Term = Milk

Grouping Information Using Fisher LSD Method and 95% Confidence

Milk	N	Mean	Grouping
Whole	18	5.03833	A
Almond	18	4.31111	B
skim	18	3.88611	C

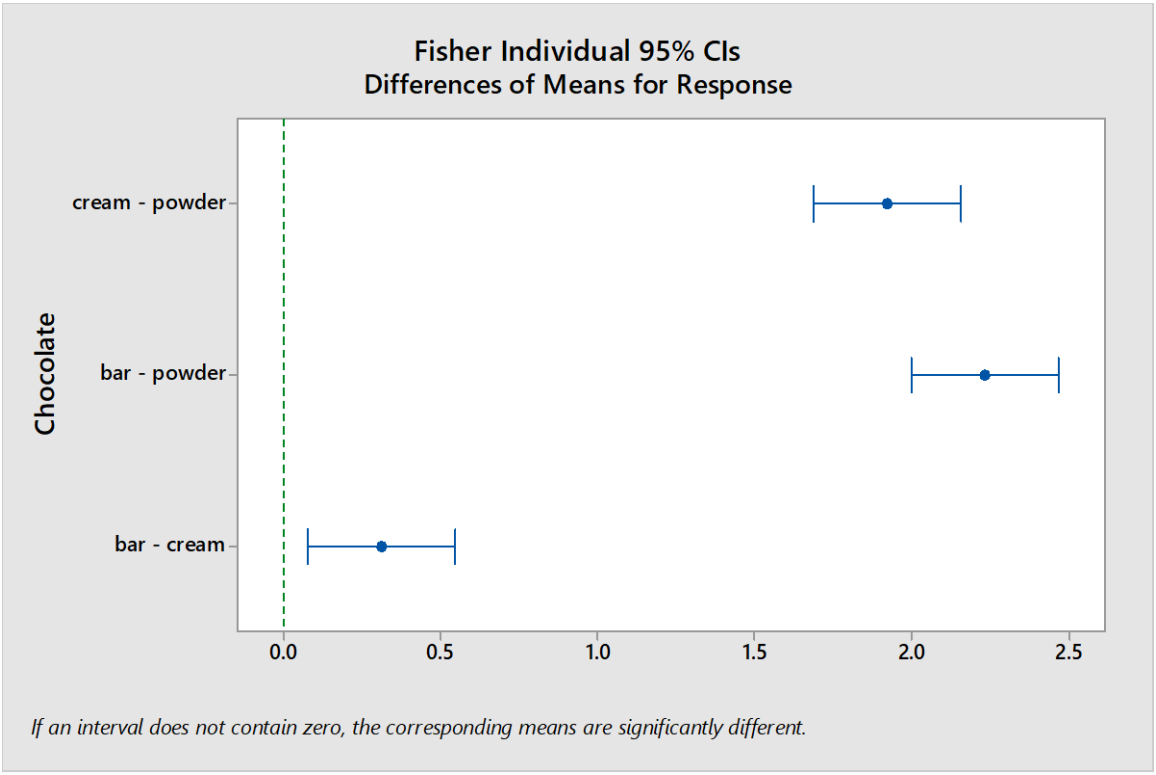
Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

Difference of Milk Levels	Difference of Means	SE of Difference	Individual 95% CI	T-Value	P-Value
Whole - Almond	0.727	0.115	(0.492, 0.962)	6.34	0.000
skim - Almond	-0.425	0.115	(-0.660, -0.190)	-3.71	0.001
skim - Whole	-1.152	0.115	(-1.387, -0.917)	-10.05	0.000

Simultaneous confidence level = 88.07%

The Fisher LSD analysis indicates significant differences among all milk types. Whole milk has the highest mean response, followed by almond and skim. All pairwise comparisons are statistically significant since none of the confidence intervals include zero. These results confirm that milk type significantly affects the response variable.



Fisher Pairwise Comparisons: Response = Response, Term = Chocolate

Grouping Information Using Fisher LSD Method and 95% Confidence

Chocolate	N	Mean	Grouping
bar	18	5.25833	A
cream	18	4.94833	B
powder	18	3.02889	C

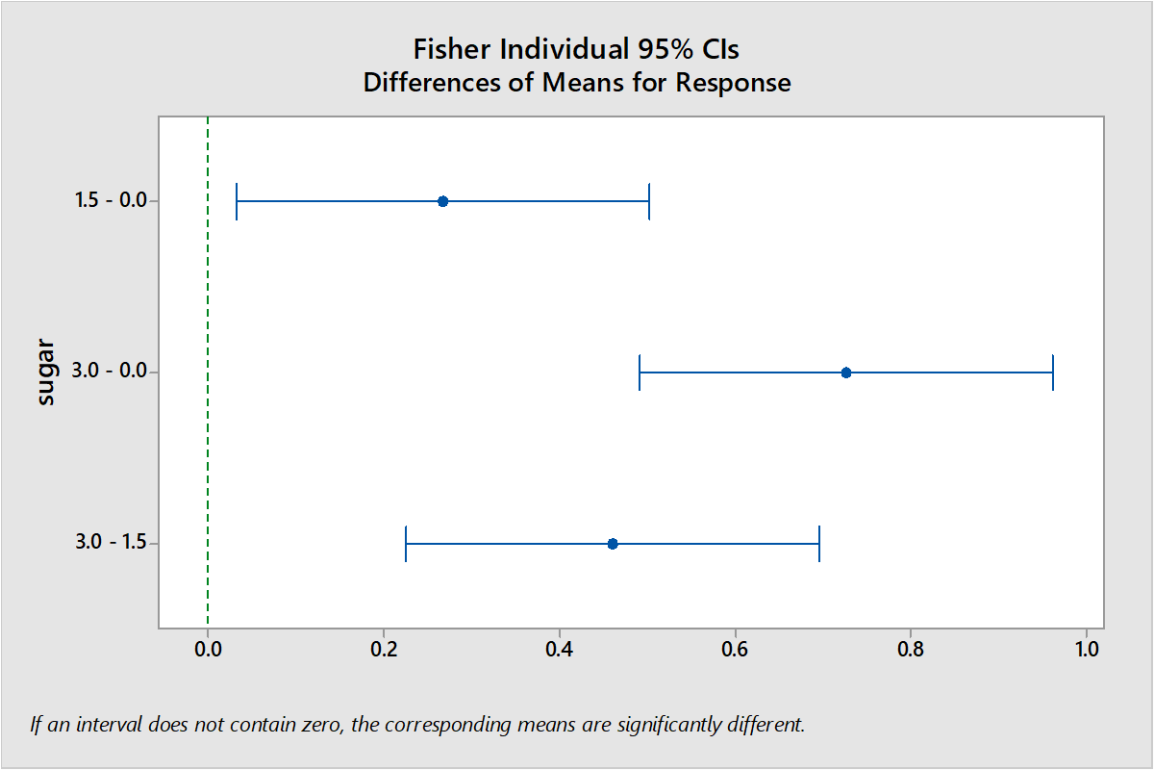
Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

Difference of Chocolate Levels	Difference of Means	SE of Difference	Individual 95% CI	T-Value	P-Value
cream - powder	1.919	0.115	(1.684, 2.155)	16.74	0.000
bar - powder	2.229	0.115	(1.994, 2.465)	19.45	0.000
bar - cream	0.310	0.115	(0.075, 0.545)	2.70	0.012

Simultaneous confidence level = 88.07%

The Fisher LSD test shows all three chocolate types differ significantly. Bar chocolate has the highest mean response, followed by cream, then powder. All confidence intervals exclude zero, confirming statistical significance. Although the bar vs. cream difference is smaller, it is still meaningful. Chocolate type clearly affects response levels.



Fisher Pairwise Comparisons: Response = Response, Term = sugar

Grouping Information Using Fisher LSD Method and 95% Confidence

sugar	N	Mean	Grouping
3.0	18	4.80722	A
1.5	18	4.34778	B
0.0	18	4.08056	C

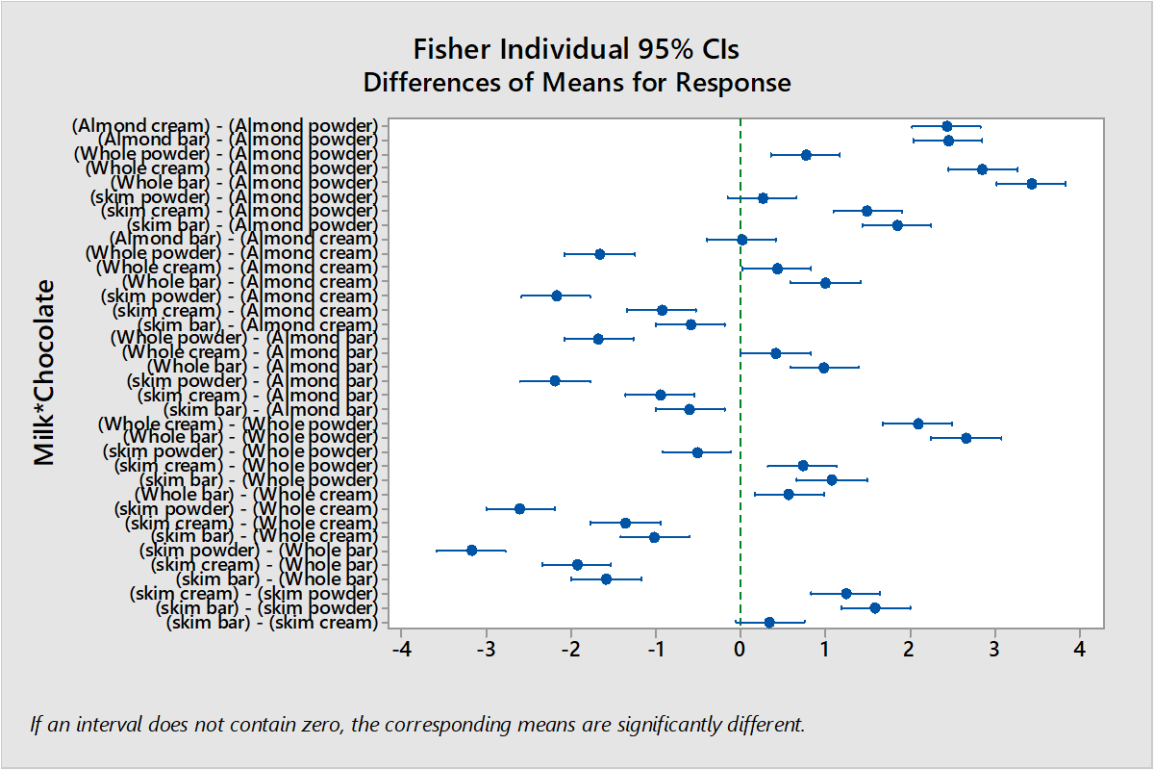
Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

Difference of sugar Levels	Difference of Means	SE of Difference	Individual 95% CI	T-Value	P-Value
1.5 - 0.0	0.267	0.115	(0.032, 0.502)	2.33	0.027
3.0 - 0.0	0.727	0.115	(0.491, 0.962)	6.34	0.000
3.0 - 1.5	0.459	0.115	(0.224, 0.695)	4.01	0.000

Simultaneous confidence level = 88.07%

The Fisher LSD results show that all sugar levels (0.0, 1.5, 3.0) differ significantly. Higher sugar content leads to higher mean responses, with 3.0 having the highest score and 0.0 the lowest. All confidence intervals exclude zero, confirming statistically significant differences. Sugar level has a clear positive impact on response.



Fisher Pairwise Comparisons: Response = Response, Term = Milk*Chocolate

Grouping Information Using Fisher LSD Method and 95% Confidence

Milk*Chocolate	N	Mean	Grouping
Whole bar	6	6.11500	A
Whole cream	6	5.54333	B
Almond bar	6	5.13000	C
Almond cream	6	5.11667	C
skim bar	6	4.53000	D
skim cream	6	4.18500	D
Whole powder	6	3.45667	E
skim powder	6	2.94333	F
Almond powder	6	2.68667	F

Means that do not share a letter are significantly different.

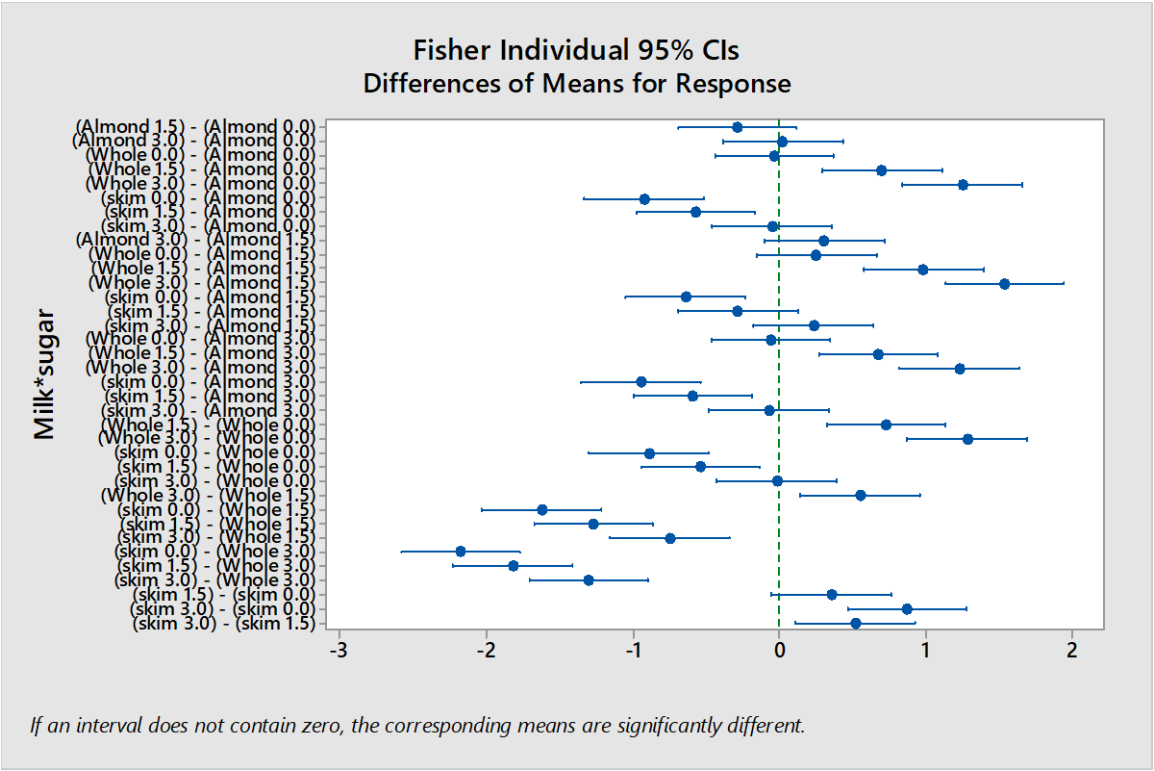
The Fisher LSD results show significant differences across Milk*Chocolate combinations. Whole bar has the highest response and belongs to its own group (A), while almond and skim powders show the lowest means (F). The confidence intervals confirm that almost all pairwise differences are statistically significant, especially between whole milk forms and powdered combinations.

Difference of Milk*Chocolate Levels	P-Value
(Almond cream) - (Almond powder)	0.000
(Almond bar) - (Almond powder)	0.000
(Whole powder) - (Almond powder)	0.001
(Whole cream) - (Almond powder)	0.000
(Whole bar) - (Almond powder)	0.000
(skim powder) - (Almond powder)	0.207
(skim cream) - (Almond powder)	0.000
(skim bar) - (Almond powder)	0.000
(Almond bar) - (Almond cream)	0.947
(Whole powder) - (Almond cream)	0.000
(Whole cream) - (Almond cream)	0.041
(Whole bar) - (Almond cream)	0.000
(skim powder) - (Almond cream)	0.000
(skim cream) - (Almond cream)	0.000
(skim bar) - (Almond cream)	0.006
(Whole powder) - (Almond bar)	0.000
(Whole cream) - (Almond bar)	0.047
(Whole bar) - (Almond bar)	0.000
(skim powder) - (Almond bar)	0.000
(skim cream) - (Almond bar)	0.000
(skim bar) - (Almond bar)	0.005
(Whole cream) - (Whole powder)	0.000
(Whole bar) - (Whole powder)	0.000
(skim powder) - (Whole powder)	0.015
(skim cream) - (Whole powder)	0.001
(skim bar) - (Whole powder)	0.000
(Whole bar) - (Whole cream)	0.008
(skim powder) - (Whole cream)	0.000
(skim cream) - (Whole cream)	0.000
(skim bar) - (Whole cream)	0.000
(skim powder) - (Whole bar)	0.000
(skim cream) - (Whole bar)	0.000
(skim bar) - (Whole bar)	0.000
(skim cream) - (skim powder)	0.000
(skim bar) - (skim powder)	0.000
(skim bar) - (skim cream)	0.094

Simultaneous confidence level = 47.64%

(skim powder) – (Almond powder) → 0.207 (Almond bar) – (Almond cream) → 0.947
(skim bar) – (skim cream) → 0.094

These pairs do not show statistically significant differences, meaning their means are likely not different at the chosen significance level.



Fisher Pairwise Comparisons: Response = Response, Term = Milk*sugar

Grouping Information Using Fisher LSD Method and 95% Confidence

Milk*sugar	N	Mean	Grouping		
Whole 3.0	6	5.65000	A		
Whole 1.5	6	5.09833		B	
Almond 3.0	6	4.42167			C
Almond 0.0	6	4.39833			C
Whole 0.0	6	4.36667			C
skim 3.0	6	4.35000			C
Almond 1.5	6	4.11333			C D
skim 1.5	6	3.83167			D E
skim 0.0	6	3.47667			E

Means that do not share a letter are significantly different.

The Fisher LSD analysis shows significant differences among Milk*Sugar combinations. Whole milk with sugar 3.0 has the highest mean, forming its own group (A), while skim milk with sugar 0.0 ranks lowest (E). Confidence intervals confirm these differences are statistically significant. Both milk type and sugar level strongly influence the response.

Difference of Milk*sugar Levels	Difference of Means	SE of Difference	Simultaneous 95% CI		T-Value	Adjusted P-Value
(Almond 1.5) - (Almond 0.0)	-0.285	0.199	(-0.953,	0.383)	-1.44	0.874
(Almond 3.0) - (Almond 0.0)	0.023	0.199	(-0.645,	0.692)	0.12	1.000
(Whole 0.0) - (Almond 0.0)	-0.032	0.199	(-0.700,	0.637)	-0.16	1.000
(Whole 1.5) - (Almond 0.0)	0.700	0.199	(0.032,	1.368)	3.53	0.035
(Whole 3.0) - (Almond 0.0)	1.252	0.199	(0.583,	1.920)	6.30	0.000
(skim 0.0) - (Almond 0.0)	-0.922	0.199	(-1.590,	-0.253)	-4.64	0.002
(skim 1.5) - (Almond 0.0)	-0.567	0.199	(-1.235,	0.102)	-2.85	0.146
(skim 3.0) - (Almond 0.0)	-0.048	0.199	(-0.717,	0.620)	-0.24	1.000
(Almond 3.0) - (Almond 1.5)	0.308	0.199	(-0.360,	0.977)	1.55	0.821
(Whole 0.0) - (Almond 1.5)	0.253	0.199	(-0.415,	0.922)	1.28	0.930
(Whole 1.5) - (Almond 1.5)	0.985	0.199	(0.317,	1.653)	4.96	0.001
(Whole 3.0) - (Almond 1.5)	1.537	0.199	(0.868,	2.205)	7.74	0.000
(skim 0.0) - (Almond 1.5)	-0.637	0.199	(-1.305,	0.032)	-3.21	0.071
(skim 1.5) - (Almond 1.5)	-0.282	0.199	(-0.950,	0.387)	-1.42	0.881
(skim 3.0) - (Almond 1.5)	0.237	0.199	(-0.432,	0.905)	1.19	0.951
(Whole 0.0) - (Almond 3.0)	-0.055	0.199	(-0.723,	0.613)	-0.28	1.000
(Whole 1.5) - (Almond 3.0)	0.677	0.199	(0.008,	1.345)	3.41	0.045
(Whole 3.0) - (Almond 3.0)	1.228	0.199	(0.560,	1.897)	6.19	0.000
(skim 0.0) - (Almond 3.0)	-0.945	0.199	(-1.613,	-0.277)	-4.76	0.002
(skim 1.5) - (Almond 3.0)	-0.590	0.199	(-1.258,	0.078)	-2.97	0.116
(skim 3.0) - (Almond 3.0)	-0.072	0.199	(-0.740,	0.597)	-0.36	1.000
(Whole 1.5) - (Whole 0.0)	0.732	0.199	(0.063,	1.400)	3.69	0.024
(Whole 3.0) - (Whole 0.0)	1.283	0.199	(0.615,	1.952)	6.46	0.000
(skim 0.0) - (Whole 0.0)	-0.890	0.199	(-1.558,	-0.222)	-4.48	0.003
(skim 1.5) - (Whole 0.0)	-0.535	0.199	(-1.203,	0.133)	-2.69	0.197
(skim 3.0) - (Whole 0.0)	-0.017	0.199	(-0.685,	0.652)	-0.08	1.000
(Whole 3.0) - (Whole 1.5)	0.552	0.199	(-0.117,	1.220)	2.78	0.168
(skim 0.0) - (Whole 1.5)	-1.622	0.199	(-2.290,	-0.953)	-8.17	0.000
(skim 1.5) - (Whole 1.5)	-1.267	0.199	(-1.935,	-0.598)	-6.38	0.000
(skim 3.0) - (Whole 1.5)	-0.748	0.199	(-1.417,	-0.080)	-3.77	0.020
(skim 0.0) - (Whole 3.0)	-2.173	0.199	(-2.842,	-1.505)	-10.95	0.000
(skim 1.5) - (Whole 3.0)	-1.818	0.199	(-2.487,	-1.150)	-9.16	0.000
(skim 3.0) - (Whole 3.0)	-1.300	0.199	(-1.968,	-0.632)	-6.55	0.000
(skim 1.5) - (skim 0.0)	0.355	0.199	(-0.313,	1.023)	1.79	0.689
(skim 3.0) - (skim 0.0)	0.873	0.199	(0.205,	1.542)	4.40	0.004
(skim 3.0) - (skim 1.5)	0.518	0.199	(-0.150,	1.187)	2.61	0.228

Individual confidence level = 99.77%

(Almond 1.5) – (Almond 0.0) → 0.874 (Almond 3.0) – (Almond 0.0) → 1.000

(Whole 0.0) – (Almond 0.0) → 1.000 (skim 1.5) – (Almond 0.0) → 0.146

(skim 3.0) – (Almond 0.0) → 0.930 (Almond 3.0) – (Almond 1.5) → 0.821

(skim 0.0) – (Almond 1.5) → 0.071 (skim 1.5) – (Almond 1.5) → 0.881

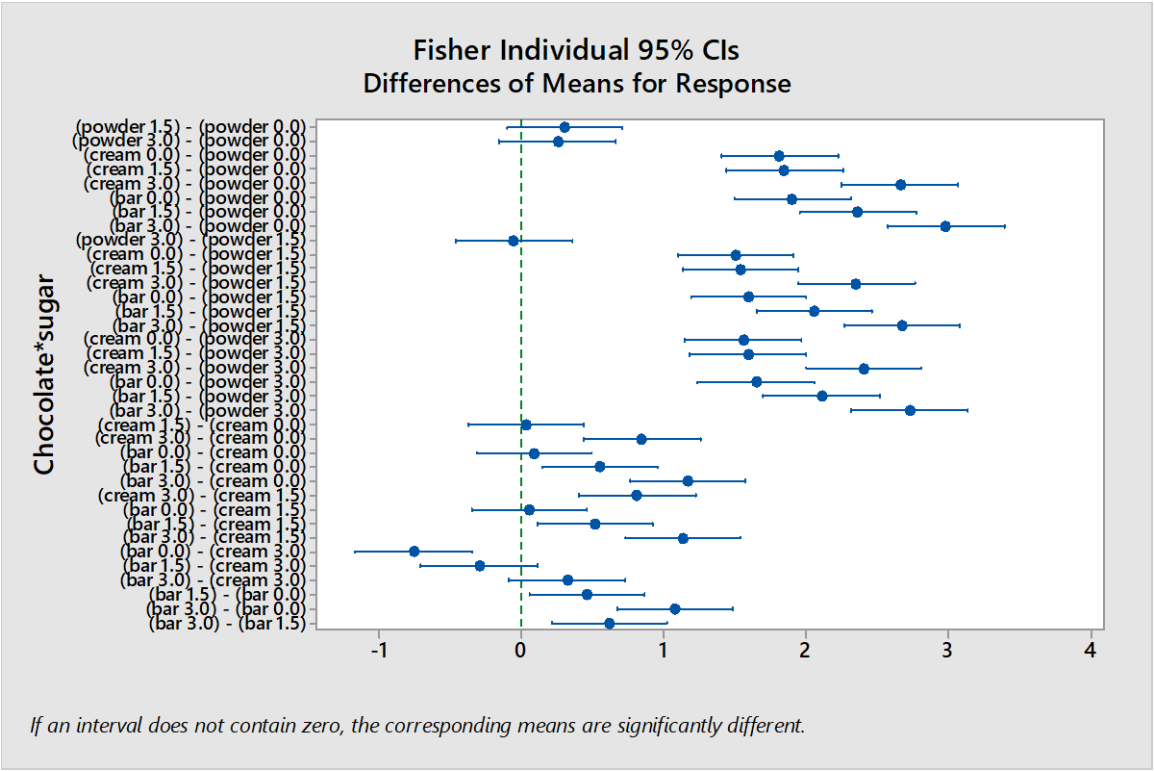
(skim 3.0) – (Almond 1.5) → 1.000 (Whole 0.0) – (Almond 3.0) → 1.000

(skim 1.5) – (Almond 3.0) → 0.116 (skim 3.0) – (Almond 3.0) → 1.000

(skim 1.5) – (Whole 0.0) → 0.197 (Whole 3.0) – (Whole 1.5) → 0.168

(skim 1.5) – (skim 0.0) → 0.689 (skim 3.0) – (skim 1.5) → 0.228

These comparisons are not statistically significant at the 99.77% confidence level, meaning there is no strong evidence of a difference in means for these Milk*Sugar combinations.



Fisher Pairwise Comparisons: Response = Response, Term = Chocolate*sugar

Grouping Information Using Fisher LSD Method and 95% Confidence

Chocolate*sugar	N	Mean	Grouping
bar 3.0	6	5.82333	A
cream 3.0	6	5.50167	A B
bar 1.5	6	5.20667	B
bar 0.0	6	4.74500	C
cream 1.5	6	4.68833	C
cream 0.0	6	4.65500	C
powder 1.5	6	3.14833	D
powder 3.0	6	3.09667	D
powder 0.0	6	2.84167	D

Means that do not share a letter are significantly different.

The Fisher LSD analysis for Chocolate*Sugar combinations shows that bar chocolate with high sugar (3.0) yields the highest mean response, forming group A. In contrast, powder chocolate at all sugar levels ranks lowest in group D. Most comparisons are statistically significant, highlighting that both chocolate type and sugar content strongly influence preferences.

Difference of Chocolate*sugar Levels	Difference of Means	SE of Difference	Individual 95% CI		T-Value	P-Value
(powder 1.5) - (powder 0.0)	0.307	0.199	(-0.101,	0.714)	1.54	0.134
(powder 3.0) - (powder 0.0)	0.255	0.199	(-0.152,	0.662)	1.28	0.210
(cream 0.0) - (powder 0.0)	1.813	0.199	(1.406,	2.221)	9.13	0.000
(cream 1.5) - (powder 0.0)	1.847	0.199	(1.439,	2.254)	9.30	0.000
(cream 3.0) - (powder 0.0)	2.660	0.199	(2.253,	3.067)	13.40	0.000
(bar 0.0) - (powder 0.0)	1.903	0.199	(1.496,	2.311)	9.59	0.000
(bar 1.5) - (powder 0.0)	2.365	0.199	(1.958,	2.772)	11.91	0.000
(bar 3.0) - (powder 0.0)	2.982	0.199	(2.574,	3.389)	15.02	0.000
(powder 3.0) - (powder 1.5)	-0.052	0.199	(-0.459,	0.356)	-0.26	0.797
(cream 0.0) - (powder 1.5)	1.507	0.199	(1.099,	1.914)	7.59	0.000
(cream 1.5) - (powder 1.5)	1.540	0.199	(1.133,	1.947)	7.76	0.000
(cream 3.0) - (powder 1.5)	2.353	0.199	(1.946,	2.761)	11.85	0.000
(bar 0.0) - (powder 1.5)	1.597	0.199	(1.189,	2.004)	8.04	0.000
(bar 1.5) - (powder 1.5)	2.058	0.199	(1.651,	2.466)	10.37	0.000
(bar 3.0) - (powder 1.5)	2.675	0.199	(2.268,	3.082)	13.47	0.000
(cream 0.0) - (powder 3.0)	1.558	0.199	(1.151,	1.966)	7.85	0.000
(cream 1.5) - (powder 3.0)	1.592	0.199	(1.184,	1.999)	8.02	0.000
(cream 3.0) - (powder 3.0)	2.405	0.199	(1.998,	2.812)	12.11	0.000
(bar 0.0) - (powder 3.0)	1.648	0.199	(1.241,	2.056)	8.30	0.000
(bar 1.5) - (powder 3.0)	2.110	0.199	(1.703,	2.517)	10.63	0.000
(bar 3.0) - (powder 3.0)	2.727	0.199	(2.319,	3.134)	13.73	0.000
(cream 1.5) - (cream 0.0)	0.033	0.199	(-0.374,	0.441)	0.17	0.868
(cream 3.0) - (cream 0.0)	0.847	0.199	(0.439,	1.254)	4.26	0.000
(bar 0.0) - (cream 0.0)	0.090	0.199	(-0.317,	0.497)	0.45	0.654
(bar 1.5) - (cream 0.0)	0.552	0.199	(0.144,	0.959)	2.78	0.010
(bar 3.0) - (cream 0.0)	1.168	0.199	(0.761,	1.576)	5.88	0.000
(cream 3.0) - (cream 1.5)	0.813	0.199	(0.406,	1.221)	4.10	0.000
(bar 0.0) - (cream 1.5)	0.057	0.199	(-0.351,	0.464)	0.29	0.778
(bar 1.5) - (cream 1.5)	0.518	0.199	(0.111,	0.926)	2.61	0.015
(bar 3.0) - (cream 1.5)	1.135	0.199	(0.728,	1.542)	5.72	0.000
(bar 0.0) - (cream 3.0)	-0.757	0.199	(-1.164,	-0.349)	-3.81	0.001
(bar 1.5) - (cream 3.0)	-0.295	0.199	(-0.702,	0.112)	-1.49	0.149
(bar 3.0) - (cream 3.0)	0.322	0.199	(-0.086,	0.729)	1.62	0.117
(bar 1.5) - (bar 0.0)	0.462	0.199	(0.054,	0.869)	2.33	0.028
(bar 3.0) - (bar 0.0)	1.078	0.199	(0.671,	1.486)	5.43	0.000
(bar 3.0) - (bar 1.5)	0.617	0.199	(0.209,	1.024)	3.11	0.004

Simultaneous confidence level = 47.64%

(powder 1.5) – (powder 0.0) → 0.134 (powder 3.0) – (powder 0.0) → 0.210

(powder 3.0) – (powder 1.5) → 0.797 (cream 1.5) – (cream 0.0) → 0.868

(bar 0.0) – (cream 1.5) → 0.778 (bar 1.5) – (cream 1.5) → 0.715

(bar 1.5) – (cream 3.0) → 0.149 (bar 3.0) – (cream 3.0) → 0.117

These comparisons are not statistically significant at the 95% level, suggesting that the observed differences in means between these chocolate and sugar combinations may be due to random variation.

Grouping Information Using Fisher LSD Method and 95% Confidence

Milk*Chocolate*sugar	N	Mean	Grouping												
Whole bar 3.0	2	6.635	A												
Whole bar 1.5	2	6.065	A	B											
Whole cream 3.0	2	6.035	A	B											
Almond cream 3.0	2	5.775		B	C										
Almond bar 3.0	2	5.760		B	C	D									
Whole bar 0.0	2	5.645		B	C	D	E								
Whole cream 1.5	2	5.480		B	C	D	E								
Whole cream 0.0	2	5.115			C	D	E	F							
skim bar 3.0	2	5.075			C	D	E	F							
Almond cream 0.0	2	5.055				D	E	F							
Almond bar 1.5	2	5.045					E	F							
skim cream 3.0	2	4.695						F	G						
Almond bar 0.0	2	4.585						F	G						
Almond cream 1.5	2	4.520						F	G						
skim bar 1.5	2	4.510						F	G						
Whole powder 3.0	2	4.280							G	H					
skim cream 1.5	2	4.065							G	H	I				
skim bar 0.0	2	4.005							G	H	I				
skim cream 0.0	2	3.795								H	I	J			
Whole powder 1.5	2	3.750								H	I	J			
Almond powder 0.0	2	3.555									I	J	K		
skim powder 3.0	2	3.280										J	K	L	
skim powder 1.5	2	2.920											K	L	M
Almond powder 1.5	2	2.775												L	M
skim powder 0.0	2	2.630												L	M
Whole powder 0.0	2	2.340													M
Almond powder 3.0	2	1.730													N

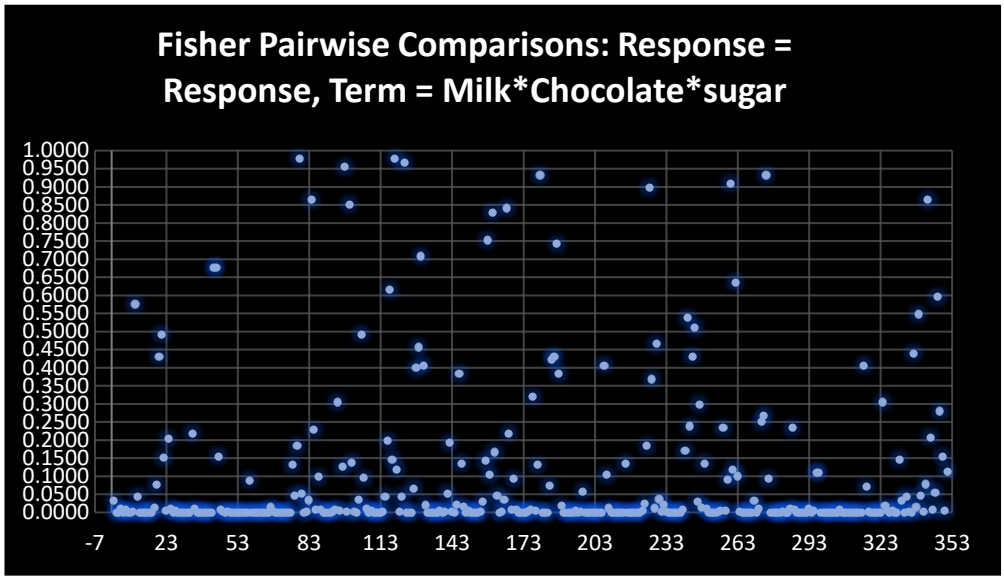
Means that do not share a letter are significantly different.

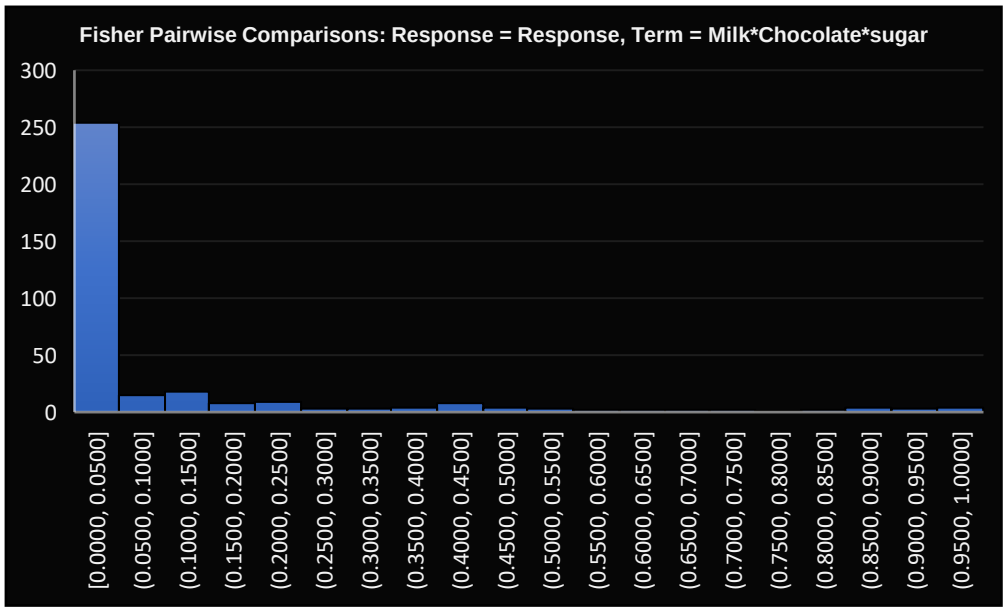
Whole bar 3.0 has the highest mean and forms its own group, indicating the best performance. Combinations with whole milk and higher sugar score significantly better. Lower means are seen in almond or skim milk with powder chocolate. Overall, chocolate type, milk type, and sugar level strongly influence responses.

Milk*Chocolate*sugar

Difference of Milk*Chocolate*sugar Levels	P-Value
(Almond powder 1.5) - (Almond powder 0.0)	0.032
(Almond powder 3.0) - (Almond powder 0.0)	0.000
(Almond cream 0.0) - (Almond powder 0.0)	0.000
(Almond cream 1.5) - (Almond powder 0.0)	0.009
(Almond cream 3.0) - (Almond powder 0.0)	0.000
(Almond bar 0.0) - (Almond powder 0.0)	0.006
(Almond bar 1.5) - (Almond powder 0.0)	0.000
(Almond bar 3.0) - (Almond powder 0.0)	0.000
(Whole powder 0.0) - (Almond powder 0.0)	0.001
(Whole powder 1.5) - (Almond powder 0.0)	0.575
(Whole powder 3.0) - (Almond powder 0.0)	0.044
(Whole cream 0.0) - (Almond powder 0.0)	0.000
(Whole cream 1.5) - (Almond powder 0.0)	0.000
(Whole cream 3.0) - (Almond powder 0.0)	0.000
(Whole bar 0.0) - (Almond powder 0.0)	0.000
(Whole bar 1.5) - (Almond powder 0.0)	0.000
(Whole bar 3.0) - (Almond powder 0.0)	0.000
(skim powder 0.0) - (Almond powder 0.0)	0.012
(skim powder 1.5) - (Almond powder 0.0)	0.076
(skim powder 3.0) - (Almond powder 0.0)	0.431
(skim cream 0.0) - (Almond powder 0.0)	0.491
(skim cream 1.5) - (Almond powder 0.0)	0.150
(skim cream 3.0) - (Almond powder 0.0)	0.003
(skim bar 0.0) - (Almond powder 0.0)	0.202
(skim bar 1.5) - (Almond powder 0.0)	0.010
(skim bar 3.0) - (Almond powder 0.0)	0.000
(Almond powder 3.0) - (Almond powder 1.5)	0.005
(Almond cream 0.0) - (Almond powder 1.5)	0.000
(Almond cream 1.5) - (Almond powder 1.5)	0.000
(Almond cream 3.0) - (Almond powder 1.5)	0.000
(Almond bar 0.0) - (Almond powder 1.5)	0.000
(Almond bar 1.5) - (Almond powder 1.5)	0.000
(Almond bar 3.0) - (Almond powder 1.5)	0.000
(Whole powder 0.0) - (Almond powder 1.5)	0.217
(Whole powder 1.5) - (Almond powder 1.5)	0.009
(Whole powder 3.0) - (Almond powder 1.5)	0.000
(Whole cream 0.0) - (Almond powder 1.5)	0.000
(Whole cream 1.5) - (Almond powder 1.5)	0.000
(Whole cream 3.0) - (Almond powder 1.5)	0.000
(Whole bar 0.0) - (Almond powder 1.5)	0.000
(Whole bar 1.5) - (Almond powder 1.5)	0.000
(Whole bar 3.0) - (Almond powder 1.5)	0.000
(skim powder 0.0) - (Almond powder 1.5)	0.677
(skim powder 1.5) - (Almond powder 1.5)	0.677
(skim powder 3.0) - (Almond powder 1.5)	0.154
(skim cream 0.0) - (Almond powder 1.5)	0.006
(skim cream 1.5) - (Almond powder 1.5)	0.001
(skim cream 3.0) - (Almond powder 1.5)	0.000
(skim bar 0.0) - (Almond powder 1.5)	0.001
(skim bar 1.5) - (Almond powder 1.5)	0.000
(skim bar 3.0) - (Almond powder 1.5)	0.000
(Almond cream 0.0) - (Almond powder 3.0)	0.000
(Almond cream 1.5) - (Almond powder 3.0)	0.000
(Almond cream 3.0) - (Almond powder 3.0)	0.000
(Almond bar 0.0) - (Almond powder 3.0)	0.000
(Almond bar 1.5) - (Almond powder 3.0)	0.000
(Almond bar 3.0) - (Almond powder 3.0)	0.000
(Whole powder 0.0) - (Almond powder 3.0)	0.087
(Whole powder 1.5) - (Almond powder 3.0)	0.000
(Whole powder 3.0) - (Almond powder 3.0)	0.000
(Whole cream 0.0) - (Almond powder 3.0)	0.000
(Whole cream 1.5) - (Almond powder 3.0)	0.000
(Whole cream 3.0) - (Almond powder 3.0)	0.000
(Whole bar 0.0) - (Almond powder 3.0)	0.000
(Whole bar 1.5) - (Almond powder 3.0)	0.000
(Whole bar 3.0) - (Almond powder 3.0)	0.000
(skim powder 0.0) - (Almond powder 3.0)	0.014
(skim powder 1.5) - (Almond powder 3.0)	0.002
(skim powder 3.0) - (Almond powder 3.0)	0.000
(skim cream 0.0) - (Almond powder 3.0)	0.000
(skim cream 1.5) - (Almond powder 3.0)	0.000
(skim cream 3.0) - (Almond powder 3.0)	0.000
(skim bar 0.0) - (Almond powder 3.0)	0.000
(skim bar 1.5) - (Almond powder 3.0)	0.000
(skim bar 3.0) - (Almond powder 3.0)	0.000
(Almond cream 1.5) - (Almond cream 0.0)	0.131
(Almond cream 3.0) - (Almond cream 0.0)	0.046
(Almond bar 0.0) - (Almond cream 0.0)	0.183
(Almond bar 1.5) - (Almond cream 0.0)	0.977
(Almond bar 3.0) - (Almond cream 0.0)	0.050
(Whole powder 0.0) - (Almond cream 0.0)	0.000
(Whole powder 1.5) - (Almond cream 0.0)	0.001
(Whole powder 3.0) - (Almond cream 0.0)	0.033
(Whole cream 0.0) - (Almond cream 0.0)	0.863
(Whole cream 1.5) - (Almond cream 0.0)	0.227
(Whole cream 3.0) - (Almond cream 0.0)	0.008
(Whole bar 0.0) - (Almond cream 0.0)	0.098
(Whole bar 1.5) - (Almond cream 0.0)	0.007
(Whole bar 3.0) - (Almond cream 0.0)	0.000
(skim powder 0.0) - (Almond cream 0.0)	0.000
(skim powder 1.5) - (Almond cream 0.0)	0.000
(skim powder 3.0) - (Almond cream 0.0)	0.000
(skim cream 0.0) - (Almond cream 0.0)	0.001
(skim cream 1.5) - (Almond cream 0.0)	0.008
(skim cream 3.0) - (Almond cream 0.0)	0.001
(skim bar 0.0) - (Almond cream 0.0)	0.304
(skim bar 1.5) - (Almond cream 0.0)	0.005
(skim bar 3.0) - (Almond cream 0.0)	0.125
(Almond cream 3.0) - (Almond cream 1.5)	0.954
(Almond bar 0.0) - (Almond cream 1.5)	0.001
(Almond bar 1.5) - (Almond cream 1.5)	0.851
(Almond bar 3.0) - (Almond cream 1.5)	0.138
(Whole powder 0.0) - (Almond cream 1.5)	0.001
(Whole powder 1.5) - (Almond cream 1.5)	0.000
(Whole powder 3.0) - (Almond cream 1.5)	0.034
(Whole cream 0.0) - (Almond cream 1.5)	0.491
(Whole cream 1.5) - (Almond cream 1.5)	0.095
(Whole cream 3.0) - (Almond cream 1.5)	0.010
(Whole bar 0.0) - (Almond cream 1.5)	0.000
(Whole bar 1.5) - (Almond cream 1.5)	0.003
(Whole bar 3.0) - (Almond cream 1.5)	0.000
(skim powder 0.0) - (Almond cream 1.5)	0.000
(skim powder 1.5) - (Almond cream 1.5)	0.000
(skim powder 3.0) - (Almond cream 1.5)	0.000
(skim cream 0.0) - (Almond cream 1.5)	0.001
(skim cream 1.5) - (Almond cream 1.5)	0.044
(skim cream 3.0) - (Almond cream 1.5)	0.197
(skim bar 0.0) - (Almond cream 1.5)	0.615
(skim bar 1.5) - (Almond cream 1.5)	0.146
(skim bar 3.0) - (Almond cream 1.5)	0.977
(Almond bar 0.0) - (Almond cream 3.0)	0.118
(Almond bar 1.5) - (Almond cream 3.0)	0.002
(Almond bar 3.0) - (Almond cream 3.0)	0.043
(Whole powder 0.0) - (Almond cream 3.0)	0.966
(Whole powder 1.5) - (Almond cream 3.0)	0.000
(Whole powder 3.0) - (Almond cream 3.0)	0.000
(Whole cream 0.0) - (Almond cream 3.0)	0.000
(Whole cream 1.5) - (Almond cream 3.0)	0.066
(Whole cream 3.0) - (Almond cream 3.0)	0.399
(Whole bar 0.0) - (Almond cream 3.0)	0.456
(Whole bar 1.5) - (Almond cream 3.0)	0.708
(Whole bar 3.0) - (Almond cream 3.0)	0.406
(skim powder 0.0) - (Almond cream 3.0)	0.019
(skim powder 1.5) - (Almond cream 3.0)	0.000
(skim powder 3.0) - (Almond cream 3.0)	0.000
(skim cream 0.0) - (Almond cream 3.0)	0.000
(skim cream 1.5) - (Almond cream 3.0)	0.000
(skim cream 3.0) - (Almond cream 3.0)	0.000
(skim bar 0.0) - (Almond cream 3.0)	0.004
(skim bar 1.5) - (Almond cream 3.0)	0.000
(skim bar 3.0) - (Almond cream 3.0)	0.001
(Almond bar 1.5) - (Almond bar 0.0)	0.052
(Almond bar 3.0) - (Almond bar 0.0)	0.192
(Whole powder 0.0) - (Almond bar 0.0)	0.002
(Whole powder 1.5) - (Almond bar 0.0)	0.000
(Whole powder 3.0) - (Almond bar 0.0)	0.022
(Whole cream 0.0) - (Almond bar 0.0)	0.383
(Whole cream 1.5) - (Almond bar 0.0)	0.135
(Whole cream 3.0) - (Almond bar 0.0)	0.015
(Whole bar 0.0) - (Almond bar 0.0)	0.000
(Whole bar 1.5) - (Almond bar 0.0)	0.005
(Whole bar 3.0) - (Almond bar 0.0)	0.000
(skim powder 0.0) - (Almond bar 0.0)	0.000
(skim powder 1.5) - (Almond bar 0.0)	0.000
(skim powder 3.0) - (Almond bar 0.0)	0.001
(skim cream 0.0) - (Almond bar 0.0)	0.030
(skim cream 1.5) - (Almond bar 0.0)	0.142
(skim cream 3.0) - (Almond bar 0.0)	0.752
(skim bar 0.0) - (Almond bar 0.0)	0.103
(skim bar 1.5) - (Almond bar 0.0)	0.829
(skim bar 3.0) - (Almond bar 0.0)	0.166
(Almond bar 3.0) - (Almond bar 1.5)	0.047
(Whole powder 0.0) - (Almond bar 1.5)	0.000
(Whole powder 1.5) - (Almond bar 1.5)	0.001
(Whole powder 3.0) - (Almond bar 1.5)	0.035
(Whole cream 0.0) - (Almond bar 1.5)	0.840
(Whole cream 1.5) - (Almond bar 1.5)	0.217
(Whole cream 3.0) - (Almond bar 1.5)	0.008
(Whole bar 0.0) - (Almond bar 1.5)	0.092
(Whole bar 1.5) - (Almond bar 1.5)	0.006
(Whole bar 3.0) - (Almond bar 1.5)	0.000
(skim powder 0.0) - (Almond bar 1.5)	0.000
(skim powder 1.5) - (Almond bar 1.5)	0.000
(skim powder 3.0) - (Almond bar 1.5)	0.000
(skim cream 0.0) - (Almond bar 1.5)	0.001
(skim cream 1.5) - (Almond bar 1.5)	0.008
(skim cream 3.0) - (Almond bar 1.5)	0.318
(skim bar 0.0) - (Almond bar 1.5)	0.005
(skim bar 1.5) - (Almond bar 1.5)	0.131
(skim bar 3.0) - (Almond bar 1.5)	0.931
(Whole powder 0.0) - (Almond bar 3.0)	0.000
(Whole powder 1.5) - (Almond bar 3.0)	0.000
(Whole powder 3.0) - (Almond bar 3.0)	0.000
(Whole cream 0.0) - (Almond bar 3.0)	0.072
(Whole cream 1.5) - (Almond bar 3.0)	0.423
(Whole cream 3.0) - (Almond bar 3.0)	0.431
(Whole bar 0.0) - (Almond bar 3.0)	0.741
(Whole bar 1.5) - (Almond bar 3.0)	0.383
(Whole bar 3.0) - (Almond bar 3.0)	0.017
(skim powder 0.0) - (Almond bar 3.0)	0.000
(skim powder 1.5) - (Almond bar 3.0)	0.000
(skim powder 3.0) - (Almond bar 3.0)	0.000
(skim cream 0.0) - (Almond bar 3.0)	0.000
(skim cream 1.5) - (Almond bar 3.0)	0.000
(skim cream 3.0) - (Almond bar 3.0)	0.005
(skim bar 0.0) - (Almond bar 3.0)	0.000
(skim bar 1.5) - (Almond bar 3.0)	0.001
(skim bar 3.0) - (Almond bar 3.0)	0.057
(Whole powder 1.5) - (Whole powder 0.0)	0.000
(Whole powder 3.0) - (Whole powder 0.0)	0.000
(Whole cream 0.0) - (Whole powder 0.0)	0.000
(Whole cream 1.5) - (Whole powder 0.0)	0.000
(Whole cream 3.0) - (Whole powder 0.0)	0.000
(Whole bar 0.0) - (Whole powder 0.0)	0.000
(Whole bar 1.5) - (Whole powder 0.0)	0.000
(Whole bar 3.0) - (Whole powder 0.0)	0.000
(skim powder 0.0) - (Whole powder 0.0)	0.406
(skim powder 1.5) - (Whole powder 0.0)	0.103
(skim powder 3.0) - (Whole powder 0.0)	0.011
(skim cream 0.0) - (Whole powder 0.0)	0.000
(skim cream 1.5) - (Whole powder 0.0)	0.000
(skim cream 3.0) - (Whole powder 0.0)	0.000
(skim bar 0.0) - (Whole powder 0.0)	0.000
(skim bar 1.5) - (Whole powder 0.0)	0.000
(skim bar 3.0) - (Whole powder 0.0)	0.000
(Whole powder 3.0) - (Whole powder 1.5)	0.135
(Whole cream 0.0) - (Whole powder 1.5)	0.000
(Whole cream 1.5) - (Whole powder 1.5)	0.000
(Whole cream 3.0) - (Whole powder 1.5)	0.000
(Whole bar 0.0) - (Whole powder 1.5)	0.000
(Whole bar 1.5) - (Whole powder 1.5)	0.000
(Whole bar 3.0) - (Whole powder 1.5)	0.000
(skim powder 0.0) - (Whole powder 1.5)	0.003
(skim powder 1.5) - (Whole powder 1.5)	0.023
(skim powder 3.0) - (Whole powder 1.5)	0.183
(skim cream 0.0) - (Whole powder 1.5)	0.897
(skim cream 1.5) - (Whole powder 1.5)	0.368
(skim cream 3.0) - (Whole powder 1.5)	0.011
(skim bar 0.0) - (Whole powder 1.5)	0.465
(skim bar 1.5) - (Whole powder 1.5)	0.036
(skim bar 3.0) - (Whole powder 1.5)	0.001
(Whole cream 0.0) - (Whole powder 3.0)	0.022
(Whole cream 1.5) - (Whole powder 3.0)	0.002
(Whole cream 3.0) - (Whole powder 3.0)	0.000
(Whole bar 0.0) - (Whole powder 3.0)	0.000
(Whole bar 1.5) - (Whole powder 3.0)	0.000
(Whole bar 3.0) - (Whole powder 3.0)	0.000
(skim powder 0.0) - (Whole powder 3.0)	0.000
(skim powder 1.5) - (Whole powder 3.0)	0.000
(skim powder 3.0) - (Whole powder 3.0)	0.007
(skim cream 0.0) - (Whole powder 3.0)	0.170
(skim cream 1.5) - (Whole powder 3.0)	0.537
(skim cream 3.0) - (Whole powder 3.0)	0.238
(skim bar 0.0) - (Whole powder 3.0)	0.431
(skim bar 1.5) - (Whole powder 3.0)	0.509
(skim bar 3.0) - (Whole powder 3.0)	0.029
(Whole cream 1.5) - (Whole cream 0.0)	0.298
(Whole cream 3.0) - (Whole cream 0.0)	0.013
(Whole bar 0.0) - (Whole cream 0.0)	0.135
(Whole bar 1.5) - (Whole cream 0.0)	0.010
(Whole bar 3.0) - (Whole cream 0.0)	0.000
(skim powder 0.0) - (Whole cream 0.0)	0.000

(skim powder 1.5) - (Whole cream 0.0)	0.000	(skim bar 1.5) - (Whole bar 0.0)	0.003
(skim powder 3.0) - (Whole cream 0.0)	0.000	(skim bar 3.0) - (Whole bar 0.0)	0.109
(skim cream 0.0) - (Whole cream 0.0)	0.001	(Whole bar 3.0) - (Whole bar 1.5)	0.109
(skim cream 1.5) - (Whole cream 0.0)	0.005	(skim powder 0.0) - (Whole bar 1.5)	0.000
(skim cream 3.0) - (Whole cream 0.0)	0.233	(skim powder 1.5) - (Whole bar 1.5)	0.000
(skim bar 0.0) - (Whole cream 0.0)	0.003	(skim powder 3.0) - (Whole bar 1.5)	0.000
(skim bar 1.5) - (Whole cream 0.0)	0.090	(skim cream 0.0) - (Whole bar 1.5)	0.000
(skim bar 3.0) - (Whole cream 0.0)	0.908	(skim cream 1.5) - (Whole bar 1.5)	0.000
(Whole cream 3.0) - (Whole cream 1.5)	0.118	(skim cream 3.0) - (Whole bar 1.5)	0.000
(Whole bar 0.0) - (Whole cream 1.5)	0.635	(skim bar 0.0) - (Whole bar 1.5)	0.000
(Whole bar 1.5) - (Whole cream 1.5)	0.100	(skim bar 1.5) - (Whole bar 1.5)	0.000
(Whole bar 3.0) - (Whole cream 1.5)	0.002	(skim bar 3.0) - (Whole bar 1.5)	0.008
(skim powder 0.0) - (Whole cream 1.5)	0.000	(skim powder 0.0) - (Whole bar 3.0)	0.000
(skim powder 1.5) - (Whole cream 1.5)	0.000	(skim powder 1.5) - (Whole bar 3.0)	0.000
(skim powder 3.0) - (Whole cream 1.5)	0.000	(skim powder 3.0) - (Whole bar 3.0)	0.000
(skim cream 0.0) - (Whole cream 1.5)	0.000	(skim cream 0.0) - (Whole bar 3.0)	0.000
(skim cream 1.5) - (Whole cream 1.5)	0.000	(skim cream 1.5) - (Whole bar 3.0)	0.000
(skim cream 3.0) - (Whole cream 1.5)	0.031	(skim cream 3.0) - (Whole bar 3.0)	0.000
(skim bar 0.0) - (Whole cream 1.5)	0.000	(skim bar 0.0) - (Whole bar 3.0)	0.000
(skim bar 1.5) - (Whole cream 1.5)	0.009	(skim bar 1.5) - (Whole bar 3.0)	0.000
(skim bar 3.0) - (Whole cream 1.5)	0.249	(skim bar 3.0) - (Whole bar 3.0)	0.000
(Whole bar 0.0) - (Whole cream 3.0)	0.267	(skim powder 1.5) - (skim powder 0.0)	0.406
(Whole bar 1.5) - (Whole cream 3.0)	0.931	(skim powder 3.0) - (skim powder 0.0)	0.070
(Whole bar 3.0) - (Whole cream 3.0)	0.092	(skim cream 0.0) - (skim powder 0.0)	0.002
(skim powder 0.0) - (Whole cream 3.0)	0.000	(skim cream 1.5) - (skim powder 0.0)	0.000
(skim powder 1.5) - (Whole cream 3.0)	0.000	(skim cream 3.0) - (skim powder 0.0)	0.000
(skim powder 3.0) - (Whole cream 3.0)	0.000	(skim bar 0.0) - (skim powder 0.0)	0.000
(skim cream 0.0) - (Whole cream 3.0)	0.000	(skim bar 1.5) - (skim powder 0.0)	0.000
(skim cream 1.5) - (Whole cream 3.0)	0.000	(skim bar 3.0) - (skim powder 0.0)	0.000
(skim cream 3.0) - (Whole cream 3.0)	0.001	(skim powder 3.0) - (skim powder 1.5)	0.304
(skim bar 0.0) - (Whole cream 3.0)	0.000	(skim cream 0.0) - (skim powder 1.5)	0.017
(skim bar 1.5) - (Whole cream 3.0)	0.000	(skim cream 1.5) - (skim powder 1.5)	0.003
(skim bar 3.0) - (Whole cream 3.0)	0.010	(skim cream 3.0) - (skim powder 1.5)	0.000
(Whole bar 1.5) - (Whole bar 0.0)	0.233	(skim bar 0.0) - (skim powder 1.5)	0.004
(Whole bar 3.0) - (Whole bar 0.0)	0.008	(skim bar 1.5) - (skim powder 1.5)	0.000
(skim powder 0.0) - (Whole bar 0.0)	0.000	(skim bar 3.0) - (skim powder 1.5)	0.000
(skim powder 1.5) - (Whole bar 0.0)	0.000	(skim cream 0.0) - (skim powder 3.0)	0.146
(skim powder 3.0) - (Whole bar 0.0)	0.000	(skim cream 1.5) - (skim powder 3.0)	0.031
(skim cream 0.0) - (Whole bar 0.0)	0.000	(skim cream 3.0) - (skim powder 3.0)	0.000
(skim cream 1.5) - (Whole bar 0.0)	0.000	(skim bar 0.0) - (skim powder 3.0)	0.044
(skim cream 3.0) - (Whole bar 0.0)	0.010	(skim bar 1.5) - (skim powder 3.0)	0.001
(skim bar 0.0) - (Whole bar 0.0)	0.000	(skim bar 3.0) - (skim powder 3.0)	0.000
(skim bar 0.0) - (skim powder 3.0)	0.044		
(skim bar 1.5) - (skim powder 3.0)	0.001		
(skim bar 3.0) - (skim powder 3.0)	0.000		
(skim cream 1.5) - (skim cream 0.0)	0.439		
(skim cream 3.0) - (skim cream 0.0)	0.014		
(skim bar 0.0) - (skim cream 0.0)	0.547		
(skim bar 1.5) - (skim cream 0.0)	0.047		
(skim bar 3.0) - (skim cream 0.0)	0.001		
(skim cream 3.0) - (skim cream 1.5)	0.078		
(skim bar 0.0) - (skim cream 1.5)	0.863		
(skim bar 1.5) - (skim cream 1.5)	0.207		
(skim bar 3.0) - (skim cream 1.5)	0.007		
(skim bar 0.0) - (skim cream 3.0)	0.055		
(skim bar 1.5) - (skim cream 3.0)	0.595		
(skim bar 3.0) - (skim cream 3.0)	0.279		
(skim bar 1.5) - (skim bar 0.0)	0.154		
(skim bar 3.0) - (skim bar 0.0)	0.004		
(skim bar 3.0) - (skim bar 1.5)	0.112		

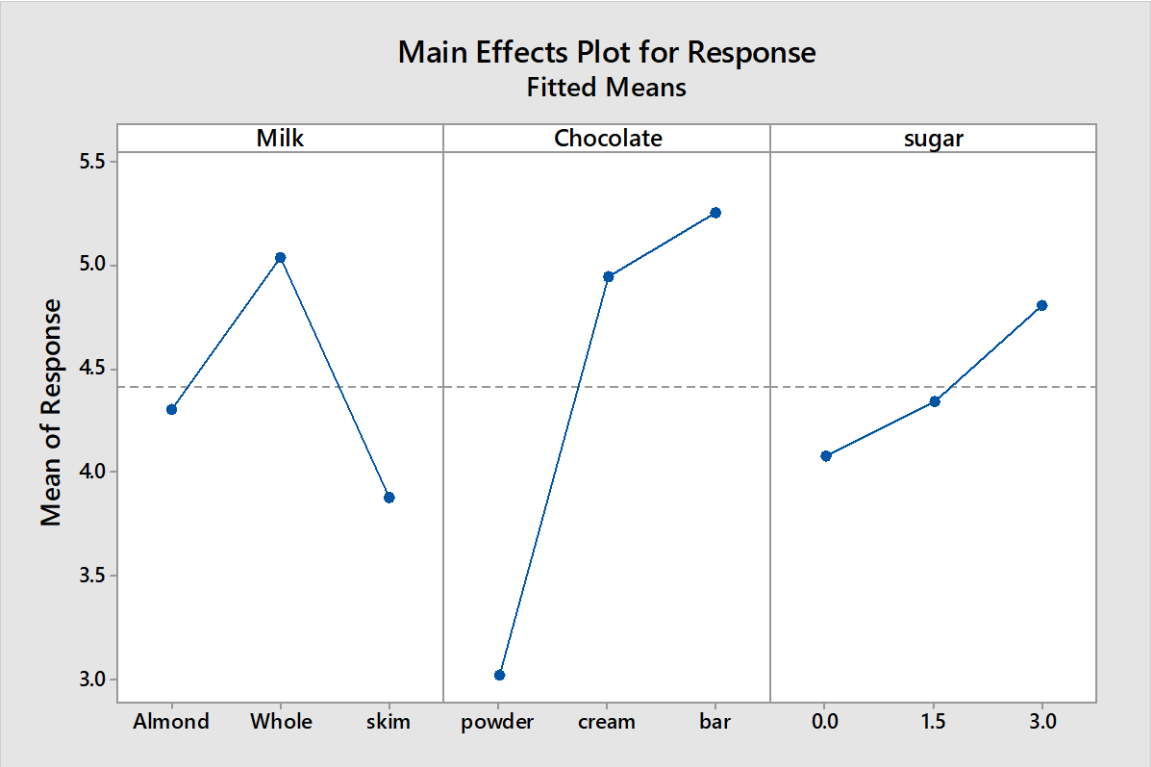




Our Fisher's LSD analysis revealed a high number of statistically significant pairwise differences ($p < 0.05$), validating the strength and sensitivity of our experiment. These results support specific product recommendations based on sugar preferences. For individuals who avoid sugar, almond cream, whole cream, and whole bar at 0.0 sugar level stand out with significant differences. For moderate sugar consumers (1.5), almond and whole-based options again show clear variations. Lastly, for those preferring high sweetness (3.0), skim and whole powders differ notably from cream variants. Overall, the test confirms that sugar level and formulation meaningfully impact product outcomes.

Comparison	P-Value
(Almond cream 0.0) - (Almond powder 0.0)	0.0000
(Whole cream 0.0) - (Almond powder 0.0)	0.0000
(Whole bar 0.0) - (Almond powder 0.0)	0.0000
(Almond cream 1.5) - (Almond powder 1.5)	0.0000
(Whole cream 1.5) - (Almond powder 1.5)	0.0000
(Whole bar 1.5) - (Almond powder 1.5)	0.0000
(Whole powder 3.0) - (Almond cream 3.0)	0.0000
(skim powder 3.0) - (Almond cream 3.0)	0.0000
(skim powder 3.0) - (Whole cream 3.0)	0.0000

8) Interaction Plot



Milk:

- Whole milk results in the highest mean response (above 5.0), indicating it is the most preferred milk type.

- Almond milk yields a moderate response.
- Skim milk has the lowest mean response, suggesting it is the least preferred among the three.

❖ The choice of milk has a clear impact on the response, with whole milk being significantly favored.

Chocolate:

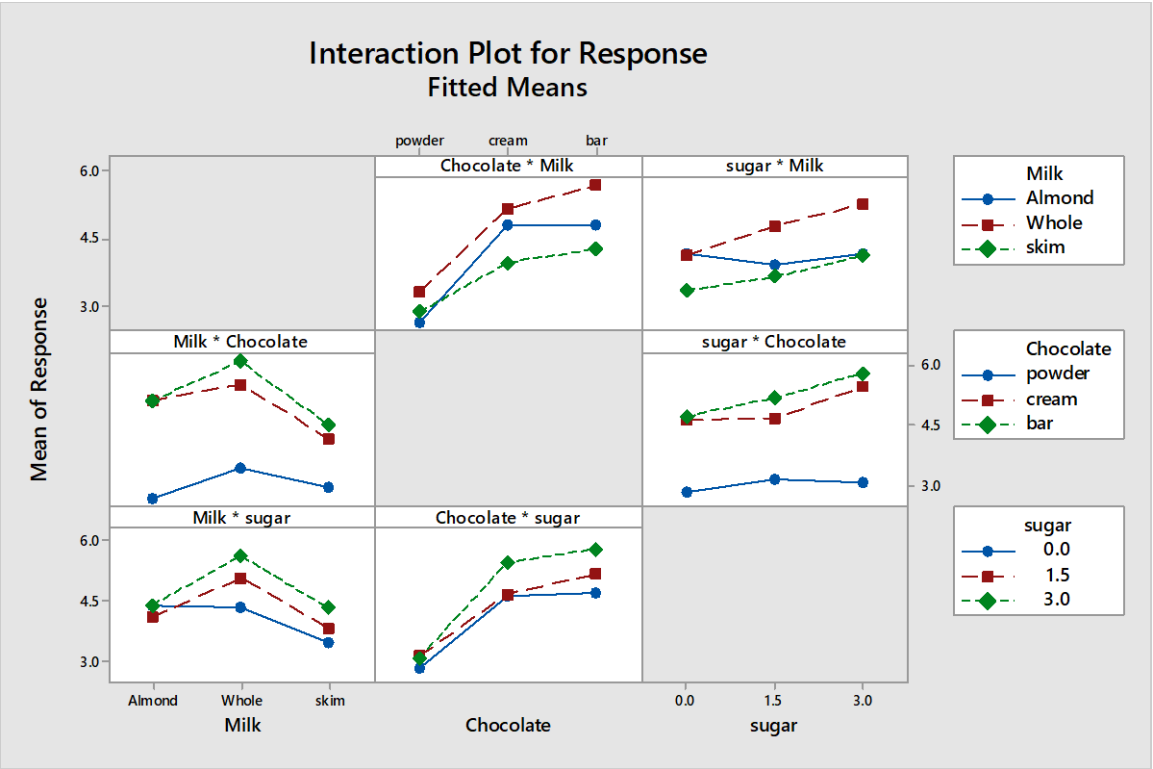
- Bar chocolate has the highest response meaning, followed closely by cream.
- Powder chocolate produces a much lower mean response, nearly 3.0.

❖ Chocolate type has the strongest effect on the response. The sharp rise from powder to cream and bar suggests consumers greatly prefer solid chocolate forms over powdered.

Sugar:

- As sugar content increases from 0.0 to 3.0, the mean response rises steadily.
- The line shows a positive trend, meaning higher sugar levels are associated with greater preference.

❖ Sugar level positively influences response, though the effect is more gradual than chocolate or milk type.



Chocolate × Milk Interaction

- The combination of whole milk and bar chocolate produces the highest response (~6.0).
- All milk types show increased response when moving from powder → cream → bar, but the effect is strongest for whole milk.
- Skim milk with chocolate powder yields the lowest response, confirming the weakness of this combination.

Sugar × Milk Interaction

- The whole milk shows a strong positive trend: higher sugar levels consistently increase response.
- For almond and skim milk, increasing sugar helps slightly but the overall response remains lower than whole milk.
- The lines are not parallel, indicating interaction exists—sugar affects each milk type differently.

Sugar × Chocolate Interaction

- As sugar increases from 0.0 → 3.0, responses rise for all chocolate types.
- Bar chocolate shows the highest improvement with sugar, followed by cream.
- Powder chocolate lags, even with increased sugar.

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9) Recommendations Based on Experiment Results

1. Prioritize Whole Milk in Product Formulations

- The whole milk consistently resulted in higher response scores, especially when combined with bar and cream chocolate.
- It should be the default base for high-preference products.

2. Use Bar or Cream Chocolate, Avoid Powder

- Bar chocolate received the highest overall ratings, followed closely by cream.
- Powder chocolate led to significantly lower responses, even when combined with favorable milk or sugar levels.

- Recommendation: Eliminate or reformulate powder chocolate options for premium products.

3. Increase Sugar Levels for Enhanced Preference

- Higher sugar levels (especially 3.0) increased mean responses across all milk and chocolate types.
- While moderation in sugar is important for health considerations, a balanced high-sugar variant can be a flagship offering.
- Recommendation: Offer tiered sugar options but highlight and market high-sugar combinations as the best-tasting variants.

4. Avoid Skim Milk and Powder Chocolate Combinations

- These combinations repeatedly resulted in the lowest consumer responses.
- Their continued use should be limited to cost-driven or low-calorie product lines, and not flagship offerings.

5. Leverage Interactions in Product Line Design

- Key interaction effects show that the impact of chocolate form is magnified when paired with whole milk.
- High-performing combinations:
  - Whole milk + Bar chocolate + Sugar 3.0
  - Whole milk + Cream chocolate + Sugar 3.0
  -

10) Final contributions

The successful execution of this project was the direct result of effective teamwork, strategic task delegation, and continuous communication among the three team members. From the planning phase through to the final report, each individual contributed their unique strengths and responsibilities, while also engaging collaboratively in all major decisions and deliverables.

- Feras Mohammad assumed responsibility for data organization and management. After the experimental phase, he meticulously entered and formatted the results in Microsoft Excel, ensuring all values were accurately recorded and clearly presented for analysis. His attention to detail in handling raw data was crucial for maintaining the integrity of the experiment and enabled smooth transitions into the statistical analysis phase.

- Abdulrahman Sallam oversaw the precise timing of the dripping process using a stopwatch, which was essential for capturing the viscosity of each hot chocolate sample. His role required a high level of consistency and focus, as the timing had to align perfectly with the physical dripping conducted by Emadeden. Abdulrahman also ensured that the measured times were correctly communicated to Feras for documentation, reinforcing the importance of real-time coordination and data accuracy.
- Emadeden Albaghdadi played a pivotal role in the hands-on execution of the Drip Time Method. He was responsible for preparing each hot chocolate sample by carefully measuring and mixing the exact quantities of milk, sugar, and chocolate required for each treatment. He also managed the physical measurement of the drip time by holding the spoon at a fixed angle, synchronizing closely with Abdulrahman's stopwatch to ensure precise timing. His consistency in sample preparation and execution contributed significantly to the reliability of the experiment.

Beyond these specific roles, the team worked collectively throughout the rest of the project. All members engaged deeply in the analysis of the data using Minitab, where they performed the ANOVA test, studied the main effects and interactions, and interpreted the statistical output together. These collaborative discussions were vital in understanding the significance of each factor (milk, chocolate, sugar) and their combined influence on the response variable. Moreover, the entire team participated equally in writing the report, constructing the case study, and developing visual plots to represent the data. They jointly interpreted graphs, wrote explanatory comments, and formulated evidence-based recommendations to guide future decision-makers. This unified approach fostered shared ownership of the content, leading to stronger alignment in conclusions and clearer communication of results.
Throughout the project, the group maintained a "3-in-1 teamwork model", meaning that although each member had designated responsibilities, everyone contributed to all phases—planning, experimentation, analysis, and reporting. This model ensured redundancy, reduced errors, and enhanced understanding for each aspect of the project. Regular face-to-face meetings and discussions played a crucial role in aligning interpretations and validating findings, especially during complex stages like interpreting interaction plots and verifying statistical outcomes.
In conclusion, the success of this project is a testament to the synergy, mutual support, and balanced workload achieved by the team. The combination of clear task distribution, shared

involvement in critical thinking, and a collaborative spirit allowed the group to deliver a comprehensive, accurate, and high-quality final report and presentation.

11) Conclusion

This study successfully demonstrated how the interplay of milk type, chocolate type, and sugar amount significantly influences the viscosity, measured as drip time, of hot chocolate. By employing a full factorial design and rigorously applying ANOVA and post-hoc tests (Tukey and Fisher LSD), the research established that each factor had a statistically significant main effect on the response variable. More importantly, the significant two-way and three-way interaction effects underscored that optimal viscosity results not from isolated factors but from specific combinations of ingredients.

The experimental findings consistently highlighted that the thickest and most preferred texture was achieved using whole milk, bar chocolate, and a high sugar level (3.0 spoons). In contrast, formulations involving skim or almond milk, powdered chocolate, and no sugar yielded the lowest viscosity values, thus being less desirable. These outcomes were verified through detailed statistical diagnostics, confirming the robustness and adequacy of the ANOVA model used.

The comprehensive statistical approach, combined with meticulous experimental design and execution, provided conclusive insights into how ingredient choices affect hot chocolate texture. The team's systematic methodology, collaborative execution, and joint analysis efforts not only ensured data reliability but also led to well-substantiated product development recommendations.

In essence, this project not only fulfilled its objective of identifying optimal ingredient combinations for a rich, thick hot chocolate but also served as an exemplary model of how factorial experimental design and teamwork can be effectively applied to real-world food product research.

THANK YOU