Coffee Cake, Coffee Flour

The search for a gluten-free, sustainable alternative to flour

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Abstract

Background

Coffee is a ubiquitous drink which is often taken for granted by consumers. Alongside coffee is often a small pastry like coffee cake. For those suffering from Celiac Sprue the sweet treat can lead to a trouble if it contains even a small amount of gluten. The production of the drink accompaniment often leads to a high amount of waste products which can invade water sources in the countries which produce the tasty drink. Coffee flour has been offered as a solution to both of these issues and as an added source of nutrients for the general population. Additional research is still in progress and needs to continue to determine the efficacy of coffee flour as a nutritional supplement or substitution.

Objective

The purpose of this research is to determine if coffee flour is an acceptable and appropriate substitute for wheat flour in coffee cake.

Design

For this experiment dependent variables are the wettability, cell size, and taste preference, with the independent variable was the coffee flour. A control product was made according to the pre-determined recipe along with substitutions of the flour content of 25% and extreme substitution (50%). In the final product testing each sample was assigned a number: #713 was the extreme substitution, #495 was the control, and #286 was the 25% substitution. A total of 15 participants tasted our products in an evaluation of each product. Participants were only notified of potential allergens and not told what part of the recipe had been altered.

Results

Overall participants had a strong preference for the control recipe. This sample was overall sweeter and did have a more pleasing appearance. Students had a mild preference for the 25% substitution with most responses being in the middle range of the scorecards overall.

Conclusion

The initial experiment sought to identify coffee flour as a positive substitute for all-purpose flour in a sweet baked good. Through experimentation and taste testing we found there is level of tolerance for the substitution, however, a complete substitution would not be pleasing to the consumer. Although the substitution did not have a favorable outcome, coffee flour has the potential to be a nutritious additive.

Introduction and objectives

Hundreds, if not thousands, of varieties of flours exist in the world today. With the diagnoses of Celiac Sprue on the rise in the United States, it is no wonder there are so many variations available in this country. Varietals include almond, potato, tapioca, and most recently coffee flour. The purpose of this experiment was to determine if coffee flour is a viable and acceptable substitute for wheat flour in a baked product; specifically, coffee cake. The sweet treat is a nice accompaniment to any tea or coffee, but is often unsuitable for persons diagnosed with Celiac Sprue. In addition to the cake usually requiring all-purpose flour, this particular dessert also has a streusel topping. The texture of this streusel topping can be affected by the type of flour based on granule size and other properties. This topping is not the only change, there are often changes in baking time, liquid ingredient amount, and even sugar amounts since some flours are more overpowering in flavor than others.

For this experiment, my partner and I selected coffee flour as our replacement ingredient for all-purpose flour in the Aunt Anne's Coffee Cake recipe as found on the popular website allrecipes.com. We were drawn to this cake for its high ratings as well as the pleasing flavor and texture prior to initiating the experiment. Coffee flour is produced by separating the coffee beans from the the husk or cherry after the drying of the coffee bean and prior to roasting The cherry is then dried and ground into a fine powder producing the flour which in certain ratios can serve as a substitute for flour in recipes. In typical production, the coffee cherry is a byproduct which is often discarded either into local water supplies or left in piles to decompose. Although the aim of our research began with the potential to help populations affected by Celiac disease, it became apparent the benefits of coffee flour can be associated with sustainability, economics, and even quality of life for the farmers.

Literature Review

Traditional processing of raw coffee beans into the more commonly known and accepted roasted coffee beans has many social, economic, and environmental benefits, but it is not without drawbacks. In Ethiopia, a specific type of processing called wet-processing can lead to "the production of considerable quantities of wastewater with high levels of organic matter" (Beyene, et al., 2012). These wastewaters pollute local lakes and rivers leading to negative environmental impacts and there is a risk for drinking water contamination. According to the United States Department of Agriculture's (USDA) latest coffee report nearly every country where coffee is produced, has a projected increase in the total number of bags of Arabica coffee (USDA, 2016). With the coming increase in production, the amount of byproducts will also be on the rise. There is potential for these byproducts to be diverted and be used more efficiently and more favorably as flour.

Much of the nutritional information regarding the beneficial attributes of coffee flour come from the main producer, Coffee Flour Inc. which boasts an astonishing 5.2g of fiber for each serving (1 tablespoon) of coffee flour or 21% of the daily values based on a 2000 calorie diet. The standard American is widely known to contain high amounts of processed foods with low fiber and consequently the risk of chronic disease is higher than other diets. A study on the S.A.D. found "this dietary pattern… has been blamed for contributing to our current staggering levels of overweight and obesity as well as diet-related diseases and conditions such as type 2 diabetes mellitus, hypertension, and heart disease" (Grotto and Zied, 2010). The high fiber content shows promise for coffee flour to be used as part of a standard diet to increase fiber intake.

There were many aspects of coffee flour that drew our attention, however, the increased amount of polyphenols coming from this product are of particular interest. A study of antioxidants in The American Journal of Clinical Nutrition found "evidence strongly [supporting] a contribution of polyphenols to the prevention of cardiovascular diseases, cancers, and osteoporosis and [suggested] a role in the prevention of neurodegenerative diseases and diabetes mellitus" (Scalbert, Johnson, and Saltmarsh, 2005). Since the release of this study, there has been a considerable amount of work although still not enough to provide a specific dietary recommendation for polyphenols. A study in the Journal of Food Scientists and Technologists found a higher amount of polyphenols were extracted from the coffee cherry than other agricultural byproducts such as rice bran, wheat bran, peanut husk, corn husk, and sugarcane bagasse (Vijayalaxmi, Jayalakshmi, and Sreeramulu, 2014). This particular study focused on the amounts of polyphenols, tannins, and flavonoids which could be extracted from these products to be used as dietary supplements or food additives. The study also noted a high antioxidant availability from the coffee cherry. Since coffee is one of the most widely consumed drinks in the world, it is also a major producer of byproducts from its harvesting and production this study shows promise for usage of the coffee cherry.

Method & Design

For the purposes of our study, the dependent variables are wettability, cell size, and taste preference. The independent variable is the coffee flour since we performed the experiment with this substitution. Our method began with the selection of our control recipe. We wanted to choose a baked recipe since we enjoy cakes and know it can be difficult for persons staying away from gluten to find products fitting into their diet. The Aunt Anne's Coffee Cake recipe found on allrecipes.com was the ultimate selection given the high reviews and general simplicity of the

ingredients (cost was also factored into our decision). The availability of the majority of the ingredients in the Miele Lab contributed to this decision since we would only be responsible for purchasing our experimental ingredient. The coffee flour was purchased from nuts.com, which was chosen for the positive reviews and the speed of shipment.

Control recipe.

In order to obtain a baseline subjective measurement, the control recipe was prepared according to the recipe (Appendix A). The dry coffee cake ingredients (2 cups all-purpose flour, ¾ cup of white sugar, 2 teaspoons baking powder, and ½ teaspoon salt) were mixed together in a large bowl. The egg, vanilla extract, and milk were mixed in a measuring cup separately since the recipe called for one large egg with ¾ cup of milk (or as needed). Since the recipe does not specify type of milk, we used 2% milk which was readily available in the lab. In a separate bowl the ingredients (¼ cup of all-purpose flour, 1 teaspoon ground cinnamon, and 2/3 cup of white sugar) for the streusel topping were mixed together.

This cake is meant to be crumbly when consuming, so the butter was cut into the dry mixtures and mixed until they resembled a slightly coarse combination. The milk-egg mixture was then added to the cake recipe and incorporated until the batter was completely wet but before overmixing. A previously greased and floured baking dish was then used to hold the mixture, the streusel topping was sprinkled over the top and the mixture was baked at a temperature of 350° Fahrenheit for ~27 minutes. Adjustments to the recipe were made based on the size of the baking dishes available in the Miele Lab. The original recipe called for a 9 x 13-inch pan, however, the baking dish used in the lab was 13.75 x 8.75 x 1.75 inches. We concluded the size of the pan would remain consistent for the rest of the experiment. The initial control cake

baked within the expected time and was generally well received by our peers. It had a taste which was not overpoweringly sweet and a nice fluffy texture.

Extreme substitution (50%).

Our next step in the experimental process was to perform our 50% substitution. During the preparation of this batter, we removed half of the all-purpose flour (1 cup) and replaced it with coffee flour. The substitution led to a significant change in the consistency of the batter. The mixture became viscous and difficult to spread. Since it was unlikely to yield a baked product at all, the decision was made to add milk to the recipe. Since the recipe stated "as needed" in regards to milk, we incorporated an additional 70mL of milk. This amount was measured out prior to the addition and done 10 mL at a time to avoid making the batter too thin. After some consideration, we determined the 50% substitution would be more appropriate as the extreme substitution for the purposes of this lab. The final product resulted in a rather dark product with a very dense texture. We noted the fine texture of the coffee flour was the likely culprit with the thicker batter and the denser texture.

25% substitution.

With the outcomes of the initial 50% mixture having led us to use the mixture as the extreme substitution, the replacement of 25% is considered the halfway substitution for the purposes of this experiment. The substitution of 25% of the flour in the recipe l We continued to use the same size baking dishes and also added additional milk (70 mL) to make a batter which could be more easily spread into the dish. We were able to successfully make this batter with the additional milk and no other changes to the recipe. The notable difference was in the baking time, although it is uncertain what exactly contributed to the increase in baking time the mixture was baked longer for a total time of about 31 minutes instead of the recommended 25-30 minutes

in the recipe. The 25% substitution was well received with a more subdued coffee flour flavor. At this point we considered a blind test for the subjective testing since the color of the final product was darker making it very obviously different from the control recipe. Ultimately, we decided to perform our final tests with an appearance component added to our scorecards to gain and understanding of how the appearance affected the tasters' perceptions of the cake.

Tasting.

The tasting was performed in the Miele Lab with the assistance of the five students we recruited from a nearby classroom. Our samples were labeled with randomly assigned three-digit numbers to avoid any unconscious bias. Each sample was placed on its own plate for individual evaluation and the three samples were presented to the tasters in one station. Each sample also had its own scorecard which used a 1 to 7 Likert scale (1 being the lowest and 7 being the highest) to evaluate appearance, texture, flavor, and overall impression. Generally, the scales were completed as directed, but there was one taster who used the 'overall impression' section to provide written feedback therefore these results are out of 14 surveys instead of 15.

Results & Discussion

Objective evaluation.

Coffee proved itself to be both a challenge and an adventure in baking. Since our product involved a baked pastry, we opted to use the wettability test and a cell size test. The cell size test provides "information about cell structure (including uniformity, size, and thickness of cell walls)" (McWilliams, 2012). Wettability provides information about the moistness of the finished product and "high moisture retention is synonymous with good wettability" (McWilliams, 2012). The wettability tests generally showed an increase in wettability with varying results for cell sizes. The Initial weight of coffee cake was 61.6 grams and after 5

seconds in water the weight changed to 83.5g yielding a change 21.9 grams. Additionally, we measured the amount of water the cake held on to after the wettability test was completed; for the control product this amount was 24mL. This change would be our baseline for the replacement tests. All of the cell size tests were performed outside of the lab, at my partner's home since there was no copy machine available in the lab. The cell size test test was performed on the control product with a final size of 6mm for the largest cell observed; the cells were also fairly uniform.

The extreme substitution yielded interesting results with a change of 10.5 mL from pre- to post-test. We noted the lack of moisture of the batter and attributed the lower wettability in this sample to the fine coffee flour texture. Coffee flour has a very fine texture, reminiscent of cocoa powder, and it can be inferred this change in consistency affected the wettability. Cell sizes had a wide variety of sizes with the largest being 4.0mm and the smallest at 0.5. This particular substitution had the trouble of a very dry mixture at the beginning which required longer mixing time. The cell size test results may have been altered by the overmixing.

The 50% substitution yielded a change in mass of 17.4 grams, with an initial weight of 66.8 g and a post-dipping weight of 84.2 g. This actually reflected a lesser wettability "score" for this product. The largest cell size for the 50% replacement was 7mm; this was 1mm larger than the control recipe, but still fairly uniform. This change we attributed to the smaller granule size of the coffee flour since the likely outcome of the mixture was a tighter binding of the granules allowing for larger air pockets to form within the finished product

Subjective evaluation.

Although we recruited 5 students to sample our finished product, we actually had 15 people complete our tasting and each provided us with valuable information. As previously

stated the samples were assigned random numbers and each participant was set up in a station with the three samples in front of them. We opted to have an individual evaluation sheet for each sample, therefore, each student could focus on one sample at a time. Participants were also provided with club soda and saltine crackers to cleanse their palate between tastings – a decision which proved necessary since the taste of some of the products was much stronger than others. Sample #495 was very popular and ranked the highest in appearance with 73% of respondents rating it as most pleasing (7). Sample #286 was not as popular as #495, but was ranked as having a pleasing appearance and texture, with flavor showing a variety of scores. Sample #713 had the most scattered responses, but there was some concentration of all attributes in the 3-5 range. Details of the responses can be located in Appendix B.

Conclusions

At the start of this experiment, we set out to determine if coffee flour could adequately replace wheat flour in a sweet, baked product. Through our research and experimentation, we found that there are far more benefits to coffee flour than can be addressed in just one study. The benefits to farmers and the environment alone warrant further studies and support of diverting a 'waste product' of coffee production toward a sustainable path. As a substitute for flour, we found coffee flour to be somewhat undesirable for coffee cake. The control coffee cake was very apparent from the start because of its much lighter coloring. Through this experiment, we determined coffee flour would not make an acceptable complete replacement of wheat flours to serve the population suffering from Celiac Sprue. Despite being an inadequate replacement, this could serve as an enhancer to other food products bringing the benefits of higher fiber, added nutrients, and an interesting flavor. Further research is still being conducted into the exact health benefits aside from higher fiber, but the work is promising.

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Appendix A

Aunt Anne's Coffee Cake
Prep 20 m
Cook 25 m
Ready In 45 m

*Recipe By:*Mary
Courtesy of Allrecipes.com

"This is the perfect cake for Sunday mornings reading the paper. Be prepared, it won't last long. Just like potato chips, you can't eat just one."

Ingredients

2 cups all-purpose flour
3/4 cup white sugar
2 teaspoons baking powder
1/2 teaspoon salt
1/2 cup butter
1 egg
3/4 cup milk, or as needed
1 1/2 teaspoons vanilla extract
1/4 cup all-purpose flour
2/3 cup white sugar
1 teaspoon ground cinnamon
1/4 cup butter

Directions

Preheat oven to 350 degrees F (175 degrees C). Grease and flour a 9x13 inch pan. Make the streusel topping: In a medium bowl, combine 1/4 cup flour, 2/3 cup sugar and 1 teaspoon cinnamon. Cut in butter until mixture resembles coarse crumbs. Set aside.

In a large bowl, combine 2 cups flour, 3/4 cup sugar, baking powder and salt. Cut in butter until mixture resembles coarse crumbs. Crack an egg into a measuring cup and then fill add milk to make 1 cup. Stir in vanilla.

Pour into crumb mixture and mix just until moistened. Spread into prepared pan. Sprinkle top with streusel.

Bake in the preheated oven for 25 to 30 minutes, or until a toothpick inserted into the center of the cake comes out clean. Allow to cool.

Appendix B

Lab documentation: Control

Product Development Documentation

I. Maryn Brown and Sandra Chavez, 9/23/16

Laboratory Conditions: Well-lit, clean lab area, the room was warm due to the ovens being on in the previous lab class.

II. Purpose: The purpose of this lab was to make our control recipe and perform our two objectives tests. We made coffee cake following the recipe for Aunt Anne's Coffee Cake. The two experimental procedures that we performed on the coffee cake were the wettability and cell structure tests.

III. Experimental Procedures:

We followed the recipe for Aunt Anne's Coffee Cake to make our control recipe for this lab. We preheated an oven to 350 degrees F. A 9 x 13 inch glass pan was greased with butter and flour was used to coat the butter and the excess flour was shaken out. In one bowl the streusel was made by combining ¼ cup all-purpose flour, 2/3 cup granulated sugar, and 1 teaspoon cinnamon. ¼ cup cold butter was then cut into this mixture and a pastry blender was used to combine the butter and dry ingredients until they resembled coarse crumbs. The next step was to make the batter. In a separate large bowl we combined 2 cups all-purpose flour, 2 teaspoons baking powder, and ½ teaspoon salt. ½ cup cold butter was cut into the dry mixture and a pastry blender was used to combine everything until it resembled coarse crumbs. One large egg was cracked into a measuring cup and then low-fat milk was poured over the egg until 1 cup was reached. 1 ½ teaspoons vanilla extract was mixed into the egg and milk mixture. The liquids were poured into the batter mixture and mixed until just moist. This mixture was spread into the buttered and floured glass pan. The streusel mixture was then sprinkled on top of the batter coating evenly. The coffee cake was placed in the preheated oven and baked for 27 minutes. A knife was inserted into the coffee cake and it came out clean so we let the coffee cake cool for 20 minutes. The coffee cake was then cut into 3 x 4 pieces to make a total of 12 pieces. The wettability test was then performed.

In performing the wettability test we weighed a cooled rectangular piece of coffee cake on the MyWeigh scale. 250ml of tap water was poured into a metal 8x8x2 inch

pan. A cooled rectangular piece of coffee cake was then placed into the water for 5 seconds. The water soaked coffee cake was then reweighed on the MyWeigh scale. The cell structure test had to be done outside of the lab because there was not a copy machine in the room. A cooled piece of coffee cake was placed on its side in a copy machine in order to take a photocopy of a cross section of the coffee cake. The cell structure test could not be completed at this time because we were waiting for further instructions.

IV. Results:

Wettability test results:

Initial weight of coffee cake – 61.6 grams

Weight of coffee cake after 5 seconds in water – 83.5 grams

Initial amount of water used – 250 ml

Amount of water left in pan after coffee cake soaked in it for 5 seconds – 226 ml

Cell structure test results:

[edited] Largest cell size: 6mm

Appendix C

Lab Documentation: 50% Substitution

I. Sandra Chavez & Maryn Brown, September 30, 2016
   a. Lab conditions: slightly warmer than usual from previous lab, cooled as the lab period went on likely due to fewer students in this section.

II. Purpose: Test another step in the product development project. This step involved the replacement of half of the flour in the selected recipe.

III. Experimental Procedures:
   a. Prepare the "Aunt Anne's Coffee Cake" recipe according to the website Allrecipes.com.
      i. Adjust the flour requirement to substitute 50% of the all-purpose flour with coffee flour.

Recipe:

2 cups all-purpose flour
***Modified**: 1 C AP flour, 1 C coffee flour*
3/4 cup white sugar
2 teaspoons baking powder
1/2 teaspoon salt
1/2 cup butter
1 egg
3/4 cup milk, or as needed
1 1/2 teaspoons vanilla extract
1/4 cup all-purpose flour
***Modified**: 1/8 C AP flour, 1/8 C coffee flour*
2/3 cup white sugar
1 teaspoon ground cinnamon
1/4 cup butter

In addition to the adjustment for the ingredient substitution, we used a 13.5" x 8.75" x 1.75" pan as opposed to the 9" x 13" the recipe called for. To the best of our knowledge this has minimal impact on the baking since the pan is relatively close in size to the required one.

All ingredients were added as the recipe stated, however, during the final mixing of the batter it was noted that the consistency was rather dry and would likely result in a very undesirable texture after baking. Since the recipe allowed for milk to be utilized "as needed" we opted to add more milk. In total we added 70ml of 2% milk which allowed the batter to become softer and slightly easier to spread into the greased pan.

Figures:

Figure 1

Figure 2

Figure 3

Figure 1: Batter prior to the addition of 2% milk

Figure 2: Batter after adding 70ml of 2% milk

Figure 3: Final Product

Test Results:

Wettability:

A slice of coffee cake was weighed and set in 250ml of water for 5 seconds. The portion was weighed again after the submersion.

Cake weight prior to test	77.5 g
Cake weight after test	88.0 g
Water before test	250 ml
Water after test	238 ml

Cell Size:

Cell sizes ranged from 0.5mm to 4.0mm. these results varied from the control recipe which showed larger cell sizes.

IV. Results & Discussion:

The final product appeared much darker than the control product created in Week 5. This was likely due to the darker color of the coffee flour. The darker color may have also affected the perception of the coffee cake itself since many of our fellow students were taken aback at the fact that it did not taste like a brownie. The darker coloring fooled many of our peers into thinking chocolate had been added. For our final product tasting, we are now considering requiring a blind test to avoid this bias – especially since the control recipe is very light. During the process of measuring ingredients, we noted the very fine texture of the coffee flour, which likely contributed to the dryness of the initial batter and the tests we performed after baking.

The finer texture is also a challenge since it can change the actual amount of flour being used. Since the recipe does not use weights and instead uses measurements such as cups and tablespoons, it is difficult to say if the exact amount was used. Another possible impact of the texture of the flour was the cell size test which resulted in smaller cells than in the control experiment. Smaller cells can also be attributed to a longer mixing time since more milk had to be added to make the batter workable – this resulted in longer mixing.

The wettability test for this sample resulted in less wettability which was surprising given the texture being chewier than the initial recipe. This likely was a result of the finer texture of the flour. Since the directions for the project call for a direct replacement of the ingredients rather than making them work as a whole, we feel that this is something we may run into going forward with other samples. It is likely that we could adjust the recipe to produce a more favorable product if we weighed the flour instead of simply measuring one cup.

Appendix D
25% Substitution

I. Sandra Chavez & Maryn Brown, October 28, 2016
   a. Lab conditions: Lab was temperate most of the period, weather had recently been rainy so there may have been some humidity changes.

II. Purpose: Test another step in the product development project. This step involved the replacement of one quarter of the flour in the selected recipe. It was decided that the 50% substitution would yield the highest amount of acceptable product substitution, therefore, a 25% substitution was determined to be the next step.

III. Experimental Procedures:
   a. Prepare the "Aunt Anne's Coffee Cake" recipe according to the website Allrecipes.com.
      i. Adjust the flour requirement to substitute 25% of the all-purpose flour with coffee flour.

Recipe:

2 cups all-purpose flour
***Modified**: 1½ C AP flour, ½ C coffee flour*
3/4 cup white sugar
2 teaspoons baking powder
1/2 teaspoon salt
1/2 cup butter
1 egg
3/4 cup milk, or as needed
1 1/2 teaspoons vanilla extract
1/4 cup all-purpose flour
***Modified**: $^{1}/_{8}$ C +1 Tbsp. AP flour, 1Tbsp. coffee flour*
2/3 cup white sugar
1 teaspoon ground cinnamon
1/4 cup butter

As stated in previous lab documentations, we used a 13.5" x 8.75" x 1.75" pan as opposed to the 9" x 13" the recipe called for.

All ingredients were added as the recipe stated, however, during the final mixing of the batter it was noted that the consistency was rather dry and would likely result in a very undesirable texture after baking. Since the recipe allowed for milk to be utilized "as needed" we opted to add more milk. In total we added 70ml of 2% milk which allowed the batter to become softer and slightly easier to spread into the greased pan.

Figures:

Figure 4 – Batter showing better texture and easier spreading than prior sample

Test Results:

Wettability:

A slice of coffee cake was weighed and set in 250ml of water for 5 seconds. The portion was weighed again after the submersion.

Cake weight prior to test	66.8 g
Cake weight after test	84.2 g
Total change	**17.4 g**

Cell Size:

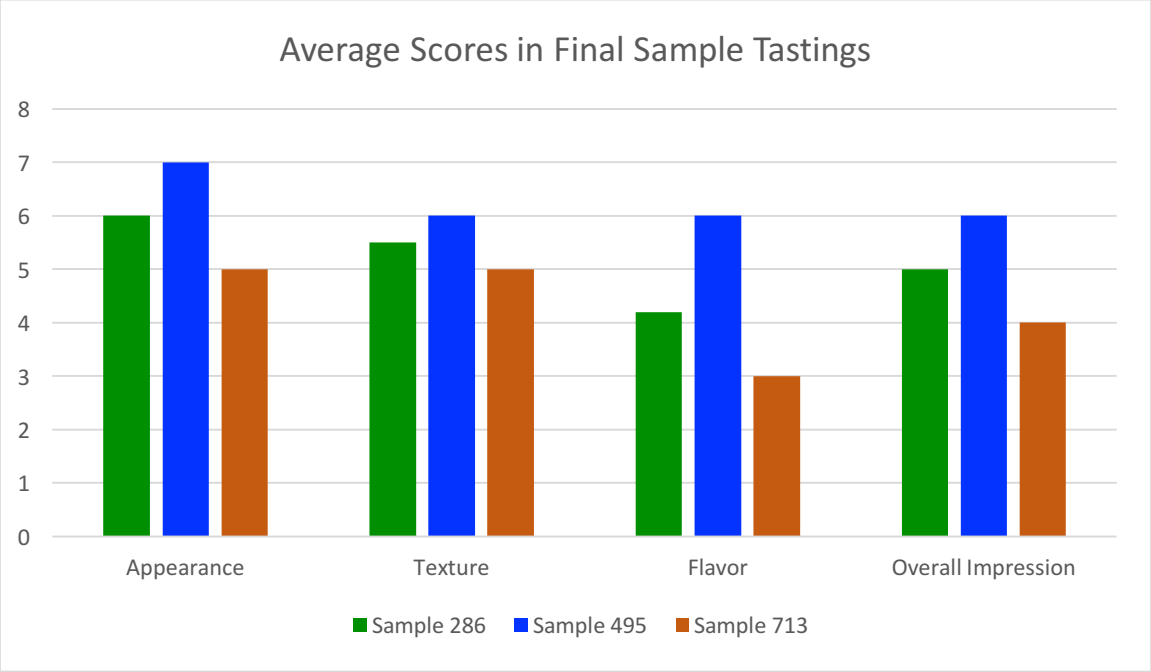
Cell sizes were larger in this sample with the largest being 7mm in diameter; the lower amount of coffee flour likely allowed for this increase in cell size. Physically, the granules of coffee flour are finer than that of AP flour generally yielding a denser product, but with this substitution we can see a better result.

IV. Results & Discussion:

In week 6, we tested the product with a 50% substitution which resulted in the need for additional milk to adjust for the moistness of the batter – the batter was un-spreadable before we added milk. We concluded that the 50% substitution would instead serve as the 100% substitution for the product since a complete substitution of coffee flour would likely result in an inedible product and would veer too far from the original recipe. This substitution validated our hypothesis of lowering the substitution amounts. According to feedback we received from some classmates, the 25% substitution worked well. This substitution led to a higher baking

time – the streusel topping did not bake as quick as the remaining product. The baking time was increased to ~31 minutes; this is an increase from the recipe's instructions of 25-30 minutes. The final product appeared darker than the control product in Week 5, but significantly lighter than the 50% substitution. The flavor profile still had the touches of fig and somewhat fruity flavors although more subdued than the higher substitution. Overall, this appeared to be a pleasant substitution. The wettability test yielded an increase in mass of 17.4 grams. This is a much higher change in weight than the higher substitution. The wettability test shows this product to be more desirable than the 50% substitution.

Appendix E
Product Evaluation Results



Overall, sample 495 scored higher in all categories over the other selections. Sample #495 was the control recipe and had distinct characteristics from the other two samples.

Appendix G

Raw Data from Trials

On a scale of 1 to 7 (with 1 being the least pleasing and 7 being the most pleasing) how do you feel about the coffee cake? Please write the # of which coffee cake you are tasting.

Coffee Cake #495	1	2	3	4	5	6	7
Appearance					1	3	11
Texture				1		6	8
Flavor				2	1	4	8
Overall Impression				1		7	6

one person left overall blank

On a scale of 1 to 7 (with 1 being the least pleasing and 7 being the most pleasing) how do you feel about the coffee cake? Please write the # of which coffee cake you are tasting.

Coffee Cake #713	1	2	3	4	5	6	7
Appearance		2		4	3	3	3
Texture		1	3	3	4	4	
Flavor	3	1	5	4	2		
Overall Impression	1	3	3	1	5	1	

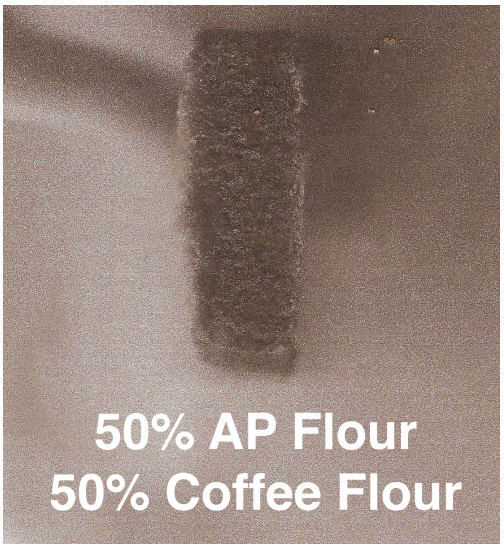
one person left overall blank.

On a scale of 1 to 7 (with 1 being the least pleasing and 7 being the most pleasing) how do you feel about the coffee cake? Please write the # of which coffee cake you are tasting.

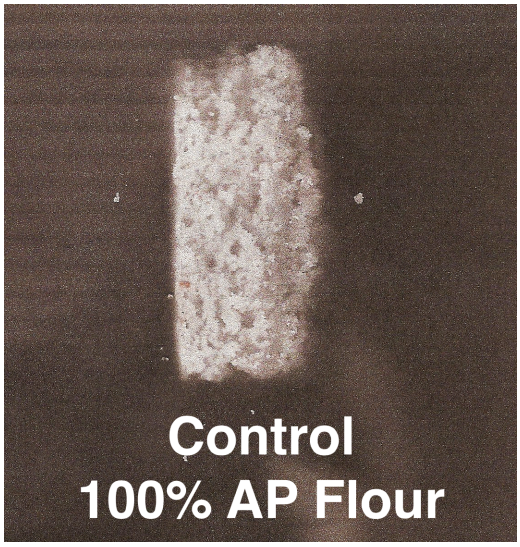
Coffee Cake #286	1	2	3	4	5	6	7
Appearance			1	2	2	7	3
Texture			1		6	6	2
Flavor	1	2		4	3	4	1
Overall Impression		2	1	2	5	2	2

one person left overall blank-(had all 6's in the other categories).

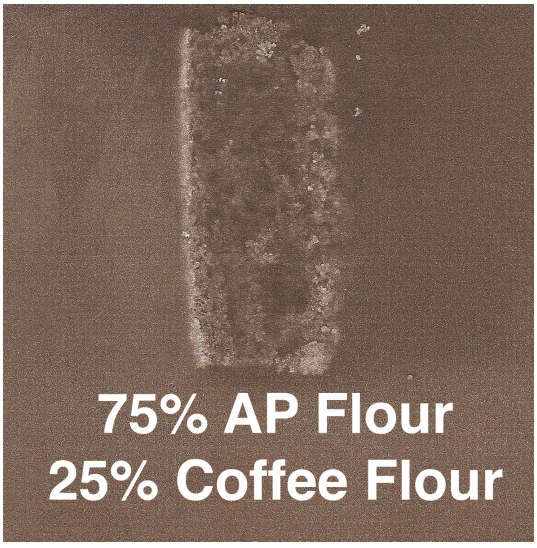
Appendix H
Cell Size Test Samples



Sample #713
Largest Cell Size: 7 mm
Mostly uniform



Sample #495
Largest Cell Size: 6 mm
Mostly uniform



Sample #495
Largest Cell Size: 4 mm
Range: 0.5-4mm – not uniform