

Sensory and Physical Properties of Zucchini Bread Prepared by Replacing Sugar with Stevia and Sucralose

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ABSTRACT:

The qualities of Zucchini bread formulated with half stevia or half sucralose in place of full sugar were analyzed to determine the overall acceptance and functionality of each bread. Quality was determined based upon categories of moistness, brownness, sweetness, aftertaste and overall acceptability. These categories were then evaluated by a randomly selected group of untrained panelists (n=25), and the information was computed using a one-way analysis of variance (ANOVA). Significance was found amongst the zucchini breads, as the control recipe received the highest overall acceptance, as well as highest rating for moistness. Even though the other two zucchini breads still contained half the called amount for sugar, they did not meet the levels in which the control recipe was accepted. Furthermore, even though sugar was the experimental ingredient, sweetness was not a significant factor. One of sugar's main roles in baking is to retain water and hold moisture in a product, therefore this significance may be due to moistness obtained by the high level of sugar in the control recipe. This is also evident because moistness was rated highest for the control recipe as well. Furthermore, objective analysis of height was measured, and was determined that there was no significance in loaf height between the three breads. This study was conducted in order to find a suitable dessert choice for those looking for healthier options, or those trying to stay on track with their diet regarding health or medical conditions. With this, Zucchini bread in particular is a heartier choice for those consumers, while still providing the sensory aspects of desserts. Formulating a bread that is wholesome, but also low in sugar, carbohydrates and calories, will provide more options for consumers such as those dealing with diabetes, heart disease and obesity. Furthermore, it may also help decrease the public's overall sugar consumption, which has been associated with dental cavities, heart disease, obesity and Type 2 Diabetes.

Key Words: Zucchini Bread, Bread, Stevia, Sucralose, Sugar, Sensory Properties

INTRODUCTION:

As the food industry expands and adapts to consumers, it seems that health conscious products are becoming increasingly popular and sought out more often. With this, products that are labeled as low-fat, sugar-free and/or low calorie are becoming high in demand, while processed and calorie dense food sit on the sidelines of present health food trends. While this benefits those looking for an overall healthier lifestyle, it also provides opportunity for the many consumers that struggle with health and medical

conditions that require a diet change. For instance, people with Diabetes, Heart Disease and obesity may be more inclined to purchase these healthier food items as it helps them stay on track. This is a large number of consumers, as approximately 29 million U.S. citizens are diagnosed with Diabetes (CDC, 2014), 37% of U.S. adults are considered obese (BMI > 30) (CDC, 2015), and about 1 in every 4 deaths are associated with Heart Disease (CDC, 2015).

These statistics may be directly related to aspects of the American Diet. For instance, there is a large prevalence of high sugar foods in every day meals, making it difficult to avoid for those with health conditions. In fact, high levels of added sugar in the diet has been directly associated with dental cavities, heart disease, obesity and Type II Diabetes (American Dietetic Association, 2016). However, the American Heart Association suggests that the maximum daily intake of sugar only should be about 37.5 grams (150 calories) for men and 25 grams (100 calories) for women.

Regardless of the statistics, humans will still always love sweet foods such as desserts, cakes and breads. However, even if they attempt to find healthier dessert option, many are still high in sugar. Therefore, to find a median ground that would be acceptable on all levels, we decided to alter the recipe of a Zucchini Bread. Zucchini bread is a heartier dessert option, and contains more fiber and vegetable product than most other breads. However, most recipes still contain a large amount of sugar. So, in our research, we decided to create a sugar free zucchini bread desirable for consumers using stevia in one batch and sucralose in another. We tested this study based upon aspects of Appearance, Flavor, Texture and Overall Acceptability, and used twenty (n = 20) randomly selected panelists. Other studies have also been done to find acceptable options using sugar replacements such as erythritol-sucralose, but it resulted in a less tender, less moist and less sweet product. (Akesowan, 2009). In other studies, stevia was used as a replacement for sugar, but it was found that it produced a more firm cake than desired. (Journal of Food, Agriculture & Environment, 2009). Although these results were determined, it had not been tested using Zucchini Bread, or a bread with a water-rich vegetable such as zucchini. Thus, the objective of this study was to determine if sugar free zucchini breads using sucralose or stevia could be acceptable in sensory and physical categories to potential consumers when making Zucchini Bread.

MATERIALS & METHODS:

Ingredients & Preparations:

Preliminary testing was done with various ratios of different sugars/sugar alcohols to determine the final experimental recipes. For the actual experiment and testing, we compared two zucchini breads to a control zucchini bread – one experimental bread contained half sugar and half Stevia, and the other contained half sugar and half Sucralose. The control contained the full amount of sugar needed for the recipe.

To prepare the breads, we used Whole wheat flour (Gold Medal Quality, General Mills Sales, Inc., Minneapolis, MN), Vegetable oil (Crisco, J.M. Smucker Company, Orrville OH), Large brown eggs (Alderfer Poultry Farm Inc, Telford, PA), Baking Soda (Arm & Hammer, Church & Dwight Co., Inc., Ewing, NJ), Baking powder (Arm & Hammer, Church & Dwight Co., Inc., Ewing, NJ), Vanilla Extract, Ground Cinnamon (Spice Supreme, Gel Spice Co., Inc., Bayonne, NJ), Ground Nutmeg (Spice Supreme, Gel Spice Co., Inc., Bayonne, NJ), White Salt and Green Zucchini (Provided by CUNY QUEENS FNES DEPT, Flushing, NY). The sugar components consisted of White Sugar, Stevia (Truvia, Cargill Inc, Minneapolis, MN) or Sucralose (Splenda, McNeil Nutritionals, LLC, Fort Washington, PA).

All three breads were cooked in the same oven (Maytag, Benton Harbor, MI) in the same type of pan (Mirro, 19 X 10 X 6 cm), and set to a timed cook as per the recipe. Three different stations were set up to indicate each bread being tested – control, sucralose, stevia. Therefore, each step in the preparation applies to all three unless otherwise stated. Furthermore, the recipe used was set for 2 loaves, so all ingredients were cut in half to make one loaf per recipe. First, the oven was preheated at 350°F. Then, all dry ingredients (flour, salt, baking powder, baking soda, cinnamon and nutmeg) were combined into a mixing bowl. Then, in a separate bowl, eggs, vegetable oil, sugar product (white sugar, sucralose, or stevia) and vanilla extract were whisked for two minutes (The eggs were previously weighed in a large bowl, then 85.5 or 1.5 eggs, were weighed and used in each recipe). As stated, each station added either white sugar, sucralose or stevia while whisking wet ingredients. Then, the zucchini was folded into the wet ingredients and was roughly mixed until soft. These ingredients were then poured into their own pre-oiled cooking pans and set to bake at the marked time of 45 minutes. The breads did not finish cooking at the same amount of time – the control baked for 45 total minutes, while the experimental breads took 55 minutes to bake.

TABLE 1: Formulations of Zucchini Bread			
INGREDIENTS	CONTROL	50/50 Sucralose	50/50 Stevia
White Sugar	200 grams (1 cups)	100 grams (1/2 cup)	100 grams (1/2 cup)
Sucralose	---	100 grams (1/2 cup)	---
Stevia	---	---	100 grams (1/2 cup)
Whole Wheat Flour	192 grams (1.5 cups)	192 grams (1.5 cups)	192 grams (1.5 cups)
Brown Eggs	85.5 grams (1.5 eggs)	85.5 grams (1.5 eggs)	85.5 grams (1.5 eggs)
Vegetable Oil	112 grams (1/2 cup)	112 grams (1/2 cup)	112 grams (1/2 cup)
Baking Soda	2 grams (1/2 t)	2 grams (1/2 t)	2 grams (1/2 t)
Baking Powder	2 grams (1/2 t)	2 grams (1/2 t)	2 grams (1/2 t)
Vanilla Extract	6.5 g (1/2 T)	6.5 g (1/2 T)	6.5 g (1/2 T)
Ground Cinnamon	4 grams (1 t)	4 grams (1 t)	4 grams (1 t)
Ground Nutmeg	1 grams (0.25 t)	1 grams (0.25 t)	1 grams (0.25 t)
Salt	2 grams (1/2 t)	2 grams (1/2 t)	2 grams (1/2 t)
Green Zucchini, Grated	150 g (1 cups)	150 g (1 cups)	150 g (1 cups)

After taking them out of the oven, the temperature was taken in each loaf, which was about 166°F. Then, each loaf was cut into 2x2 cm square pieces for sampling. They were immediately transferred to small sample plates and taken to a sampling room. During the time of cutting, it would have lowered the temperature of the sample to a more acceptable tasting temperature – this temperature change was not recorded.

Sensory Evaluation:

Twenty individuals (n=20) who were students at CUNY Queens College, NY, were randomly selected on one day to participate in the research study. They were informed of the general background of the study and were given a form to fill out containing set criteria to choose from using a hedonistic scale. They were not notified of which sample was the control, sucralose or stevia loaf. Each participant sampled the loaves in the dining room of Remsen 300. Lighting, noise, outside smells, and temperature were controlled and consistent.

The samples were, again, cut while the internal temperature was 166°F/75°C, but the time in between setting, cutting and sensory testing would have decreased this temperature to a more appropriate one. However, this temperature change was not recorded. The, the samples were placed on a small plate with three random three digit numbers to distinguish which loaf was which – the panelist was not aware of which number suggested which loaf. Water was provided to panelists to cleanse palate.

On the given form, they were asked to rate between 1-9 their opinion of appearance for surface brownness, flavor of sweetness, flavor of aftertaste, texture of moistness, and overall acceptability. Aftertaste, texture and moistness was rated from ‘1: weak’ to ‘9: strong’. Also, the overall acceptability was rated from ‘1: dislike extremely’ to ‘9: like extremely’. The definitions of each criteria are expressed in Table 2.

TABLE 2: SENSORY ATTRIBUTES		
<u>SENSORY</u>	<u>ATTRIBUTE</u>	<u>DEFINITION</u>
Appearance	Brownness	Intensity of surface brown color, from Light to Dark. Light Brown means “pale brown.”
Flavor	Sweetness	The sweet taste on the tongue. Weak means “bland” and strong means “very sweet.”
	Aftertaste	Taste lingering in the mouth after swallowing
Texture	Moistness	The quality or state of being slightly wet. Weak means “having less moisture” and strong means “having more moisture.”
Overall Accept.	Liking	Indicate how much you like or dislike each sample.

Height Measurement: We tested height on each loaf by measuring the height on three different areas (the middle, and each ends) in centimeters to find the average for each bread (Table 4). This was done by inserting a toothpick in the three areas, and then measuring the residue with a standard ruler.

Table 4: Height Averages of Zucchini Breads			
	CONTROL	50/50 SUCRALOSE	50/50 STEVIA
Average Height of Each Bread	5.9 ± 0.6	5.5 ± 0.5	6.4 ± 0.8
Mean ± Standard Deviations of each Zucchini Bread			

Data Analysis: The collected data was analyzed in a one-way analysis of variance (ANOVA) with a Tukey test set at a level of significance of $p < 0.05$. The mean values were then determined. The ingredients were analyzed using a computer program. using a serving size of a 2x2 slice. Nutrients analyzed included Total Fat, Saturated Fat, Trans Fat, Cholesterol, Sodium, Carbohydrates, Dietary Fiber, Sugar and Protein. Also, Vitamin A and C, and Calcium and Iron were also in the analysis.

RESULTS

Brownness

It was determined that the results of Brownness did not show significantly different between any of the three breads. There was a slight difference was noticed in ratings between the 100% Control and the 50/50 stevia replacement, but it was not significant enough to find statistically pertinent (See Table 3). Within the data, the 100% Control Recipe rated the highest for Brownness, while the 50/50 Sucralose rated second, and the 50/50 Stevia rated last.

Sweetness

Again, it was determined that the results of Sweetness were not significantly different between any of the three breads. However, within the results, the 100% Control rated the highest for Sweetness, while the 50/50 Sucralose rated second, and the 50/50 Stevia rated last. (See Table 3)

Aftertaste

It was determined that there was no significance found between any of the breads in the category of Aftertaste. However, within the results, the 100% Control rated the highest for Aftertaste, while the 50/50 Stevia rated second, and the 50/50 Sucralose rated last. (See Table 3).

Moistness

It was determined that there was a significant difference found between the 100% Control and both 50/50 Sucralose bread and 50/50 Stevia bread. The 100% Control was found to have the highest rating of Moistness (Mean \pm SD = 7.25 \pm 2.34) compared to the lower score of 50/50 Sucralose (Mean \pm SD = 5.35 \pm 1.95) and lowest score of 50/50 Stevia (Mean \pm SD = 4.60 \pm 1.82). This determined that the moisture content had changed when replacing the sugar content with sugar replacements. (See Table 3)

Overall Acceptability

There was also significance found between the results of the 100% Control and both 50/50 Sucralose bread and 50/50 Stevia bread. The 100% Control was found to have the highest rating of Overall Acceptability (Mean \pm SD = 7.30 \pm 1.72) compared to the lower scores of 50/50 Stevia (Mean \pm SD 5.70 \pm 1.53) and lowest score of 50/50 Sucralose (Mean \pm SD = 5.15 \pm 2.03). This determined that the 100% Control was the most liked upon panelists.

<u>Sensory Attribute</u>	<u>Treatment</u>		
	Control 100% Sugar	50/50% Sucralose	50/50% Stevia
BROWNESS	6.75 \pm 1.65	6.10 \pm 1.28	5.50 \pm 1.64
SWEETNESS	5.85 \pm 2.18	5.60 \pm 1.85	5.40 \pm 1.93
AFTERTASTE	6.05 \pm 2.24	5.55 \pm 2.44	5.70 \pm 2.00
MOISTNESS	7.25 \pm 2.34	5.35 \pm 1.95	4.60 \pm 1.82
OVERALL ACCEPT.	7.30 \pm 1.72	5.15 \pm 2.03	5.70 \pm 1.53

Mean \pm Standard Deviations of 20 panelists using 9-point scale; (where 1: weak/disliked and 9: strong/liked)

Objective Analysis of Zucchini Breads

Height was measured using a toothpick, and then the residue on it was measured with a standard ruler. It was tested in the three highest parts of each bread, then calculated for an average to represent each Zucchini bread. After analysis, it was determined that there was no significance between the three breads for height. (See Figure 1). The Zucchini bread with the greatest recorded average height was the 50/50% Sugar/Stevia loaf (6.40 cm), second was the Control 100% Sugar (5.933) and the shortest was the 50/50% Sugar/Sucralose loaf (5.467). Visible differences were seen between each loaf after baking, and the Stevia-containing loaf seemed to be greater in volume than the recipe anticipated, while the Sucralose containing loaf seemed to be slightly shorter than anticipated.

FIGURE 1: Average Height of Zucchini Bread Formulations

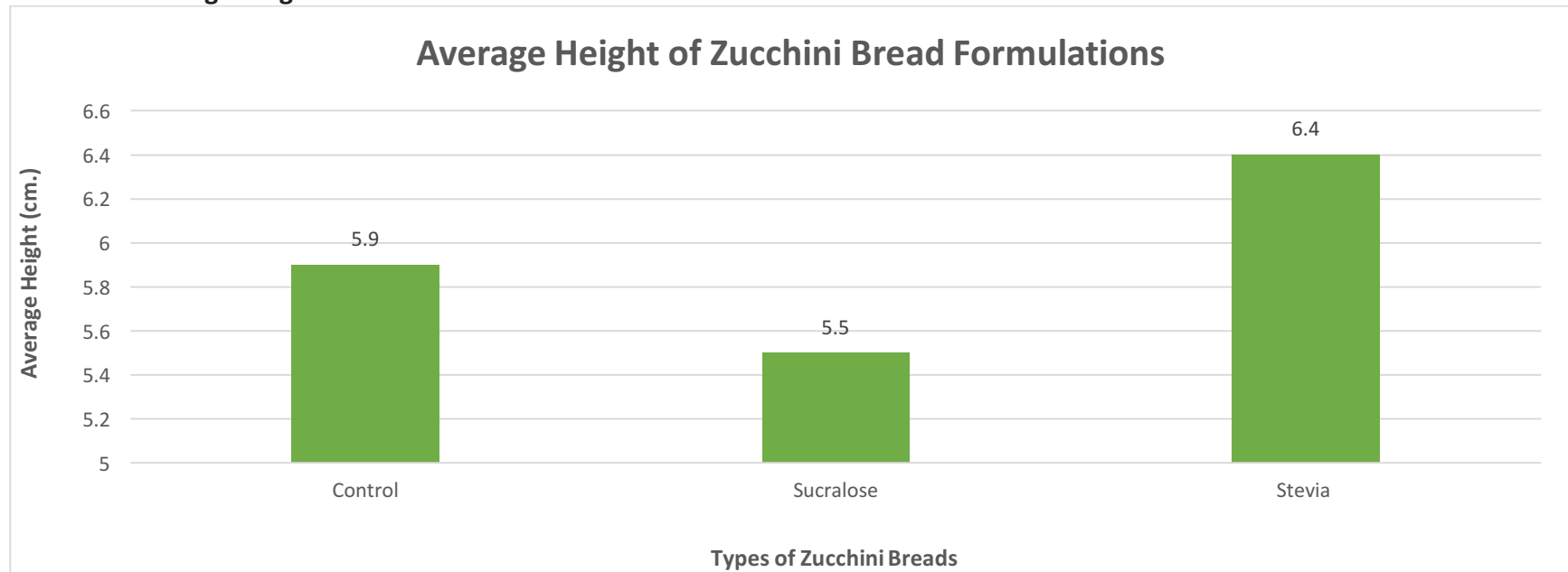
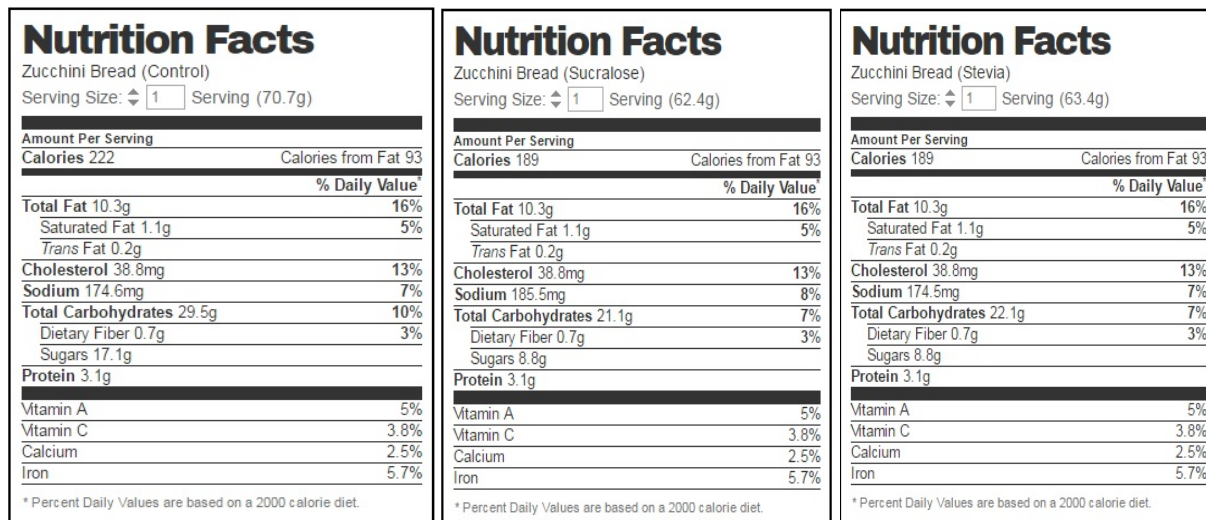


FIGURE 2: NUTRIENT FACTS FOR ALL ZUCCHINI BREADS



Vitamin D** : 0 IU
 Phosphorus** : 48 mg
 Potassium** : 80 mg
 Caffeine** : 0 mg

Vitamin D** : 0 IU
 Phosphorus** : 48 mg
 Potassium** : 79 mg
 Caffeine** : 0 mg

Vitamin D** : 0 IU
 Phosphorus** : 48 mg
 Potassium** : 79 mg
 Caffeine** : 0 mg

Nutritional Analysis for Each Zucchini Bread

When analyzed, differences were shown between the three recipes in contents of Carbohydrates, Sugar, Calories and Sodium. The Sucralose-containing Zucchini Bread was shown to have a 28.5% decrease in Carbohydrates, a 48.5% decrease in Sugar, a 14.9% decrease in Calories and a 6.24% increase in Sodium compared to the control recipe. The Stevia-containing Zucchini Bread was shown to have a 25.8% decrease in Carbohydrates, a 48.5% decrease in Sugar and a 14.9% decrease in Calories compared to the control recipe. Both experimental Zucchini breads decreased the Sugar content substantially, and decreased Carbohydrates and Calories moderately. The increase in sodium content in the Sucralose- containing bread was an unexplained, minimal value and not significantly significant to the study (See Figure 2)

The control recipe contained 68.4% of the maximum daily intake of sugar for women, and 45.6% of the maximum daily intake of sugar for men (American Dietetic Association, 2016). The 50/50 sucralose bread and 50/50 stevia bread only contained 35.2% of the of the maximum daily intake of sugar for women, and 23.5% of the maximum daily intake of sugar for men.

Although the experimental Zucchini breads were reduced in those areas, all three breads still contained 10.3 grams of fat (16% DV), 1.1g Saturated Fat (5% DV) and 38.8mg Cholesterol (13%).

DISCUSSION:

Sensory Attributes

After analyzing the sensory results, it was found that the Control 100% Zucchini Bread had the highest mean rating for all sensory categories, significant or not. However, Moistness and Overall Acceptability were the only categories found to be of significance when comparing the 100% Control to the two sugar-substituted Zucchini Breads. With this, Moistness is evident to be an important factor in the acceptance of Zucchini bread, as it was found to be the only sensory attribute statistically significant other than Overall Liking. The differences in moisture content between the three breads may be directly due to the amount of sugar in each, as sugar tenderizes products by absorbing water (McWilliams, 2014). Therefore, the Control 100% Sugar was most accepted most tender and moist, while the 50/50% Sucralose and 50/50% Stevia were less moist. This was also the case in previous study, where the sugar in Chiffon cakes were substituted with erythritol-sucralose. In the study, the replacement cakes scored lowest on the scale of moistness, while the control rated the highest. This further proves that sugar directly relates to moisture content. (Akesowan, 2009) Furthermore, another study found that yogurt cakes replaced with stevia were more firm than the control. This was most directly a result from the lack of sugar in the altered recipe, which would have produced a softer bread. This study further proved the results of both of these studies (Journal of Food, Agriculture & Environment, 2009).

The results did not find absolute significance between the breads for browning, but a slight difference was found between the Control bread and both experimental breads ($p < 0.05$, $p = 0.054$). Specifically, a difference between the Control and the 50/50 Stevia bread ($p < 0.05$, $p = 0.042$) This slight difference may be related to the Maillard Reaction creating a browning on the surface of the Control bread. When sugars interact with amino acids in baked goods, it creates an attractive, browned effect on the surface. With this, the sugar replacement breads containing Stevia or Sucralose would have had a decreased potential for this to occur due to the decreased level of sugar in the recipe. However, this would need further research to be absolutely proven. (McWilliams, 2014)

Although sugar was the experimental ingredient, the results showed no significant difference in sweetness between any of the breads.

Objective Analysis

There were no significance differences between any of the breads in the area of height. However, the control recipe resulted in being the middle height between both experimental loaves, and visibly seemed the most even-balanced. Sugar is a leavening and gelatinizing agent, and allows baked products to rise appropriately in a uniformed manner, so it would be consistent that the loaf using 100% Sugar would be the most uniform. (Figure 2).

Nutrition Analysis:

After analyzing the data, it was clear that the substitution of Sucralose or Stevia resulted in an overall healthier product when compared to the nutrients of a control Zucchini bread. Although the serving size was set at 2x2 inch samples, inconsistencies were observed in the grams per serving between the control, 50/50 sucralose, and 50/50 stevia after analysis. By decreasing the total amount of sugar and carbohydrates, a more suitable product for Diabetics and health-conscious consumers can be offered. Furthermore, by decreasing the caloric density of the Zucchini bread from 222 calories to 189 calories (14.9%), a more health conscious product for those struggling with obesity and/or heart conditions can be obtained. While these nutrients were decreased, the breads still contained a significant amount of fat, which is related to the eggs and vegetable oil included in the recipes. Fat content was not altered in this experiment.

CONCLUSIONS:

This study demonstrated that the overall acceptability of Zucchini bread half replaced with stevia or half replaced with sucralose has potential, but may need further research to improve the quality of the recipes. After testing, we determined that the control recipe was the most accepted overall among the testers, and that moistness was a significant aspect of this acceptance. However, the Zucchini breads replaced as 50% sugar/50% Stevia and 50% Sugar/50% Sucralose were not as liked overall, as both these breads scored low on moistness and acceptability. Even though the two experimental breads were only substituted half-way, it significantly affected their ability to be positively accepted by testers as it changed the aspects of brownness, sweetness, aftertaste, and moistness. Therefore, although the sugar-replacements produced nutritionally healthful options of Zucchini bread, and lowered levels of sugar, calories and carbohydrates, they did not obtain the desired feedback from testers. Instead, the control recipe for Zucchini bread obtained the highest level of acceptance. Furthermore, there was also no significance found in the areas of height for any of the breads, which concludes that replacing Zucchini breads with sucralose or stevia does not affect height in a large manner. Further research could be implemented to determine more acceptable options of Zucchini Bread that still provide health benefits to the public. For instance, the recipe could benefit by adding a healthy fat to increase moisture content, such as avocado or coconut

oil. The fat would help balance the loss of moisture when the sugar is taken out, and may also decrease the level of fat from the eggs. Therefore, this would allow more options for diabetics, those on low-calorie and/or low carbohydrate diets or consumers just trying to find their favorite foods in a low-sugar form. This research could also be done on a larger scale to obtain more accurate results. Regardless, more research is needed to make further conclusions.

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Female Male Age_____

Date:_____ WG1zbread

Please taste samples and circle the number that you feel best describes your perception of each distributes listed below.

Appearance: Surface Brownness – Intensity of surface brown color, from Light to Dark. Light Brown means “pale brown.”

Code: _574__	1	2	3	4	5	6	7	8	9
	Light Brown							Dark Brown	

Code: _307__	1	2	3	4	5	6	7	8	9
	Light Brown							Dark Brown	

Code: _129__	1	2	3	4	5	6	7	8	9
	Light Brown							Dark Brown	

Flavor: Sweetness – The sweet taste on the tongue. Weak means “bland” and strong means “very sweet.”

Code: _574__	1	2	3	4	5	6	7	8	9
	Weak							Strong	

Code: _307__	1	2	3	4	5	6	7	8	9
	Weak							Strong	

Code: _129__	1	2	3	4	5	6	7	8	9
	Weak							Strong	

Flavor: Aftertaste – Taste lingering in the mouth after swallowing.

Code: _574__	1	2	3	4	5	6	7	8	9
	Weak							Strong	

Code: _307__	1	2	3	4	5	6	7	8	9
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	Weak								Strong
Code: _129__	1	2	3	4	5	6	7	8	9
	Weak								Strong

Texture: Moistness – The quality or state of being slightly wet. Weak means “having less moisture” and strong means “having more moisture.”

Code: _574__	1	2	3	4	5	6	7	8	9
	Weak								Strong
Code: _307__	1	2	3	4	5	6	7	8	9
	Weak								Strong
Code: _129__	1	2	3	4	5	6	7	8	9
	Weak								Strong

Overall Acceptability – Indicate how much you like or dislike each sample.

Code: _574__	1	2	3	4	5	6	7	8	9
	Dislike extremely								Like extremely
Code: _307__	1	2	3	4	5	6	7	8	9
	Dislike extremely								Like extremely
Code: _129__	1	2	3	4	5	6	7	8	9
	Dislike extremely								Like extremely

Thank you!

Female Male Age_____ Date:_____ WG1zbread

Please taste samples and circle the number that you feel best describes your perception of each distributes listed below.

Appearance: Surface Brownness – Intensity of surface brown color, from Light to Dark. Light Brown means “pale brown.”

Code: _307__	1	2	3	4	5	6	7	8	9
	Light Brown							Dark Brown	
Code: _129__	1	2	3	4	5	6	7	8	9
	Light Brown							Dark Brown	
Code: _574__	1	2	3	4	5	6	7	8	9
	Light Brown							Dark Brown	

Flavor: Sweetness – The sweet taste on the tongue. Weak means “bland” and strong means “very sweet.”

Code: _307__	1	2	3	4	5	6	7	8	9
	Weak							Strong	
Code: _129__	1	2	3	4	5	6	7	8	9
	Weak							Strong	
Code: _574__	1	2	3	4	5	6	7	8	9
	Weak							Strong	

Flavor: Aftertaste – Taste lingering in the mouth after swallowing.

Code: _307__	1	2	3	4	5	6	7	8	9
	Weak							Strong	
Code: _129__	1	2	3	4	5	6	7	8	9
	Weak							Strong	
Code: _574__	1	2	3	4	5	6	7	8	9
	Weak							Strong	

	Light Brown								Dark Brown
Code: _574__	1	2	3	4	5	6	7	8	9
	Light Brown								Dark Brown
Code: _307__	1	2	3	4	5	6	7	8	9
	Light Brown								Dark Brown

Flavor: Sweetness – The sweet taste on the tongue. Weak means “bland” and strong means “very sweet.”

Code: _129__	1	2	3	4	5	6	7	8	9
	Weak								Strong
Code: _574__	1	2	3	4	5	6	7	8	9
	Weak								Strong
Code: _307__	1	2	3	4	5	6	7	8	9
	Weak								Strong

Flavor: Aftertaste – Taste lingering in the mouth after swallowing.

Code: _129__	1	2	3	4	5	6	7	8	9
	Weak								Strong
Code: _574__	1	2	3	4	5	6	7	8	9
	Weak								Strong
Code: _307__	1	2	3	4	5	6	7	8	9
	Weak								Strong

Texture: Moistness – The quality or state of being slightly wet. Weak means “having less moisture” and strong means “having more moisture.”

Code: _129__ 1 2 3 4 5 6 7 8 9
Weak Strong

Code: _574__ 1 2 3 4 5 6 7 8 9
Weak Strong

Code: _307__ 1 2 3 4 5 6 7 8 9
Weak Strong

Overall Acceptability – Indicate how much you like or dislike each sample.

Code: _129__ 1 2 3 4 5 6 7 8 9
Dislike extremely Like extremely

Code: _574__ 1 2 3 4 5 6 7 8 9
Dislike extremely Like extremely

Code: _307__ 1 2 3 4 5 6 7 8 9
Dislike extremely Like extremely

Thank you!

Female Male Age_____ Date:_____ WG1zbread

Please taste samples and circle the number that you feel best describes your perception of each distributes listed below.

Appearance: Surface Brownness – Intensity of surface brown color, from Light to Dark. Light Brown means “pale brown.”

Code: _574__ 1 2 3 4 5 6 7 8 9
Light Brown Dark Brown

Code: _129__ 1 2 3 4 5 6 7 8 9
Light Brown Dark Brown

Code: _307__ 1 2 3 4 5 6 7 8 9

Light Brown

Dark Brown

Flavor: Sweetness – The sweet taste on the tongue. Weak means “bland” and strong means “very sweet.”

Code: _574__ 1	2	3	4	5	6	7	8	9
Weak								Strong
Code: _129__ 1	2	3	4	5	6	7	8	9
Weak								Strong
Code: _307__ 1	2	3	4	5	6	7	8	9
Weak								Strong

Flavor: Aftertaste – Taste lingering in the mouth after swallowing.

Code: _574__ 1	2	3	4	5	6	7	8	9
Weak								Strong
Code: _129__ 1	2	3	4	5	6	7	8	9
Weak								Strong
Code: _307__ 1	2	3	4	5	6	7	8	9
Weak								Strong

Texture: Moistness – The quality or state of being slightly wet. Weak means “having less moisture” and strong means “having more moisture.”

Code: _574__ 1	2	3	4	5	6	7	8	9
Weak								Strong
Code: _129__ 1	2	3	4	5	6	7	8	9
Weak								Strong

