The Sensory and Textural Evaluation of St. Louis Style Butter Cakes Made with Low-Fat Greek Yogurt as a Fat Replacer

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Introduction

In America today, obesity and heart disease are on the rise. Nutrition professionals attribute this rise nutrition-related diseases to the Western Diet, which has a high sugar and fat content. The expansion of this diet, along with a sedentary lifestyle, is contributing to weight gain and increased blood pressure. One of the reasons that these foods are escalating in the western hemisphere is due to the palatability of the foods. These foods that are high in sugar and fat are attractive to the consumer population because of the flavors that these foods provide. When a person is unable to have these foods due to the development of nutrition-related diseases, the person is hesitant to change, thus exacerbating the problem. One possible solution to this hesitation is to increase the nutritional content of the foods that the consumer enjoys eating. An example, would be to use a low-fat ingredient as opposed to a high-fat ingredient in a baked good that is popular among an area.

Greek yogurt has been growing in popularity in response to the increased awareness of nutritional health. Due to the thick consistency of the yogurt, it is possible that it could make an ample fat replacer in a baked good that would require a fat base. This would allow the food to not lose the consistency that is expected, without affecting the palatability of the food. Fat-free Greek yogurt, as opposed to cream cheese, has more protein and calcium, and lower in calories, total fat, cholesterol, and sodium, which all play a role in cardiovascular disease (United States Department of Agriculture [USDA], 2017). The different characteristics of the and contents of Greek yogurt have been explored by many researchers, but the research regarding Greek yogurt as a fat replacer has not been researched as extensively.

As opposed to normal yogurt, Greek yogurt is known of having a thicker consistency and being more concentrated regarding the fat content. The process of producing Greek yogurt is

done by straining normal yogurt, which pulls the moisture out of the yogurt making the milk fat content higher. Over time, however, processing procedures have been able to decrease the fat content of the yogurt and produce a fat free yogurt. This loss of fat has been found to increase the moisture of yogurt, as well as the protein, and calcium levels (Jaoude et al., 2010). Jaoude et al's study in 2010 found that a trend that as the fat content is lowered the moisture and protein content increases providing more of these nutrients during the fat removal process. Having a higher percentage of these nutrients, would in turn increase the percentage of these nutrients in the finished product.

The sensory properties of the yogurt take part in altering the physical properties of the butter cake. Regarding the flavors of the yogurt, Atamian, Olabi, Baghdadi, and Toufeili (2014) found that when comparing cow's (bovine) milk Greek yogurt to Greek yogurt derived from sheep (ovine) and goats (caprine) milk that the flavor was less bitter and *goaty* in flavor. These characteristics seemed to make it more acceptable to the consumer acceptability as later in the study results found that bovine derived Greek yogurt was favored over the ovine and caprine yogurts (Atamian et al 2014). The texture, flavor, and appearance were also tested by the panelists, and the bovine yogurt had was favored in these categories as well (Atamian et al 2014). The favorability of the bovine yogurt, which is what is normally consumed in the United States, demonstrates the capabilities that Greek yogurt has an ample substitute. With Greek yogurt being favored in terms of flavor, texture, and appearance it can be assumed that products made with it may also be acceptable to the consumer.

One of the main health benefits of Greek yogurt is that it is higher in its protein content than other yogurts. Proteins are used to help with many processes in the body such as being enzymes and transporters, while promoting satiety within the individual (Gropper & Smith

2013). Satiety is the feeling of fullness that one receives after eating, and protein is known to promote this feeling. Due to this satiety, proteins have been shown to help with weight management and glycemic control. Pasiakos (2015) found that eating higher levels of protein, almost twice the Recommended Daily Allowance (RDA) can help maintain lean body mass, and helps promotes long-term weight loss in obese and overweight individuals. In addition, it was found that higher protein diets that were rich in dairy products provide enhanced results regarding weight loss and the protection of lean body mass (Pasiakos, 2015). The research that Pasiakos uses suggested that this may be due to the complimentary effects that calcium and dairy proteins have on one another, however, there is limited research on the subject (Pasiakos, 2015). By having the Greek yogurt implemented into the product, the percentage of protein will increase, thus possibly increasing satiety and promoting weight loss.

Research Objectives

The experiment is determining the sensory and textural differences and consumer acceptability between one original St. Louis style butter cake and one prepared with low-fat Greek yogurt as a substitution for the cream cheese in the filling mixture. The viscosity of the batter was assessed, and the baked butter cake was assessed regarding tenderness, sweetness, and moisture. It was hypothesized that due to the modification of the recipe to include Greek yogurt, the batter will be more liquefied. This liquification of the batter is hypothesized to improve the moisture that the butter cake is known for. Also, because of this improvement it is expected that the consumer acceptability of the modified butter cake will rise.

Proposed Methods

St. Louis Style Butter Cake Production

Both the modified and the tradition butter cakes are produced in the Murray State University food lab. All ingredients are purchased from the local Murray, Kentucky Walmart. The cream cheese, butter, Greek yogurt, and eggs were in a refrigerator set to 5° C, while the cake mix, confectioner's sugar, and vanilla extract are stored at room temperature. There was one original butter cake and one modified butter cake produced for the experiment, and was baked with in a 23 x 33 cm metal baking pan, with a depth of approximately 10 cm. The original cake was baked using full fat Great Value Brand cream cheese in the filling batter, while the modified cake was produced with Great Value brand fat-free Greek yogurt in the filling batter. After both cakes were baked, they were cooled overnight in a 5°C refrigerator. Both cakes were removed from the refrigerator two (2) hours before the experiment was to be performed the next day, and then cut into 25 x 25 cm squares. The cakes were then placed on 23 cm diameter round paper plates, and served to the selected panelist in the main Nutrition department class room, room N208, in the North Applied Health Sciences building on the Murray State University campus.

Original St. Louis Style Butter Cake Recipe

Table 1.

Original St. Louis Style Butter Cake Recipe

Ingredients	Home Measures	Metric Units
Butter	½ cup	113 g
Yellow Cake Mix	18 oz., 1 package	510 g
Large Eggs	3	170 ml
Cream Cheese*	8 oz., 1 block	227 g
Vanilla Extract	½ teaspoon	2.5 ml
Confectioner's Sugar	4 cups	907 g

Substituted with 1 cup fat-free Greek Yogurt; 226.8 g of fat-free Greek yogurt

Equipment:

22 x 33 x 10 cm metal pan Hand mixer

2 7.6-liter large Glass mixing bowl	Digital stopwatch	400-ml measuring cup
	Non-stick spray	23 cm paper plates
Digital kitchen scale	Plastic mixing spoon	Non-stick cooking spray
Kitchen timer	Microwave	Plastic fork
Toothpicks	Cooling rack	Coffee filter
100 ml graduated cylinder	Conventional oven	Metal butter knife
10 ml graduated cylinder	200 ml glass beaker	Folding spatula

Instructions:

1. **Preheat oven to 177 °C.**

Lightly grease 22 x 33x 10 cm metal pan with non-stick spray.

2. **Measure yellow cake mix**

Use digital kitchen scale and coffee filters to measure 510 g of dry yellow cake mix. Place the yellow cake mix into one of the 7.6 liter mixing bowls and set aside until the butter, and eggs have been measured.

3. **Measure butter**

Use digital kitchen scale and coffee filters to measure 113 g of unsalted butter. Place butter in a glass 400 ml measuring cup and place in microwave. Heat for 30 seconds then stir until smooth, repeat until butter is completely melted. Place butter in 7.6 containing the yellow cake mix and wait for eggs to measured.

4. **Measure eggs**

Use digital kitchen scale and 200 ml beaker to measure 170 ml of beaten eggs. Pour 57 ml of the eggs into a 100-ml graduated cylinder and then pour the graduated cylinder amount of eggs into

the 7.6-liter bowl with the butter, and the yellow cake mix. Set the rest of the eggs aside for the filling mixture.

5. **Prepare crust**

Stir melted butter, yellow cake mix, and eggs in the 7.6-liter mixing bowl until the consistency I similar to that of cookie dough. Then, place cookie dough like mixture in greased metal pan using a spatula to flatten the dough and spread it until is completely covering the bottom. Set crust aside until filling is prepared.

6. **Measure cream cheese**

Use digital kitchen scale and coffee filters to measure 227 g of cream cheese. Place cream cheese in the other 7.6-liter mixing bowl and set aside until vanilla extract and confectioner's sugar is measured. **For the original recipe skip Step 7 and go to Step 8.**

7. **Modification Recipe ONLY**

When preparing the modified recipe, the fat-free Greek yogurt will be measured rather than the cream cheese. **When preparing the modified cake, skip Step 6 and perform Step 7.** Use digital kitchen scale and coffee filters to measure 227 g of fat-free Greek yogurt. Place fat-free Greek yogurt in the other 7.6-liter mixing bowl and set aside until vanilla extract and confectioner's sugar is measured.

8. **Measure vanilla extract**

Use 10 ml graduated cylinder to measure 2.5 ml of vanilla extract. Pour vanilla extract into the 7.6-liter bowl containing the cream cheese, then set bowl aside until confectioner's sugar is measured.

9. **Measure confectioner's sugar**

Use digital kitchen scale and coffee filters to measure 907 g of confectioner's sugar. Pour confectioner's sugar into the 7.6 liter mixing bowl containing the cream cheese and vanilla extract.

10. Prepare filling

Pour remaining eggs into 7.6 liter mixing bowl containing cream cheese, vanilla, and confectioner's sugar. Using the hand mixer, mix the ingredients for three minutes at medium to high speed or until the mixture is smooth with no lumps. Measure out 20 ml of batter, using a graduated cylinder, to be used for objective testing.

11. Combine crust and filling

Pour the remaining batter on top of the premade crust and use spatula to make sure that the filling is evenly coated over the crust.

12. Bake

Bake the butter cake for 30 minutes or until the cake has a light golden brown crystal-like top crust. Take butter cake out of the oven and place on cooling rack. Let cake sit on the rack until it is completely cool, then cut the cake into 25 x 25 cm square serving. Place slices on 23 cm diameter paper plates and prepare for subjective testing.

Objective Testing

Nutrient analysis. The USDA Super Tracker was used to analyze the nutrient content of both recipes. The results below show that there is a significant decrease in calories, sodium, fat, and cholesterol. With this modification there is a 53-calorie reduction, a 61-mg sodium reduction, a 6-g reduction of total fat, a 20-mg reduction of cholesterol. These nutrients play a role in hypertension. Sodium increases the volume of blood in the blood vessels by adding additional water with its sponge-like properties. Fat increases the thickness or viscosity of the

blood making it more difficult for the heart to pump, and excess cholesterol is built up in the arteries where it can promote plaque formation and increase blood pressure (Mahan, Escott-Stump, & Raymond, 2012). There is a significant decrease in Vitamin A as the cream cheese was a major source of that nutrient in the butter cake. There was also a slight increase in protein and calcium, but is not as not significant as the other differences above (see Table 2).

Table 2.

Comparison of Nutrient Composition in Modified and Original Butter Cakes
Servings: 12; 25 x 25 cm square

Nutrient	**Control**	**Modified**
Calories	465 kcal	412 kcal
Total Fat	16 g	10 g
Saturated Fat	10 g	6 g
trans Fat	0 mg	0 mg
Cholesterol	82 mg	62 mg
Sodium	404 mg	343 mg
Potassium	65 mg	68 mg
Selenium	5 mcg	7 mcg
Total Carbohydrate	77 mg	77 g
Dietary Fiber	1 g	1 g
Sugars	59 g	59 g
Protein	4 g	5 g
Vitamin A	151 mcg	82 mcg
Vitamin C	0 mcg	0 mcg
Calcium	119 mg	123 mg
Phosphorus	179 mg	187 mg
Vitamin B_{12}	.2 mcg	.3 mcg
Iron	1 mg	1 mg

Consistency. The Bostwick consistometer assessed the viscosity of the filling batters by testing the flowing abilities of the batter; the consistometer's cup is filled to the rim, then by removing one side of the cup the batter is released and measured (McWilliams, 2012). 100 ml of the modified and original batters were placed in the consistometer and measured in terms of how far the batter spreads within a 30 second time span. The test was conducted three times and then

the average spread was taken of the three trials. The original and modified cake batters were assessed with this method.

Tenderness. The penetrometer, with the cone attachment, assessed the tenderness of the finished product by dropping a cone into a baked good and determining how deep the cone goes within the baked good; the test was conducted three (3) times for accuracy (McWilliams, 2012). The cake pieces that were used were center pieces and the test was taken from the center of the cake piece. The average of the three (3) tests were taken and that was how the data was collected. The original and the modified cakes was assessed with this method.

Moisture. A wettability test is testing the moisture of a center piece of cake by testing how much water is absorbed into the baked good after being submerged in water (McWilliams, 2012). The cake piece was measured by a kitchen scale, then placed in a 400-ml glass beaker filled with 200 ml of distilled water. The cake was then removed after 10 seconds and the piece of butter cake was reassessed. The modified and original cakes were assessed with this method.

Subjective Testing

Participants were recruited by an Institutional Review Board (IRB) approved email (see Appendix A), along with the consent form (see Appendix B), and asked to respond whether they could participate or not. The pieces of cake were served to the panelists on 23-cm paper plates and taken to the nutrition classroom on the second floor of the building Applied Health Sciences building. The panelists were given a consent from at the beginning of the experiment and then handed both cake samples, 546 and 302 along with the scorecard (see Appendix C) that evaluates tenderness, moisture, and sweetness of the cakes. The scorecards were collected when the panelists are finished and coded accordingly to their responses.

Data Analysis

Consistency evaluation. The results were determined by how far the batter had spread on the left wall, the center, and the right wall of the Bostwick consistometer. After the tests were conducted the average cm were taken from these three (3) areas in the trials creating a total average for the individual trials. These averages were then used to calculate the overall average of each batter.

Wettability test evaluation. The data was evaluated in terms of grams gained while the product was in the water. The product was weighed before being placed in the water and after it had set in the water for 10 seconds. The data was gathered by subtracting the weight before the water from the weight after the water. This difference was the data that was monitored during the procedure and average of the three (3) trials were taken for each batter and then compared to one another in the results.

Penetrometer test evaluation. Three (3) center pieces of each cake were used for this test and the results from each piece of cake was averaged depending on what cake was used. The results from the original cake and modified cake were averaged and compared to one another for a comparison of tenderness.

Standard scale evaluations. The first three (3) questions on the scorecard (See Appendix A) were coded using a hedonic coding scale of 1 – 9. "1" was defined as most unlike the characteristic being evaluated, and a 9 was coded as most like the characteristic being evaluated. For example, on the stickiness scale a 1 on the scale as represented as "very crumbly" and a 9 on the scale was represented as "very sticky." This type of coding was used for the characteristics of "tenderness and sweetness." The averages of each question were calculated based on this coding scale for both the original and modified recipes. After averages were found the medians and modes of each recipes were calculated as a measure of spread. The acceptance

question after these characteristic questions was coded on a scale of 1 – 7. 1 meaning that is was "extremely disliked" and 7 meaning that is was "extremely liked." The means of these scales were calculated, along with the medians and modes of the data as well.

Comparison question evaluations. The results of these questions were coded as occurrences of each answer. Each question had a fixed amount of answers, so the appearance of each answer was counted and placed in a table based on the answers that were given.

Open-ended question evaluation. This question was coded based on the reoccurring themes with in the answers. The answers were summarized and scanned for similar themes or reasons for preferring one butter cake over the other. Once all the themes were compiled they were placed within a table that organized the themes into main themes and sub-themes.

Results

Objective Results

Consistency results. The results of this test are taken before both cakes were baked with 100 ml of each filling batter. The averages of each trial were calculated and from those averages the overall average was calculated. In the original cake the three (3) trials averages ranged from 1.33 cm – 1.68 cm creating an average of 1.47 cm overall (see Table 3). The modified cake differed as it had its trial averages range from 12.25 cm – 13.83 cm, which made the overall average for the modified cake 13.11 cm (see Table 4). This is significantly larger than the results of the original cake. The results of each individual trial are outlined in Table 3 and the averages are outlined in Table 4.

Wettability test results. The results of this test were taken after the cakes were baked and the results of each trial were averaged into an overall average for each recipe. The original cake gained on average four (4) grams when subjected to the water, while the modified gained

approximately six (6) grams after being subjected to the water (see table 5). The results for the individual trials can be seen in Table 5.

Tenderness test results. The test was conducted with the penetrometer three (3) times with a three (3) pieces of each cake. The results were averaged from the three (3) pieces of the modified and original cakes. The results from the original cakes had an average of 73.3 mm meaning that the cone of the penetrometer went 73.3 mm within the butter cake. For the modified butter cake, the average was a 97-mm depth (see Table 6). The results for the individual trials are present in Table 6.

Panelists Results

Scaled questions results. The results of these questions were coded using the method mentioned above (see Standard Scaled Evaluations section) and averaged out from the 7 responses received. The scores for the original cake's stickiness ranged from 5 – 8 with a mode of 6 and an average of 6.4, while the modified cake had a range of 7-9 with a mode of 9 and an average of 8.4. The range for tenderness was 7-9 both cakes, but the modes for the original cake were 7 and 8; the modes for the modified cake were 8 and 9. The average for tenderness of the original cake was 7.7 and average of the modified was 8.3. Sweetness ranged from 7-9 on the original cake and 5-9 on the modified with modes of 7 and 8 respectively. The sweetness average for the original was 7.9 and average for the modified was 7.3. Regarding acceptance, the original cakes range was from 6-7 and the modified from 4-6. The modes were for the original and 6 for the modified with averages of 6.6 and 5.6 (see Tables 7&8).

Comparison questions results. These results were tallied from the seven (7) response to the survey. However, regarding the tenderness comparison question only had six (6) responses as one of the panelists did not answer that question. Regardless, 5/6 panelists marked that the

modified cake was more tender and all seven (7) panelists agreed that the modified cake was stickier than the original. 5/7 panelists believed there was a difference in the sweetness of both cakes, while two (2) though it was equal in sweetness (see Table 9).

Open-ended question themes. The themes present in the table below represent repetitive answers within the open-ended question at the end of the scorecard. The themes were split into the two (2) main themes and one (1) subtheme under each. The first theme is the "preference of the original cake" and the sub category is the reasons why the panelist preferred that cake. Then the second theme is "lessened acceptance of the modified cake" with a subtheme talking about the reasons why they did not enjoy the modified as much (see Table 10). To see the main reasons specified refer to Table 10.

Discussion

Objective Results

Based on the results of the consistency test, the consistency of the modified batter was thinner than that of the original batter. The average spread of the original batter was 1.47 cm, while the average spread of the modified batter was 13.11 cm; the higher the number of centimeters the thinner the consistency of the product. This could be possible due to the consistency of the cream cheese and the Greek yogurt used in each cake. Greek yogurt has a more liquified texture than that of full fat cream cheese. As found in Jaoude et al's (2010) study, when Greek yogurt is reduced to in fat the amount of moisture seems to increase as fat makes up majority of the ingredients in full-fat or normal Greek yogurt. The watery consistency of the Greek-yogurt translated to the batter of the butter cake causing the modified batter to move more fluidly during the consistency test. Due to the change in texture between Greek yogurt and cream cheese, this was and expected change.

During the wettability test, on average the amount of water absorbed by the modified cake is more than the amount absorbed by the original cake. The data is indictive of the modified cake being moister than its original counterpart. The fat content in the cream cheese may have influenced this as fat and water do not interact with one another without having an emulsifying agent (Jaoude et al., 2010). Due to this, the fat was repelling the water in the beaker and preventing the cake from absorbing it more readily. With the wettability test being indicative of moisture, the results of the penetrometer test, assessing tenderness, are seen to correlate. The moister the product, the more tender the product and that correlation is seen in the results for the penetrometer test. The results in Table 6. demonstrate that, on average, the modified cake is more tender than the original recipe. This may be due to the increased moisture content of the fat-free Greek yogurt and the more fluid texture in comparison to the cream cheese, as it is more solid due to the fat content. These results were expected due to the textural changes in the ingredients used in the two cakes.

Panelists Results

Seven (7) panelists, five (5) Murray State University students and 2 adult faculty members, evaluated the stickiness, sweetness, acceptability, and tenderness of the cakes. The collected data suggests that overall the panelists viewed the modified cake as more tender and stickier than the original; however, the original cake was more accepted and sweeter than the modified. The answers to the comparison questions are consistent with this data as 5/6 panelist marked the modified cake as more tender and all seven (7) panelists marked the modified cake as stickier than the original. Even though the sweetness comparison only asked if there was a difference between the two (2) cakes, three (3) panelists commented which cake they thought was sweeter. 2/3 panelists that made this comment stated that the modified cake was sweeter,

though the average response regarding sweetness was the original cake being sweeter. However, only half the panelists mentioned which cake they thought was sweeter, which could make the data seem contradictory. The results regarding the textural characteristics of the cakes were expected, however the acceptance of the cakes was not consistent with the hypothesis as the stickiness and sweetness of the modified cake seemed to be reasons why it was not as accepted among consumers.

The responses to the last question were very similar in nature, causing many of the same themes to occur between them. The two main themes were the preference of the original cake and the lowered acceptance of the modified cakes, while the subthemes being the reasons why one cake was preferred over another. All panelists commented that they preferred the original cake over the modified and the main reasons for this include the "crunchy texture, the lessened sweetness, the tenderness, and the lessened stickiness." Regarding the modified cake, the reasons that were found for the lessened acceptance were due to the cake being too sweet and sticky. These results are consistent with majority of the objective data in terms of stickiness, but some panelist found the original cake to be more tender even if the objective data shows that the modified version is more tender. This could mostly be due to personal preference of whether the panelists prefer a certain texture over another. Overall, the panelists found the modified version to be more tender, which is consistent with the objective data collected.

Confounding Variables

There are a few confounding variables to consider as they had an outcome on the results of the cakes. The first being that the panelists were not given forks to eat their samples with. This may have caused then to consider the sticky external feel of the cakes and the internal texture as well. This may have increase their ratings in the stickiness category. The other

confounding variable is that the cakes were baked the day prior to the experiment and refrigerated overnight until it was time for the experiment. The cakes were placed at room temperature for two hours to warm up naturally, but the centers of some of the pieces were not completely at room temperature. Temperature can influence the acceptability, and stickiness of the two cakes. Also, a panelists preference of certain textures could play a role if they did not like a certain texture of one the cakes they it could skew the data. Finally, one of the panelists skipped one of the comparison questions, which may have been due to the formatting of the scorecard, so the readability of the scorecard may also be a confounding variable.

Conclusion

The hypothesis for this experiment was that the modified cake would be tolerated better due to the increased tenderness and stickiness of the modified cake. However, this hypothesis was rejected as panelists preferred the original cake over the modified because it was less sticky and sweet compared to the modified. The experiment was successful in determining what factors make the original cake well accepted by the consumer and what factors inhibit acceptance. Changes to the experiment would be to provide eating utensils to the panelists, so that the rating of stickiness may not be as biased. Also, going over the scorecards and making sure that all questions have been answered would be a way to ensure that the amount of responses are equal among all scorecard questions. With this information, others can take these variable into consideration and make changes to help combat these dislikes. Further research could be done on decreasing the amount of powdered sugar in the cake and finding a substitution that will give the cake a similar texture and flavor to discover if the consumer population will be more accepting of the product if these areas of sweetness and stickiness are adjusted.

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Appendix A: IRB Approval

MURRAY STATE UNIVERSITY

Institutional Review Board

328 Wells Hall
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TO: Jessica Paine, Nutrition

FROM: Jonathan Baskin, IRB Coordinator

DATE: 10/30/2017

RE: Human Subjects Protocol I.D. – IRB # 18-058

The IRB has completed its review of your student's Level 1 protocol entitled *Projects for NTN 432, Experimental Foods.* After review and consideration, the IRB has determined that the research, as described in the protocol form, will be conducted in compliance with Murray State University guidelines for the protection of human participants.

The forms and materials that have been approved for use in this research study are attached to the email containing this letter. These are the forms and materials that must be presented to the subjects. Use of any process or forms other than those approved by the IRB will be considered misconduct in research as stated in the MSU IRB Procedures and Guidelines section 20.3.

Your stated data collection period is from 10/24/2017 to 12/1/2017.

If data collection extends beyond this period, please submit an Amendment to an Approved Protocol form detailing the new data collection period and the reason for the change.

This Level 1 approval is valid until 10/29/2018.

If data collection and analysis extends beyond this date, the research project must be reviewed as a continuation project by the IRB prior to the end of the approval period, 10/29/2018. You must reapply for IRB approval by submitting a Project Update and Closure form (available at murraystate.edu/irb). You must allow ample time for IRB processing and decision prior to your expiration date, or your research must stop until such time that IRB approval is received. If the research project is completed by the end of the approval period, then a Project Update and Closure form must be submitted for IRB review so that your protocol may be closed. It is your responsibility to submit the appropriate paperwork in a timely manner.

The protocol is approved. You may begin data collection now.

Appendix B: Consent Form

Project Title: Projects for NTN 432, Experimental Foods

Investigators: Katie Gipson, Karly Hardin, Caprisse Johnson, MaCall Key, Casey Montgomery and Jessica Orscheln

Faculty Sponsor: Jessica Paine, MS, RD, LD; (270) 809-3152

You are being asked to participate in a sensory taste panel for the food product developed as part of a class project conducted through Murray State University. In order to comply with federal regulations, if you choose to participate in this project your signed agreement to participate in this project is necessary.

You must be at least 18 years of age to participate. Your participation in this panel is voluntary and you are free to discontinue participation at any time without prejudice. The data will be confidential. No individuals will be identified in reporting the results.

A basic explanation of the project is provided on below. Please read this explanation and discuss with me any questions you may have. If you then decide to participate in the project, please sign on the space indicated.

1. ***Nature and purpose of the Project:*** The purpose of the study is to determine the acceptability of a food product developed by the investigator as compared to a similar product. In order to prevent bias the ingredients of the product will not be revealed to you until after all the tasting sessions are complete.
2. ***Explanation of Procedures:*** The investigator will ask if you have any known food allergies so that you can be eliminated from the study if allergens are present in the food. The investigator will also explain the tasting procedure to you. Samples of the foods to be evaluated will be presented to you along with a score card which will be used to evaluate various characteristics of the food. Characteristics such as flavor, aroma, texture, appearance, and overall quality may be included. Your score card and any uneaten samples will be given to the investigator when you have finished.
3. ***Confidentiality:*** Your name will be associated with your data for the purpose of tracking your responses from the tastings. However, no one but the researcher and faculty sponsor will have access to this information.
4. ***Discomfort and Risks:*** Allergic reactions to substances in the food products are a possibility, although subjects who have known allergies to the food ingredients will not be allowed to participate. Other discomforts and risks would be the same as if tasting a food at home or in a restaurant.
5. ***Benefits:*** The formula and directions for making the food products will be given to any participant who wants it after the testing is completed. It is possible that this will lead to the development of new foods that are more beneficial to health and more acceptable to the public.
6. ***Refusal/Withdrawal:*** Participation in this research is voluntary. Refusal to participate will involve no penalty and withdrawal may occur at any time without penalty or prejudice from the researcher.

This project has been reviewed and approved by the Murray State University Institutional Review Board (IRB) for the Protection of Human Subjects. If you have any questions about your rights as a research participant, you should contact the MSU IRB Coordinator at (270) 809-2916 or msu.irb@murraystate.edu.

_____ _____

Participant/s signature Date

Appendix C

Sensory and Textural Evaluation of St. Louis Style Butter Cakes

Evaluation of Sample 546

Please try Sample A, then answer the following questions regarding this sample.

Please mark the square on the scale below that expresses your overall opinion on **stickiness/viscosity** of the cake.

Very Sticky □ □ □ □ □ □ □ □ □ **Very Crumbly**

Please mark the square on the scale below that expresses your overall opinion on **tenderness/softness** of the cake.

Very Tender □ □ □ □ □ □ □ □ □ **Very Hard**

Please mark the square on the scale below that expresses your overall opinion on **sweetness** of the cake.

Very Sweet □ □ □ □ □ □ □ □ □ **Very Bitter**

Please rate Sample 546 using the following scale below.

- □ Extremely Dislike
- □ Moderately Dislike
- □ Slightly Dislike
- □ Neither like nor dislike
- □ Slightly Like
- □ Moderately Like
- □ Extremely Like

Please cleanse your mouth by drinking some water from the small cup provided.

Evaluation of Sample 302

Please try Sample B, and answer the following questions about the sample.

Please mark the square on the scale below that expresses your overall opinion on **stickiness/viscosity** of the cake.

Very Sticky □ □ □ □ □ □ □ □ □ **Very Crumbly**

Please mark the square on the scale below that expresses your overall opinion on **tenderness/softness** of the cake.

Very Tender □ □ □ □ □ □ □ □ □ **Very Hard**

Please mark the square on the scale below that expresses your overall opinion on **sweetness** of the cake.

Very Sweet □ □ □ □ □ □ □ □ □ **Very Bitter**

Please rate Sample 302 using the following scale below.

- Extremely Dislike
- Moderately Dislike
- Slightly Dislike
- Neither like nor dislike
- Slightly Like
- Moderately Like
- Extremely Like

Please cleanse your mouth by drinking some water from the small cup provided.

Comparison Between Samples

Answer the following questions regarding both samples, feel free to try both samples again.

Please mark which sample you think is more **tender/soft**? ____ 546 or ____ 302

Are samples 546 and 302 equal in **sweetness** or different? _____

Please mark which sample you think is more **sticky/viscous**? ____546 or ____302

Which sample, 546 or 302, did you prefer and why?

Comments:

Appendix D: Images

B1: Objective Tests

Bostwick Consistometer

Penetrometer

B2: Finished Products

Original Butter Cake

Modified Butter Cake

Tables

Table 3.

Comparison of Individual Trial Results for the Bostwick Consistometer Test

Trials	Original Recipe			Modified Recipe		
	Left	Center	Right	Left	Center	Right
1	1.65 cm	1.75 cm	1.65 cm	13.5 cm	13.75 cm	14.25 cm
2	1.25 cm	1.5 cm	1.25 cm	13 cm	13.25 cm	13.5 cm
3	1.25 cm	1.7 cm	1.25 cm	11.75 cm	12.25 cm	12.75 cm

Table 4.

Comparison of Trial Averages and Overall Averages for Bostwick Consistometer Test

Recipe	Trial 1 Averages	Trial 2 Averages	Trial 3 Averages	Overall Averages
Original	1.68 cm	1.33 cm	1.40 cm	1.47 cm
Modified	13.83 cm	13.25 cm	12.25 cm	13.11 cm

Table 5.

Comparison of Trial Results for Wettability Test

Recipes	Trial 1	Trial 2	Trial 3	Overall Average
Original	+ 4 g	+ 6 g	+ 2 g	+ 4 g
Modified	+ 4 g	+ 6 g	+ 8 g	+ 6 g

Table 6.

Comparison of Trial Results for Penetrometer Test

Recipes	Trial 1	Trial 2	Trial 3	Overall Averages
Original	55 mm	98 mm	67 mm	73.3 mm
Modified	89 mm	95 mm	107 mm	97 mm

Table 7.

Averages, Medians, and Modes of Panelist Scaled Data (Original Recipe)

Characteristic	Averages	Medians	Modes
Stickiness/viscosity	6.4	6	6

Tenderness/softness	7.7	8	7, 8
Sweetness	7.9	7	7
Acceptance	6.6	7	7

Table 8.

Averages, Medians, and Modes of Panelist Scaled Data (Modified Recipe)

Characteristic	**Averages**	**Medians**	**Modes**
Stickiness/viscosity	8.4	9	9
Tenderness/softness	8.3	8	8, 9
Sweetness	7.3	8	8
Acceptance	5.6	6	6

Table 9.

Comparison Questions Results

Comparison	**Modification**	**Original**
More Tender (n = 6)	5	1
Comparison	**Different**	**Equal**
Equal in Sweetness	5	2
Comparison	**Modification**	**Original**
Stickier	7	0

Table 10.

Themes of the Open-Ended Question

Theme 1: Preference of Original Cake

Sub theme: Reasons for Preference

- Crunchy
- Less sticky
- Less sweet
- More tender

Theme 2: Less Acceptance of Modified

Sub-theme: Reasons of Lower Acceptance

- Too sticky in comparison
- Too sweet in comparison