
Objective and Subjective Evaluation of Palatability for Almond Flour Brownies Made with Alternative Sweeteners.

— Jessica Luong and Rahyana Shahsamand —

Clinical Condition: Diabetes Type I and Type II

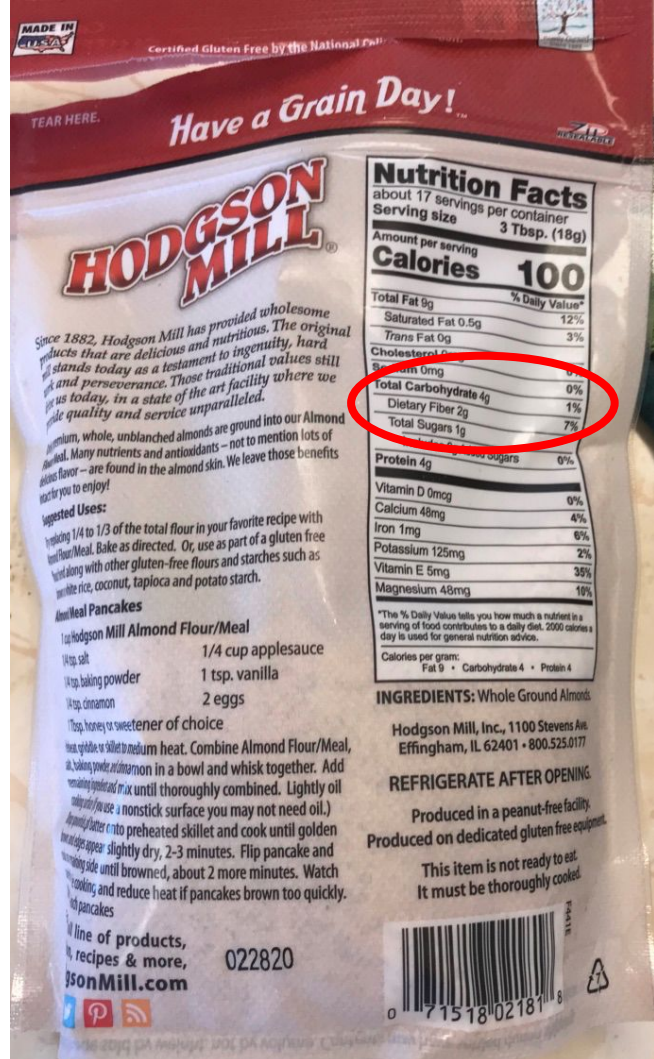
- Diabetes is one of the leading causes of death in the world
- Effects **insulin**
 - a hormone made by the pancreas that allows the body to utilize glucose from dietary CHO for energy or to store
 - CHO can cause blood sugar levels to quickly increase in diabetic individuals
 - Insulin helps keep blood sugar levels from getting too high or too low
- Type II diabetes is much more common than type I
 - According to the 2017 National Diabetes Statistics Report 30.3 million people in the U.S. have diabetes (that's 1 in 10 people)
 - 90-95% have Type II
- **Nutritional Management** is a vital part of treatment and controlling blood sugar levels
- Type I (Juvenile diabetes or Insulin-dependent diabetes)
 - The immune system attacks and destroys the insulin producing beta cells of the pancreas, thus body cannot produce insulin to metabolize CHO.
- Type II (Adult-onset or non-insulin-dependent diabetes)
 - The body produces insulin but is unable to use it effectively, insulin resistance.

Food Product: Almond Flour Brownies

Almond Flour Brownies v AP Flour Brownies

Flour	Serving	Calories	Carb (g)	Fiber (g)	Fat (g)	Protein (g)
All-purpose flour	¼ cup	120	24	1	0.5	4
Almond flour	¼ cup	160	6	3	14	6

- Almond meal is a low carb flour that will not make blood sugar levels rise to undesirable ranges
- Among alternative flours like coconut, chickpea or oat, almond flour has the **least total carbs**.
- Almond flour is **high in fiber** as compared to AP flour so it can help control blood sugar levels.
- Almonds also have a glycemic index of **0**.



Since 1882, Hodgson Mill has provided wholesome products that are delicious and nutritious. The original stands today as a testament to ingenuity, hard work, and perseverance. Those traditional values still live on today, in a state of the art facility where we provide quality and service unparalleled.

Almond meal, whole, unblanched almonds are ground into our Almond Flour/Meal. Many nutrients and antioxidants — not to mention lots of delicious flavor — are found in the almond skin. We leave those benefits intact for you to enjoy!

Suggested Uses:
 Incorporating 1/4 to 1/3 of the total flour in your favorite recipe with Almond Flour/Meal. Bake as directed. Or, use as part of a gluten free flour blend along with other gluten-free flours and starches such as brown rice, coconut, tapioca and potato starch.

Almond Meal Pancakes
 1 cup Hodgson Mill Almond Flour/Meal
 1/4 tsp. salt
 1/4 tsp. baking powder
 1/4 tsp. cinnamon
 2 tsp. honey or sweetener of choice
 1/2 cup applesauce
 1 tsp. vanilla
 2 eggs

Mix, right before or shortly before medium heat. Combine Almond Flour/Meal, salt, baking powder, and cinnamon in a bowl and whisk together. Add remaining ingredients and mix until thoroughly combined. Lightly oil a nonstick surface you may not need oil.) Preheat skillet and cook until golden brown on one side until browned, about 2 more minutes. Watch cooking, and reduce heat if pancakes brown too quickly. Flip pancakes.

Nutrition Facts	
about 17 servings per container	
Serving size 3 Tbsp. (18g)	
Amount per serving	
Calories	100
Total Fat 8g	% Daily Value*
Saturated Fat 0.5g	12%
Trans Fat 0g	3%
Cholesterol 0g	0%
Sodium 0mg	0%
Total Carbohydrate 4g	0%
Dietary Fiber 2g	1%
Total Sugars 1g	7%
Protein 4g	8%
Vitamin D 0mcg	0%
Calcium 48mg	4%
Iron 1mg	6%
Potassium 125mg	2%
Vitamin E 5mg	36%
Magnesium 48mg	16%

*The % Daily Value tells you how much a nutrient in a serving of food contributes to a daily diet. 2000 calories a day is used for general nutrition advice.

Calories per gram:
 Fat 9 • Carbohydrate 4 • Protein 4

INGREDIENTS: Whole Ground Almonds
 Hodgson Mill, Inc., 1100 Stevens Ave.
 Effingham, IL 62401 • 800.525.0177

REFRIGERATE AFTER OPENING.
 Produced in a peanut-free facility.
 Produced on dedicated gluten free equipment.

This item is not ready to eat.
 It must be thoroughly cooked.



022820

line of products,
 recipes & more,
 HodgsonMill.com



Control vs Experimental Variables

Ingredients:

- 1 ½ c almond flour
- 1 tsp baking powder
- 5 tbsp butter
- ¾ c cocoa powder
- 3 eggs
- ½ tsp salt
- 1 ¾ c sugar
- 1 tsp vanilla extract

Control

- 1 ¾ cup sugar → 1 ¼ cup sugar

Three **Variables**

- **Date Paste:** 1 ¼ c dates & 1 c water
- 1 ⅔ c **erythritol** → **xylitol**
- 1 ¼ c → ⅔ cup **monk fruit sweetener**

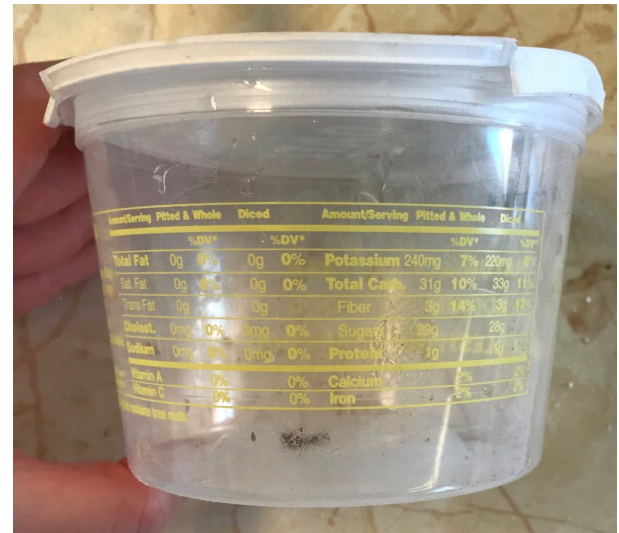
Granulated Sugar (Control)

- Simple CHO
 - Raises blood sugar levels very rapidly compared to complex CHO
- Higher amount of carbohydrates per serving
 - 4g per 1 tsp



Date Paste

- **High in fiber** → controls blood sugar levels
 - 5 dates=1.4 oz has 3 g fiber
- **Low glycemic index** of 42/100 as compared to granulated sugar which has GI of 65/100
- **Flavonoids** → antioxidant proposed as a functional food that can help manage blood glucose levels by improving glucose metabolism



Xylitol (sugar alcohol)

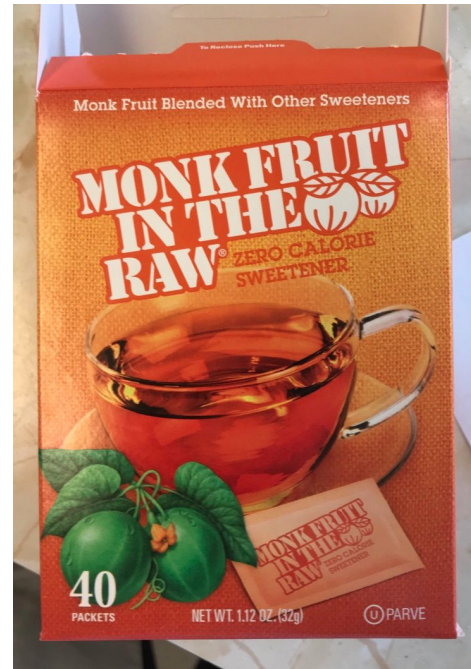
- Sugar alcohols do not raise blood sugar levels
- GI of 7/100 → does not spike blood sugar levels as high as sugar would
- Studies have shown that xylitol when substituted for sugar can
 - Decrease
 - Blood glucose levels
 - Body weight
 - Increase
 - Serum insulin concentration
 - Glucose tolerance



Monk Fruit Sweetener

- Also known as Luo Han Guo, it is made from the pulp of the gourd fruit that has been used in Traditional Chinese Medicine
- As recently as 2009 it has been permitted to be used in the U.S.
- Studies have shown mogroside, the active sweet substance, to
 - Stimulate secretion of insulin in beta cells of the pancreas
 - Body does not recognize monk fruit as a sweetener because mogroside is an antioxidant NOT sugar
- Zero GI

Zhou Y. *Insulin secretion stimulating effects of mogroside V and fruit extract of luo han kuo (Siraitia grosvenori Swingle) fruit extract* PubMed.gov



MONK FRUIT IN THE RAW® IS A PRODUCT OF
CUMBERLAND PACKING CORP.
2 CUMBERLAND ST., BROOKLYN, NY 11205 USA

Nutrition Facts

Serving Size 1 Packet (0.8g)
Servings Per Container 40

Amount Per Serving

Calories 0

	% Daily Value*
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Sodium 0mg	0%
Total Carbohydrate Less than 1g	0%
Sugars Less than 1g	

Protein 0g

Not a significant source of calories from fat, cholesterol, dietary fiber, vitamin A, vitamin C, calcium and iron.

*Percent Daily Values are based on a 2,000 calorie diet.

INGREDIENTS: Dextrose, Monk Fruit Extract

Monk Fruit is naturally sweeter than sugar. So, like many zero calorie sweeteners, it is blended with dextrose. This helps create the perfect balance of sweetness, making it easier to pour and measure.

SUITABLE FOR PEOPLE WITH DIABETES.

Each packet contains less than 3 calories per serving which the FDA considers dietetically zero.

Procedures

1. Preheat the oven to 350 F. Grease an 8" square pan.
2. In a medium sized bowl stir together melted butter, sugar (or sugar substitute), salt, vanilla extract, cocoa and eggs.
3. Stir in the almond flour and baking powder.
4. Pour the batter in the pre-greased pan.
5. Bake for 33 to 38 minutes or until a toothpick inserted at the center comes out clean.
6. Cool for 15 min before cutting into 2"-3" squares.

Equipment: 4 - medium-sized bowls, 4 - 8" square pans, measuring spoons and cups, saucepan, rubber spatula, whisk, 1-200 g scale, 1- knife, 1 - food processor, ruler, line-spread board and ring

Objective Evaluation Procedures

- **Density**
 - Measure the L X W X H of 3 - 3" brownie squares and take the average
 - Take the average mass of 3 - 3" brownies
 - $M/V=D$
- **Line spread test**
 - Perform line spread test for all 4 brownie batters to evaluate viscosity
- **Height**
 - Take the average height of 3 - 3" brownie squares



Sensory Evaluation: Sensory Ballot

SAMPLE 989

APPEARANCE (exterior)

How chocolate (color) is the sample?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1	2	3	4	5	6	7	8	9

TEXTURE

How chewy is the sample?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1	2	3	4	5	6	7	8	9

How thick (dense) is the sample?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1	2	3	4	5	6	7	8	9

How moist is the sample?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1	2	3	4	5	6	7	8	9

TASTE

How sweet is the sample?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1	2	3	4	5	6	7	8	9

FLAVOR

How chocolatey (flavor) is the sample?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1	2	3	4	5	6	7	8	9

OVERALL LIKING

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1	2	3	4	5	6	7	8	9

Comments:

Results



Control



Date Paste

Objective Results: Height



Height: Measure of Thickness		
Type of Sweetener	Height (3 stacked brownies)	Average
Sugar	9 cm	3 cm
Date Paste	8 cm	2.67 cm
Xylitol	7.7 cm	2.57 cm
Monk Fruit	8.3 cm	2.77 cm

Objective Results: Density

Density			
Type of Sweetener	Mass (g)	Volume (cm ³)	Density (g/cm ³)
Sugar	46, 42, 48	27	1.68
★ Date Paste	64, 67, 68	24.03	2.76
Xylitol	45, 46, 49	23.13	2.02
Monk Fruit	47, 48, 46	24.93	1.89

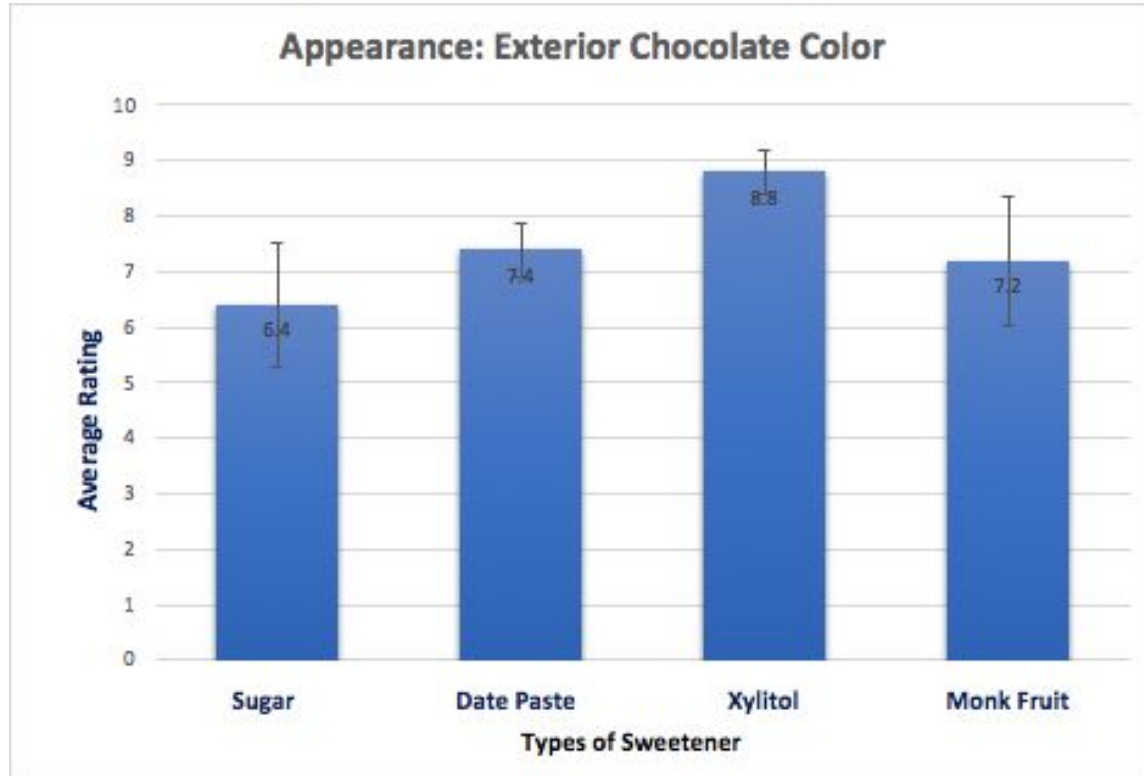
Objective Results: Line-spread test

Line-spread test: Measure of Viscosity		
Type of Sweetener	Measurements	Average
Sugar	1, 0.5, 0.5, 1	0.75
Date Paste	5.5, 6, 6.5, 7	6.25
Xylitol	2, 1, 1.5, 2	1.63
Monk Fruit	1, 1.5, 2, 1.5	1.5

Most viscous

Least viscous

Subjective Results: Appearance (exterior color)



P- values:

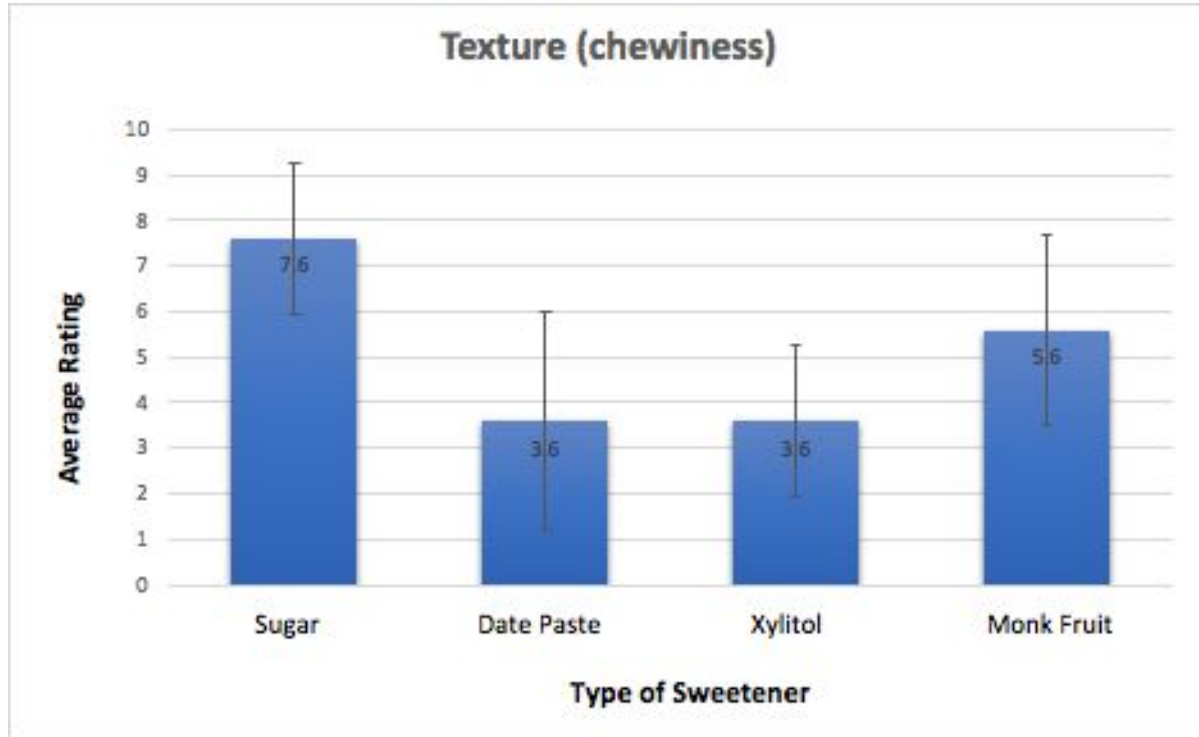
Control

0.14

0.004

0.41

Subjective Results: Texture (Chewiness)



P-values:

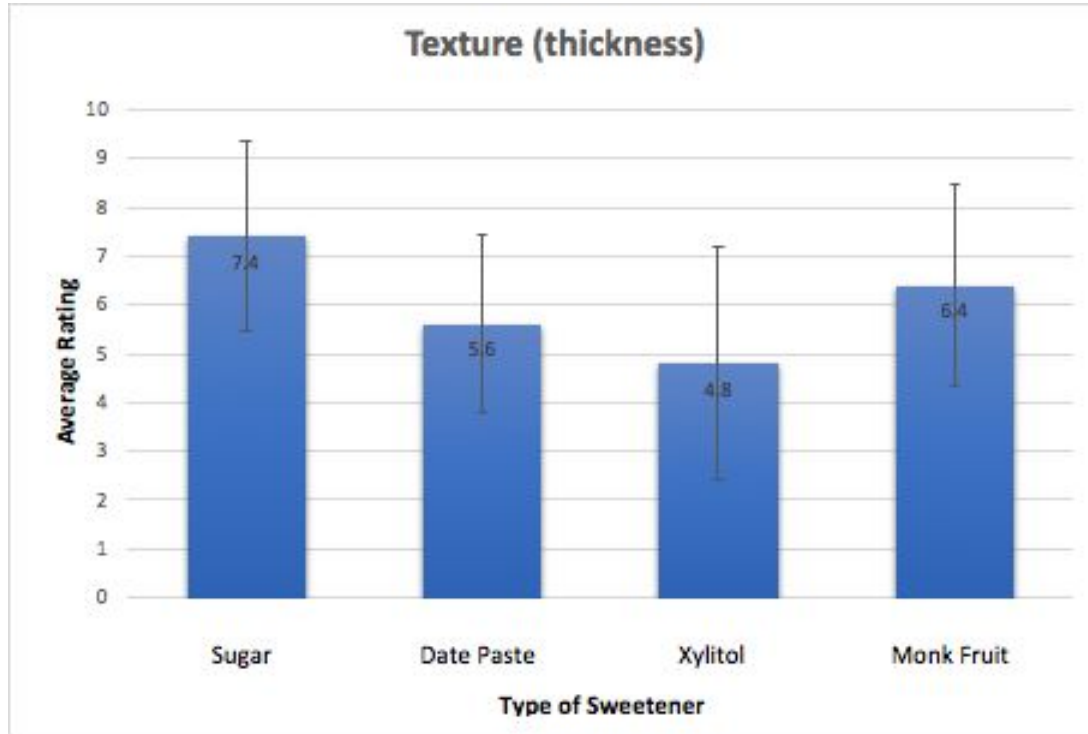
Control

0.01

0.01

0.2

Subjective Results: Texture (thickness)



P-values:

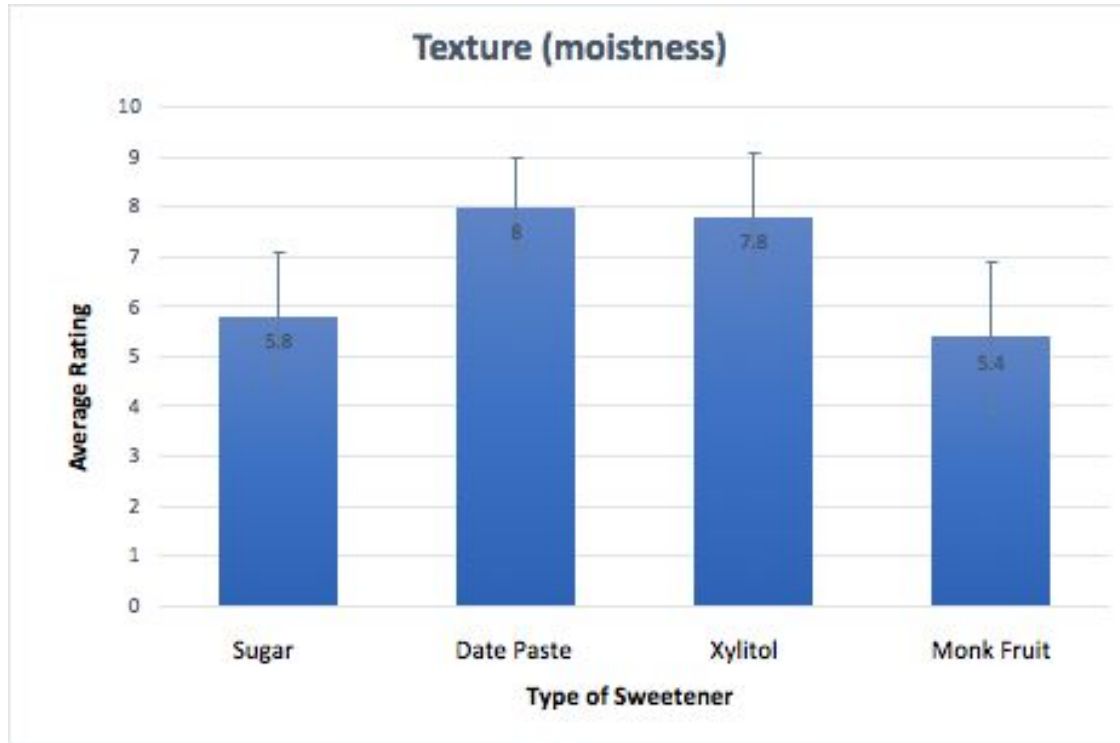
Control

0.05

0.16

0.35

Subjective Results: Texture (Moistness)



P-values:

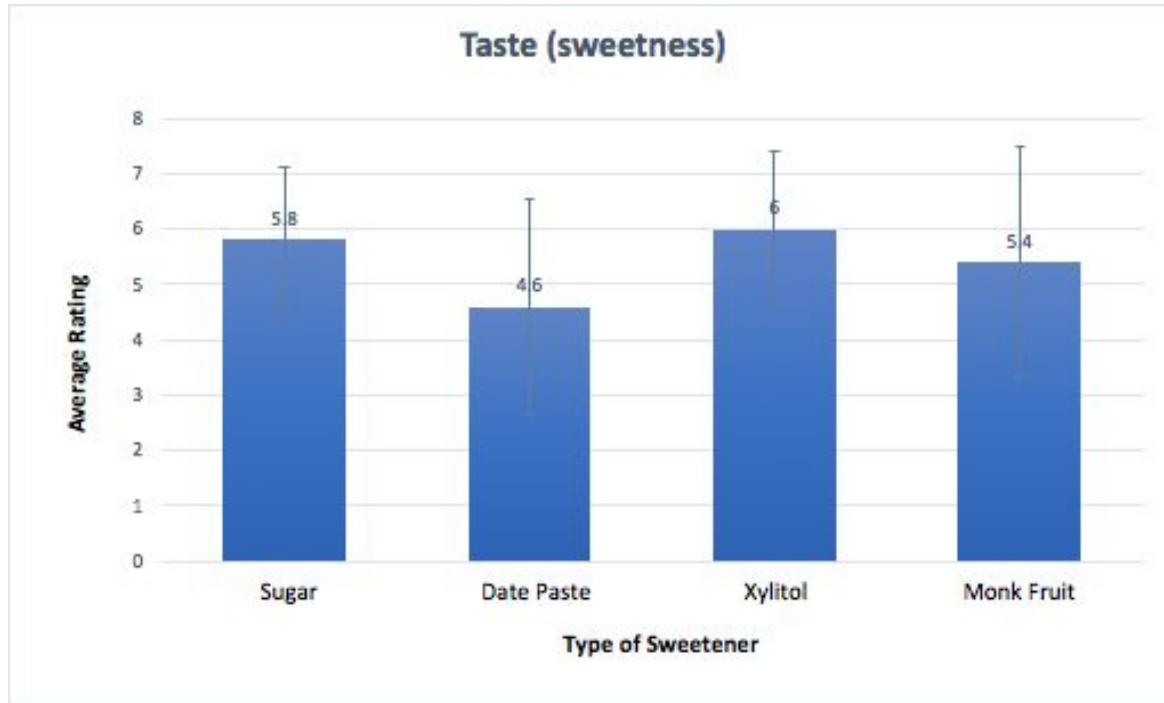
Control

0.05

0.03

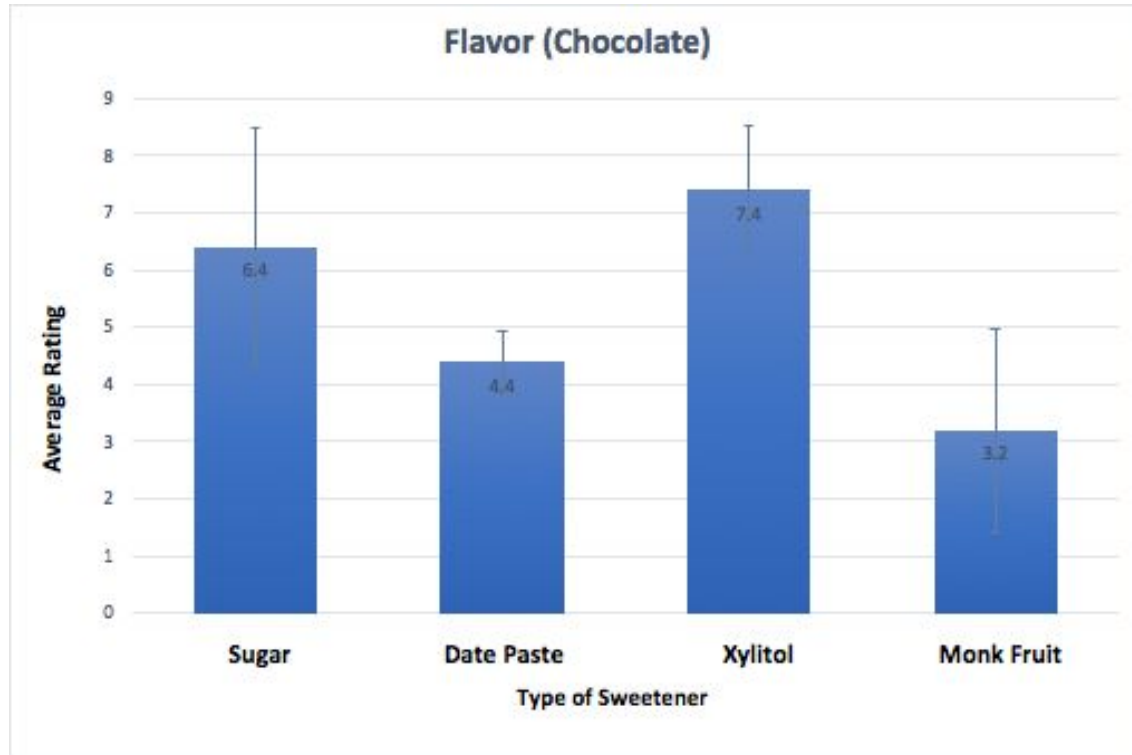
0.59

Subjective Results: Taste (sweetness)



P-values: Control 0.24 0.70 0.69

Subjective Results: Flavor (Chocolatiness)



P-values:

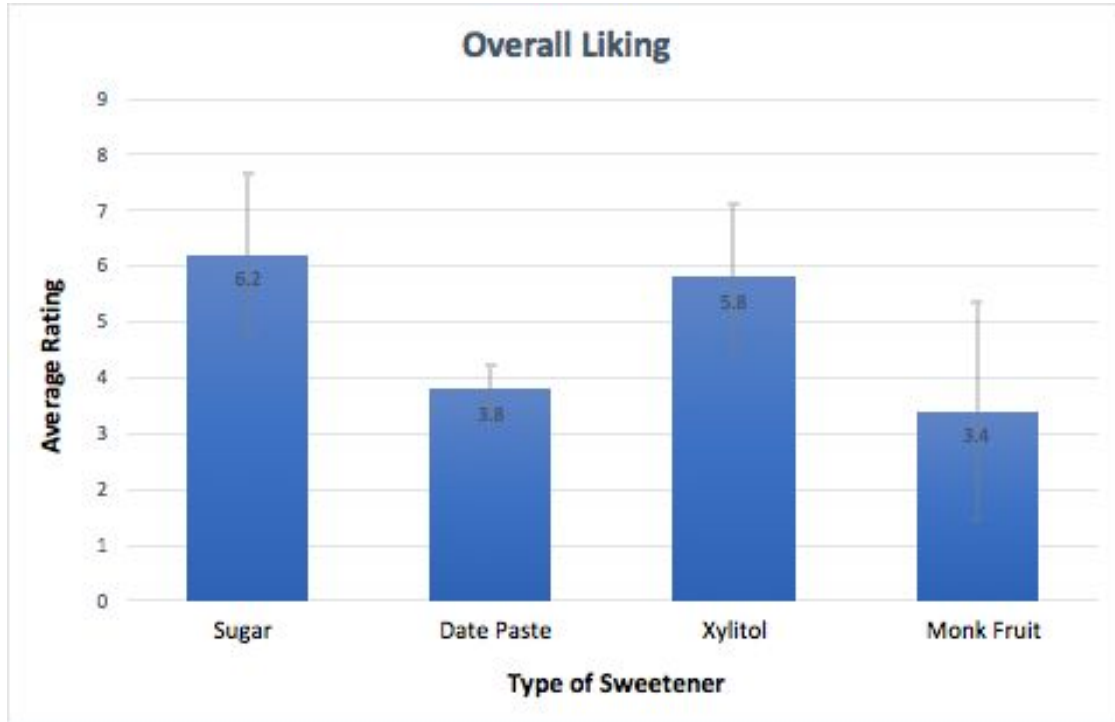
Control

0.15

0.39

0.01

Subjective Results: Overall Liking



P-values:

Control

0.01

0.73

0.04

Comments from Sensory Ballot

★ Sample 989 Control Sugar

- “**Not** very chocolatey”
- “A little sour. Hard on the outside”
- “Very **chewy** but slightly dry”

★ Sample 712 Xylitol

- “Very fluffy, light & crumbly. **Nice amount of moisture.**”
- “Crumbles too easily. **Too moist** on the inside”
- “**Very moist** due to warmth”
- “Was still hot, falls apart easily”

★ Sample 513 Date Paste

- “Very crumbly, **moist**, but **little chocolate flavor**”
- “Very soggy”
- “A bit **bitter** chocolate taste”

★ Sample 131 Monk Fruit Sweetener

- “The **aftertaste** is like **artificial sweetener**”
- “**Weird aftertaste**”
- “**Strange taste**”
- “The taste of **beans** was stronger than chocolate. Crumbled easily.”
- “Slightly chewy, **sweeter** than the rest”

Nutrition Facts

PREMIUM PURE CANE GRANULATED

Nutrition Facts

Serving Size 1 Teaspoon (4g)
Servings Per Container About 1,134

Amount Per Serving	
Calories 15	
	% Daily Value*
Total Fat 0g	0%
Sodium 0mg	0%
Total Carbohydrate 4g	1%
Sugars 4g	
Protein 0g	

*Percent Daily Values are based on a 2,000 calorie diet.

INGREDIENT: SUGAR

DISTRIBUTED BY:
Domino Foods, Inc.
Yonkers, NY 10705

CONTAINS: Approximately 22 1/2 cups.

Questions or Comments? Call: 1-800-729-4840

Granulated sugar

Nutrition Facts

Serving Size 6-7 Dates (40g)
Servings Per Container About 6

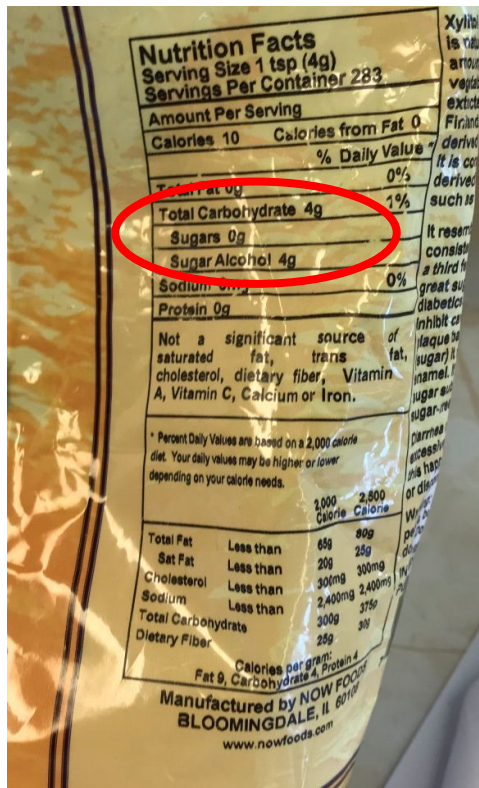
Amount Per Serving	
Calories 120	Calories from Fat 0
	% Daily Value*
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 0mg	0%
Potassium 200mg	7%
Total Carbohydrate 30g	10%
Dietary Fiber 3g	12%
Sugars 25g	
Protein 1g	
Vitamin A 0%	Vitamin C 0%
Calcium 2%	Iron 2%
Vitamin E 2%	Riboflavin 4%
Niacin 2%	Vitamin B6 4%
Folate 2%	Pantothenic Acid 4%
Phosphorus 2%	Magnesium 4%
Manganese 4%	

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

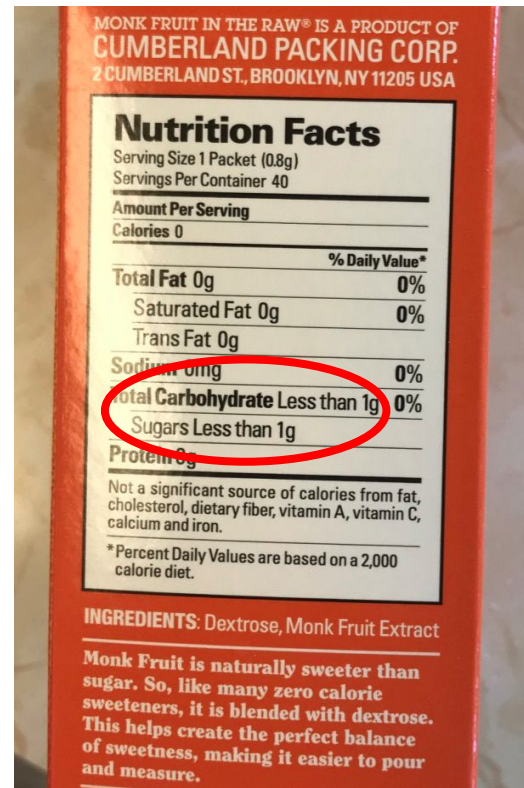
	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Potassium	Less than	3,500 mg	3,500 mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Dates



Xylitol



Monk Fruit Sweetener

Discussion: Objective Evaluation

Height

- Expectation for the **highest** → **Sugar (control)**
 - Why? Sugar is hygroscopic, holding onto water so that once heat is applied the liquid to gas expansion gives height to the final product
 - **Result** → **Sugar**
- Expectation for the **lowest** → **Date Paste**
 - Why? Contained no added sugars and the viscous paste gives no room for gas formation when heat is applied
 - **Result** → Lowest height was the **xylitol** sweetened brownies at an average of 2.57 cm whereas the date paste sweetened brownies had an average height of 2.67 cm
 - The difference is not too big, 0.1 cm so it could be that the addition of 1 cup of water also increased the amount of batter

Discussion- Objective Evaluation

Density

- Expectation for **most** dense→ **Date paste** sweetened brownies
 - Why? The addition of water to an already dense item will create a more compact product.
 - **Result**→ **Date paste**
- Expectation for **least** dense→ **Sugar (control)** sweetened brownies
 - Why? Sugar melts differently compared to alternative sweeteners. It is hygroscopic so the liquid it absorbs from the egg once in the oven melts causing an increase in volume. Helps create air within the batter.
 - **Result**→ **Sugar**

Sugar alternatives may mimic the sweetness of sugar they do not have the same chemical properties so will create a more flat and dense product.

Discussion: Objective Evaluation

Line-spread Test

- Expectation for **most** viscous→ **Sugar (control), Xylitol** and **Monk Fruit** Sweeteners to be equally viscous
 - Why? No addition of any liquid was added to any of these batters
 - **Result**→ **Sugar**
- Expectation for **least** viscous→ **Date Paste** sweetener
 - Why? The addition of a liquid, 1 c water, which the other 2 alternatives and control did not contain made the brownie batter with date paste the least viscous
 - **Result**→ **Date Paste**

Discussion- Subjective Evaluation

Appearance

- Expectation for most **chocolate color** → **date paste** sweetened brownies
 - Why? → dark color of date paste darkened brownies
- Result → **xylitol** sweetened brownies p-value (0.004) < 0.05

Texture

- Expectation for most **chewy** → **date paste** sweetened brownies
 - Why? → addition (1 c) water was added to make date paste
- Result → **sugar (control)** sweetened brownies were the chewiest

Moistness

- Expectation for most **moist** → **date paste** sweetened brownies
 - Why? → additional (1 c) water was added to make date paste
- Result → **date paste** sweetened brownies were the **most moist**

Sweetness (no statistical significance)

- Expectation for most **sweet** → **sugar (control)** brownies
 - Why? → sugar has a sweetness value of 100
- Result → **xylitol** sweetened brownies were the **sweetest**

Flavor (no statistical significance)

- Expectation for most **chocolate flavor** → **sugar (control)** sweetened brownies
- Result → **Xylitol** sweetened brownies

Discussion- Expectations

- P-values < 0.05
 - Chewiness→ xylitol and date paste not as chewy
 - Chocolate flavor→ monk fruit the least chocolate flavor
- Expected the control to be the most liked BUT did not expect xylitol to come in a close second
 - We expected that the aftertaste of a sugar alcohol would not be pleasing
- Expected the monk fruit sweetener not xylitol to be the sweetest because it is 300X sweeter
 - Monk fruit sweetener is combined with dextrose which has a sweetness value of 74 compared to 100 for sucrose (sugar)
 - Expected xylitol and sugar to be at the same level of sweetness
 - Xylitol and Sucrose (sugar) both have a sweetness values of 100
 - Which was true, p value (0.70) > 0.05 → insignificant

Discussion: Expectations

- Sources of error
 - We did not have all of our ingredients
 - Had to substitute erythritol for xylitol
 - Did not have the Lakanto brand monk fruit sweetener which does not contain dextrose which this brand of monk fruit sweetener had, affected the overall product
 - Also did not have enough of the sweetener so while we cut the recipe in half we forgot to shorten the baking time→ resulting a drier product
 - Delay in baking resulted in less time for baking
 - Xylitol sweetened brownies were served hot while the other brownies had cooled for 1 hr affecting the subjective evaluation

