Substitution of Eggs for Ground Flaxseed in Baked Products

Among Cardiovascular Diseases and Cholesterol Levels

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DFM Experimental Food Study

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December 10, 2014
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Abstract

Flaxseeds contain a large amount of dietary fiber which have shown to lower low density cholesterol levels and improve cardiovascular conditions. They also have similar functional properties to eggs, and can be used as an alternative emulsifying agent for people with cardiovascular problems. Three different recipes were tested; a control recipe using just eggs, a partial substitution recipe using 50% ground flaxseeds and 50% eggs, and an experimental recipe using 100% ground flaxseeds.

Objective evaluations were performed to test volume and moisture. The results showed minimal volume differences between the three samples before and after baking. The wettability test showed a slight increase in moisture, with more water retention in the experimental sample. In addition, sensorial evaluations were conducted for each sample to determine if substituting ground flaxseeds would alter the color, texture, flavor, and the overall acceptability of the cake. The subjective evaluation showed similarities responses in the texture preferences, 36% of the evaluators reported a strong desirability towards the texture of the control and the experimental samples. The overall acceptability was higher for the experimental sample containing the ground flaxseeds, at 39% versus the control at 36%. This suggests that flaxseeds had minimal variations on subjective and objective characteristics and thus would be an attractive alternative for individuals who are looking to lower their cholesterol and improve their cardiovascular health.

Introduction/Purpose

Flaxseeds are a good source of soluble and insoluble fiber about 4 grams of ground flaxseeds provide about 3 grams of fiber. In addition, flax seeds also contain omega-3 fatty acids, protein, vitamin E, some B-group vitamins and minerals (Martinchik, Baturin, Zubtsov & Molofeev, 2012). The Academy of Nutrition and Dietetics (2013) suggest an intake of 25 grams
of fiber per day for adult women and 38 grams for adult men. However, the consumption of dietary fiber among Americans is only about 15 g/day; this may increase the chances of developing cardiovascular disease, obesity, metabolic syndrome and some types of cancers. The Academy states that an adequate fiber intake has been positively associated with lowering Low Density Lipoprotein Cholesterol (LDL-C) levels, in addition to reducing risk factors for several chronic diseases.

The purpose of the experiment is to determine the effectiveness of replacing ground flaxseeds for eggs on subjective and objective characteristics. Flaxseeds contain an abundance of lignans, which gives them a gelatinous consistency and the ability to bind water in addition to the capacity to function as an effective thickening and emulsifying agent. These properties make for a more appealing and healthier alternative to eggs in baking cakes and muffins. Different experiments were performed to test and evaluate a control sample, containing only eggs; an intermediate sample using 50% eggs and 50% flaxseeds and finally an experimental sample using 100% flaxseeds.

**Review of Literature**

Research have shown a positive impact in the uses of flaxseed; Bloedon et al. (2008) conducted a study over sixty-two men and post-menopausal women, using a double blind, randomized, controlled trial method incorporating baked products with wheat versus products with flaxseeds among participants. Results reflected that flaxseed participants had a 13% decrease in LDL-C levels, after 5 weeks of consuming baked products containing 40 g/day of ground flaxseed; moreover, participants also showed a reduction on insulin resistance levels by 23.7%.
In additional research, a randomized placebo-controlled parallel study was conducted in China, where 189 participants between the ages of 35 and 65 years, at risk for metabolic syndrome, showed a significant increase in n-3 PUFAs, α-linoleic acid, eicosapentaenoic acid and docosapentaenoic acid in blood levels when comparing to placebo group. Control group received 30 g of ground flaxseed in capsule form to take once every day during a 12 week period. This experiment eliminates dietary variables by controlling diet for individuals in both groups (Zong, Demark-Wahnefred, Wu & Lin, 2012).

Therefore, The Academy of Nutrition and Dietetics (AND) recommends flaxseeds as a good source of fiber; each teaspoon of whole ground flaxseed provided three grams of fiber. Furthermore, flaxseeds contain a good source of omega-3 fatty acids, which have aim to reduce cholesterol levels, reduce inflammation and lower risk for certain type of cancers. The A.N.D., also suggests that the best way to consume flaxseed is by grinding the whole seed; our body is unable to break down the whole seed and access to fatty acids; by grinding the seeds we can access to fatty acids and still take advantage of fiber on the seeds (AND, 2013).

The two important characteristics of flaxseeds are its ability to attract and bind water, and its limited caloric contribution when consume (Rodriguez-Leiva, Bassett, McCullough & Pierce, 2013). Flaxseeds are gums, a complex hydrophilic carbohydrate composed of monosaccharides other than glucose, and undergo into minimal digestion in the small intestines. For this reason, they are classified as soluble fiber. The fact that gums are digested and absorbed quite inefficiently comparing with sugar and starches, makes them useful in food products aimed at weight conscious consumers. The most effective calorie savings are seen when gums are used to replace fats and oils, where gums provide about 1 and 3 calories per gram versus fat which contributes 9 calories per gram (McWilliams 2012). Therefore, flaxseeds chemical
characteristics exhibits several health benefits such as reducing low density cholesterol levels and incrementing anti-inflammatory precursors in blood, in addition to their low calorie content (Mahan, Escott-Stump & Raymond, 2012).

**Method and Design**

*Procedure*

The experiment was conducted over a 4 week period; the first step was to work in our controlled recipe and standardize amount of ingredients. We used school ovens and Karla’s house oven. We did not include or consider cooking time as a variable into this experiment, because we want to have three samples optimally cooked. Therefore, final testing samples were elaborated at Karla’s home in order to allow a correct cooling process for the cake which aims to be between 3-4 hours after baking.

In our first lab experiment, we worked on the control recipe; for this procedure, the first step was to preheat the oven at 350°F for at least 5 minutes; then, a Pyrex (8 x 4 x 2 ½ in) container was greased and set aside; thereafter, dry ingredients were mixed; flour, cinnamon, baking soda and salt, were sifted it into a medium bowl; in a different bowl oil, eggs/flaxseeds and sugar were also mixed. A third bowl included the rest of the ingredients. All the ingredients were mixed together in one bowl, and then transferred into our Pyrex container and placed in the oven for about 40 to 55 minutes. To determine if the cakes were baked completely a toothpick was inserted into the middle; considering that there were fully cooked until toothpick came out without residuals from batter.

According to Patrick-Goudreau (2007), one teaspoon of ground flaxseed and 3 teaspoons of water is equivalent to one egg: flaxseeds need to be ground in a coffee maker and soaked in water for 5 minutes before using as eggs substitution. Recipes were distributed as following: the
control recipe uses 100% eggs, the experimental uses 100% ground flaxseeds; and a third intermediate sample, using eggs and ground flax seeds (50/50) was included in the experiment. To assess if the cakes were done we used a toothpick to insert into the center of the cake. Coke was consider fully bake when toothpick showed no batter residue. These steps were followed for each one of the three cakes.

Study Design

A controlled experimental design was implemented to compare differences between flaxseeds and eggs in baked products. Therefore a third sample containing 50% of the control and 50% of the experimental ingredient was developed to use as an intermediate comparison.

Objective Measurement

The volume was measured before and after baking for each one of the three samples. The measurement was done from the base of the pyrex container to the top of the cake before and after baking. Immediately, after the cake was removed from the oven, the height measurement was taken using the same instrument. Additionally, a wettability test was performed after the cake was cooled down. A small square sample was taken from each of the three cakes and standardized in weight at 20 grams. Each sample was submerged in water for five seconds, and weighed immediately after to detect moisture differences between baked products.

Subjective Measurement

Cake samples were cut into small pieces and placed into cups in designated rows. Each cake was given its own random three digit number. Evaluation sheets using a hedonic scale were placed close to the samples. Evaluators were allowed to rate color, texture, flavor and overall acceptability on a 1-7 scale with 1 being the least acceptable and 7 the most acceptable.
Data Analysis

Data from the subjective evaluation was collected and graphically analyzed using Microsoft Excel and displayed on 12 pie charts. These graphs are based on the total number of individuals (36) who evaluated the 4 subjective characteristics according to personal preferences for each of the three samples.

Results

The intention to improve health benefits among baked products by substituting eggs for flaxseeds was the main objective of this experiment. Subjective and two different objective evaluations were conducted to analyzed outcomes of each experiment. During the initial phase when standardizing our control recipe, some modifications among sugar and oil were made. There was a common dislike when tasting the first control product with individuals reporting that the cake tasted oily and sweet. Consequently, sugar and oil in were cut by half from the original recipe. Adjustment was successful and used for each of the followed experiments.

Objective Results

The volumes for each of the three cakes were measured using the appropriate instruments before and after baking. Before baking, the control, 50/50 and the experimental volumes were 56, 56, and 60 cubic inches respectively. After baking, they expanded to 88 cubic inches for the control, 96 cubic inches for the 50/50 and the experimental samples. The control had an increment of 32 cubic inches; the 50/50 by 40 cubic inches and the experimental cake 36 cubic inches (Appendix D-4, Table#1).

Moisture was examined using a wettability test; the results showed that the experimental sample, 100% flaxseed, had the highest water-retention. All three samples were weighed and standardized at 20 grams before being immerse in water. After they were submerge for five
seconds the values for the control, 50/50 and the experimental were 25.5, 24.6 and 26.6 grams respectively. While the control had a 5.5 grams increment and the 50/50 only 4.6 grams, the experimental sample had the biggest increase in water retention with a 6.6 gram increment (Appendix D-4, Table #2).

Subjective Results

Subjective characteristics were evaluated for each of the three experiments using a hedonic scale. The most relevant data is from the final public testing when evaluators had the chance to taste the three samples at the same time. Graphs #1-3 reflect color preferences among the three cakes. Color preferences were found to be higher among the 50/50 recipe where 53% of the evaluators found it more appealing (Appendix D-1). Therefore, color preferences among control and experimental cakes were ranked closely with an acceptance of 47% and 44% respectively (Appendix D-1, Graphs #1, #3). Additionally, 6% of the evaluators ranked the lowest color preferences among the experimental cake (Appendix D-1, Graphs #3).

When analyzing texture, Graphs #4-6, evaluators reviewed the 50/50 recipe to be their favorite over the other two. 42% of testers found the 50/50 recipe more appealing when evaluating the texture (Appendix D-2). The control and the experimental cake had similar ranking results at 36%. For both cakes the evaluators rated the texture with a 7, which indicates a strong desirability (Appendix D-2, Graphs #4, #6).

Flavor preference shown on Graphs #7-9, revealed that most of the evaluators enjoyed the flavor of the control over the other two samples. About 42% of the evaluators rated 7 on the flavor, indicating a strong desirability (Appendix D-3). Flavor preferences for the 50/50 and the experimental samples were slightly similar; at 39% for the 50/50 and 36% for the experimental. Moreover, according to flavor preferences, the 100% flaxseed sample only had a 3% of
unacceptability rating whereas the 50/50 recipe had the highest at 5%. (Appendix D-3, Graphs #7-9).

Finally, on Graphs #10 – 12 the overall acceptance of the three samples was evaluated and the results revealed that the 50/50 recipe has the highest ranking %. About 42% of the total evaluators rated this sample as 7; indicating their strong desirability towards the sample as a whole. The 50/50 was closely followed by the 100% substitution recipe at 39% and then the control came in last at 36% (Appendix D-4, Graphs #10-12).

Discussion:

The results of the present study demonstrate that using ground flaxseeds in replace of eggs in baling products, does not significantly alter physical or sensorial characteristics of the final cake product. Despite slight differences were observed between the three samples; additionally, the tasters rated the 50/50 sample the best on 3 of the 4 subjective preferences. Therefore, when considering all evaluation levels, the control showed the highest overall acceptance out of the three samples.

We observed small variations in volume when comparing the three samples before and after baking. The 50/50 sample expanded after baking more than the experimental sample by 4 cubic inches, which is not a significant variation. However, the small difference in volume may have been due to poor measurement procedures, or the fact that the cakes were made and measured on different days. Even though, a different texture containing more holes left from the CO2 gas bubbles during baking was easier to appreciate in the control recipe.

The wettability test revealed that the experimental sample had the highest water retention. Therefore, the difference in grams between the three samples did not have a considerable range. The control weighed 1 gram more than the 50/50 sample and the experimental weighed 1 gram
more than the control after being steeped in water. Results were expected to be highest on the experimental sample and diminish gradually towards the control; as a result of flaxseeds having a stronger water binding. However, the control surpassed the 50/50 sample by about a gram, and may have been due to a lack of standardization with the weighing and timing process between the samples.

The main objective of the study was to explore the uses of flaxseeds as an alternative of eggs in baking products. Therefore, after reviewing all the data obtained from the subjective evaluation, all the three samples had very similar results among the four categories that were evaluated. As was review in the results section, the 50/50 sample ranked highest in 3 of the 4 categories; only the flavor preference failed short. Additionally, evaluators seemed to enjoy the combination of both eggs and ground flaxseeds on appearance, texture and overall acceptability. This corroborates that using flaxseeds instead of eggs in baking products can be an effective and healthier alternative.

Although the control recipe had the highest ranked overall preference it was only higher than the experimental by 3%. Despite when using a subjective evaluation, it is difficult to assess an evaluator's preference because each person has a different palate and experiences each taste at different levels. However, health benefits among each sample were not exposed among evaluators; the main differences among the cakes were that, the experimental cake had 6 grams of fiber and do not have cholesterol while the control recipe do not have fiber and had more than 700 milligrams of cholesterol; additionally, according to the A.N. D the fatty content in flaxseeds provide fatty acids omega 3, omega which help to reduce inflammation and lower cholesterol levels (AND, 2013). In addition, using three tablespoons of ground flaxseeds (111 Kcal) in
replacing 4 eggs (320 Kcal) cuts about 200 calories from the entire cake because flaxseeds have 1-3 calories per gram versus fat which is 9 calories per gram (McWilliams 2012).

**Conclusion**

Overall using flaxseeds reveal minimal differences in subjective and objective evaluations. With that said, flaxseeds are a healthier alternative to consider when substituting for eggs within baked goods, additionally, it produces similar final products that those that uses eggs. As was reviewed, Americans under consume the recommended daily amount of dietary fiber, and by consuming baked products containing flaxseeds they can easily improve their fiber consumption and incorporate additional benefits that are closely linked to flaxseed and fiber; therefore the use of flaxseeds in baked goods is also a good alternative to lowering calories in products. Moreover, the omega 3 fatty acids found within this seed, can help to lower cholesterol in individuals suffering from cardiovascular diseases and want to enjoy a nice treat once in a while. To conclude, the unique characteristics and nutritional benefits that come from flaxseeds outweigh the health cost of consuming a baked product that uses eggs.
References


Lab #1 – Carrot Banana Cake Control Evaluation

Date: October 17, 2014

Laboratory Conditions: We prepared the carrot-banana cake at Karla’s house the night before using her oven which is newer and heats.

Purpose:
To create a product that can be used as a reference to compare with our 50/50 (50% eggs, 50% flaxseeds) and with experimental product.

Experimental Procedures:
1. Preheat oven to 350°F. Grease a pyrex container
2. Sift first 4 ingredients into medium bowl
3. Whisk oil, sugar, brown sugar and eggs in large bowl until well blended
4. Mix in dry ingredients
5. Add carrots, pineapple, banana, pecans and blend well
6. Transfer batter to prepared pyrex container
7. Bake until tester inserted near center of cake comes out clean. About an hour
8. Let cake stand in container 10 min.
9. Turn out cake onto rack and cool

Results:
Subjective evaluation:
Please refer to Appendix D-4

Objective Evaluation:

Discussion:
For our first control evaluation we baked the standard recipe to use as a reference for our experimental project. As we started to combine the ingredients, we noticed that the recipe asked for a lot of sugar and oil; we also realize that the recipe was too big for elaborating a similar batch each time, serving size was for 12 people. However, we decided to follow instructions fully and make any adjustments needed later. After combining the wet and dry ingredients, batter looked watery, so we decided to add a little more flour to make the batter thicker. Right after, we
poured mixture into a pre-greased pyrex container and placed it into the oven; baking time was close to an hour.

We observed the exterior to have a nice dark brown color to it with speck of orange from the carrot and lumps of pecans spread throughout.

The next day took half of the cake into class and let the other students to try and give feedback about the control. The class was able to rate on a Likert scale from 1-5 being 5 the highest ranking level; the students rated for the appearance was 4.29; the majority of the students liked the appearance. Once the cake was cut, the interior look was light brown with bits of orange from the carrot.

The average rating for the taste was also 4, indicating that in average student liked the taste. Students also rated the texture; desirability on texture ranged from 2-5, having as an average a desirability of 4, which means that most people liked the texture of the cake.

Finally in the comments section students describe that the cake was very moist and chewy. The moistness of the cake may have been due to the large amount of oil used to bake the cake. In addition, when making the cake, we noticed that the batter was watery, we do not knew exactly why the batter was that watery but this may have been caused by the mashed up banana or for draining incorrectly the canned shredded pineapple which could have contributed the extra fluid.

After reviewing the evaluations and comments on the control recipe; we decided to bake another cake and amount of sugar and oil by cutting both ingredients by half. Under the comments section we received some helpful information. One comments said, “There’s a savory flavor possibly from the oil that was used?” Other comments said that the cake had lots of flavor and that it tasted too sweet.
Pictures from Experiment #1
Lab #2 - Banana-Carrot Pineapple Cake, control and 50/50 development

Date: October 24, 2014

Laboratory Conditions: The second experiment was made in lab. There were problem with the oven not working and heating properly.

Purpose:
To create a product that can be used as a reference to compare with our 50/50 and experimental product: additionally an intermediate but also creating a product that contains 50% of the experimental ingredient to determine any subjective or objective differences in the final product as compared to the control.

Experimental Procedures:
1. Preheat oven to 350°F. Grease a pyrex container
2. Sift first 4 ingredients into medium bowl
3. Whisk oil, sugar, brown sugar and eggs in large bowl until well blended
4. Mix in dry ingredients
5. Add carrots, pineapple, banana, pecans and blend well
6. Transfer batter to prepared pyrex container
7. Bake until tester inserted near center of cake comes out clean. About an hour
8. Let cake stand in the container for 10 min.
9. Turn out cake onto rack and cool

Result:

Subjective evaluation:
Please refer to Appendix D-4

Objective Evaluation:

Table # 1: Volume Comparison among control and 50/50 recipe

<table>
<thead>
<tr>
<th>Name of the Product</th>
<th>Volume before Baking (Inches)</th>
<th>Volume after Baking (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Cake (100% eggs)</td>
<td>56in.³</td>
<td>88 in.³</td>
</tr>
<tr>
<td>50/50 Cake (50% eggs &amp; 50% Flax seeds)</td>
<td>56in.³</td>
<td>96in.³</td>
</tr>
</tbody>
</table>
**Discussion:**

In our second experiment we worked on the 50/50 cake as well as the control. We worked again first on the control to corroborate that changes made in recipe do not alter the product that we are looking.

In lab we prepared all the ingredients from the original recipe; this time we used only half or the total recipe in order to have a smaller cake. In addition, we used half the amount of oil and sugar for both products to observe and evaluate again differences in the flavor and texture. For this second experiment, we measured the volume before and after baking to see if there were any differences between the two cakes.

As we began preparing our two products we noticed that the ovens were not working correctly. They took longer than usual to pre-heat which and ended up taking longer for us in finishing the cake and in having sample the cake. We prepared the two cakes, separated them and labelled with a random three digit numbers for each. The control received the number 275 and the 50/50 was 648.

When mixing the ingredients, we noticed that the 50/50 had a more fluid/gelish consistency than the control. This was probably due to the gelatinous nature of flaxseeds when they are soaked in liquids. Both of the products were placed in the middle of the oven and equally apart from each other. After 37 minutes, the control finished baking so we removed it from the oven and allowed it to cool. However, the 50/50 stayed in the oven for an additional 8 minutes; totally 45 minutes of baking. This may have been due to the flax seeds which have a tendency to hold water and may require more time during cooking to evaporate that extra water.

The control cake came out and had a golden brown exterior with a slight crunch; it also had chunks of pineapple, slivers of carrot and pieces of pecans spread throughout. For this second experiment we used chunks of pineapple in the can versus the crushed pineapple, which is why we see more of the pineapple than before. The 50/50 product had a dark brown exterior due to either the flaxseeds or the additional heat needed to bake the cake. Texture, appearance and taste were evaluated again with both the control and the 50/50. When reviewing the evaluations, we noticed that the majority of the students loved the texture, appearance and taste of the control product. Students thought that the texture was light, fluffy and soft; the appearance was colorful with nice browning and the taste was great overall, not too sweet and balanced. The 50/50 product had mixed reviews about texture, appearance and taste. There were only 2 students
who loved the texture and 6 students that liked the texture. Most of the comments reported that
the cake was too moist. Flaxseeds are a good source for soluble fiber, as we review in class,
soluble fiber tends to hold water which may have been a reason why the interior of the cake was
still a little moist. However, the ovens are very old and do not heat evenly throughout the
interior, so that cake may be undercook in some parts and this can be contributing factor as well
for that moisture. Students reported that they loved the appearance, and some thought it looked
appetizing, but we also received a comment that the cake looked too dark. The appearance of the
50/50 being too dark could have been due to the extra time needed in the oven to bake and or the
flaxseeds giving a darker color. The average of all the students who tried the cake reported that
they “like it”, and some comments stated the taste had a nice balance and wasn’t too sweet or
sugary.

Objective tests were done to observe differences in volume between the control and the
50/50 product. We measured the volume of the control and the 50/50 sample both cakes were 56
cubic inches before placing them in the oven. After they finished baking, we measured the
volume again using the same methods and tools. The volume of the control grew to 88 cubic
inches, while the 50/50 sample grew to 96 cubic inches. In addition we visually noticed a
difference in height between the two cakes after they were pulled out of the oven. However, as
time went by, the volume for the 50/50 cake gradually fell and rather quickly; unfortunately we
did not took a measurement again, because some samples were already cut.
Pictures from Experiment #2

Flaxseeds soaked in water

Mixing flaxseeds with eggs

Pouring liquid into dry ingredients

Karla’s working in Lab
Dry-wet mixing

Rest of the ingredients

Pyrex pan

Control -50/50 before baking
Lab #3 – Carrot Banana Cake 100% Flax Seed Evaluation

Date: November 14, 2014

Laboratory Conditions: The third experiment was made in the PM lab. There were no issues with the oven this time.

Purpose:
To create a product that contains 100% of the experimental ingredient and to evaluate subjective or objective measurements.

Experimental Procedures:
1. Preheat oven to 350°F. Grease a pyrex container
2. Sift first 4 ingredients into medium bowl
3. Whisk oil, sugar, brown sugar and eggs in large bowl until well blended
4. Mix in dry ingredients
5. Add carrots, pineapple, banana, pecans and blend well
6. Transfer batter to prepared pyrex container
7. Bake until tester inserted near center of cake comes out clean. About an hour
8. Let cake stand in the container for 10 min.
9. Turn out cake onto rack and cool

Result:

Subjective Evaluation:
Please refer to Appendix D-4

Objective Evaluation

Table # 2: Volume Measurement in Experimental Cake

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Volume before Baking (inches)</th>
<th>Volume after Baking (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Cake</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(100% Flax Seeds)</td>
<td>60 in.³</td>
<td>96 in.³</td>
</tr>
</tbody>
</table>

Discussion:
The third experiment was a complete substitution of eggs from flaxseeds, sensory evaluations was used again to assess variances in texture, taste and appearance. In addition, an
objective evaluation method was implemented in the same way that we implemented in the other cakes.

We followed the same procedures from the second experiment. In addition, more time cutting and chopping the pineapple chunks into smaller pieces was spend, we looked through have them more dispersed throughout the cake. We used a coffee blender to ground up the flaxseeds to replace the eggs in the cake. Each tablespoon of flaxseed was soaked it in 3 tablespoons of water for five minutes before being mixing with other ingredients. We found out in a vegan baking book that for each egg, one tablespoon of flaxseed with three tablespoons of water should be added. this recipe asked for 4 eggs, subsequently we added it 4 tablespoons of flaxseeds and 12 of water. In addition, same pyrex container (8 in x 4 in.) was used to accurately measure and compare the volume between samples.

Immediately, after removing the cake from the oven we noticed that the cake had a nice shiny, dark brown exterior and a golden brown interior with specks of yellow and orange spread throughout. The cake was baked for approximately 42 minutes. In addition, we noticed that it was very tender and breakable when we removed it from the pyrex container. Also, after cutting into the cake we saw two distinct layers. There was a top layer that was cooked through and a bottom layer that was darker and moister. This may have been due to the ovens that may not be heating equally. We realized that the more flaxseeds is used within a product, a longer cooking time is required.

Students reported that the appearance was colorful and nice; additionally, they report that the cake tasted not too sweet. The texture of the cake received mixed reviews and some students commented that it was very soft and that it also stuck to the roof of their mouth. We personally thought that some of the cake was still under cook, even though this was still a hard assumption because we did not allow the cake to cool down properly; additionally, this may have been to the increased amount of flaxseeds which can cause more of a gelatinous texture and make products stickier.

In addition to the sensory evaluation, we also used objective testing to determine differences in volume that may have been caused by the flaxseeds. The initial volume before the cake was placed in the oven was 60 cubic inches, and after baking the volume grew to 96 cubic inches. In the previous experiment we saw a 32 cubic inch increase from the control and a 40 cubic inch increase in the 50/50 product. The 100% flaxseed resulted only in a 36 cubic inch
increase in the volume after baking. This is value was smaller in compared to the 50/50 product, and that may have been due to poor measurement procedures when preparing the ingredients.

**Pictures from Experiment #3**

![Experimental Cake](image1)

![Consistency of experimental cake](image2)

![Experimental Samples](image3)
Lab #4 – Final Banana-Carrot Pineapple Trial Using Control, 50/50 and Experimental Cakes

Date: December 5, 2014

Laboratory Conditions: We baked the cakes at Karla’s house where we used her oven which is newer than the ones found in lab. In addition we used aluminum half pans instead of using the pyrex containers in lab.

Purpose:
To perform a final subjective and objective test that will assess the evaluators’ desirability, and determine any differences with the moisture of the three cake samples.

Experimental Procedures:
1. Preheat oven to 350°F. Grease a pyrex container
2. Sift first 4 ingredients into medium bowl
3. Whisk oil, sugar, brown sugar and eggs in large bowl until well blended
4. Mix in dry ingredients
5. Add carrots, pineapple, banana, pecans and blend well
6. Transfer batter to prepared pyrex container
7. Bake until tester inserted near center of cake comes out clean. About an hour
8. Let cake stand in the container for 10 min.
9. Turn out cake onto rack and cool

Results:

Objective Test:

Wettability: A physical method to determine moisture in a product

Methods:
1. Sample weighed
2. Sample soaked in water for specific time (5 sec)
3. Sample weighed again to see how much water retained
Table #3: Wettability Test

<table>
<thead>
<tr>
<th>Cake Sample</th>
<th>Weight before soaking (grams)</th>
<th>Weight after soaking (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% control</td>
<td>20 grams</td>
<td>25.5 grams</td>
</tr>
<tr>
<td>50/50</td>
<td>20 grams</td>
<td>24.6 grams</td>
</tr>
<tr>
<td>100% Replacement</td>
<td>20 grams</td>
<td>26.6 grams</td>
</tr>
</tbody>
</table>

Subjective Test:
The following table shows the collection of results in an excel spreadsheet. For additional information, please refer to Appendix D.

568 (Control)  
<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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763 (50/50)  
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985 (100% exp)  
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Discussion:
This lab was the final tasting where the public evaluated the subjective characteristics of the three cakes at the same time. During this lab, we realized or second objective evaluation, the wettability test. The three samples were baked at Karla’s house the night before the evaluations, so that we can be ready and provide the evaluators with cold samples the next morning. The testing took place in lab where evaluators were allowed to test the desirability of the three samples and choose their overall favorite.

For public evaluations we used a hedonic scale from 1-7 being one the least acceptable and 7 the most acceptable. Testers evaluate color, texture, flavor and the overall acceptance of
the three samples. Random numbers were used again to omit influences in tester preferences. Being 568 our control; 763 our 50/50 and 985 our experimental sample. We had a good turn out on the testing lab with 36 people completing evaluation forms for our samples. Data was collected and analyzed using Microsoft Excel; finally after evaluating the data some graphs, pie charts, were created for each one of the characteristics on each sample.

The wettability test is a physical method to determine moisture in a product. We hypothesized that the 100% flaxseed sample would have the most water retention, followed by the 50/50 and lastly the control. Flaxseeds content soluble fiber, specifically a gums, which have the ability to attract and bind with water swelling into a gelish consistency. The moisture-retaining ability of flaxseeds allows them to function similarly to eggs. All three samples were weighed and standardized at 20 grams, so there were no discrepancies in the water seeping process. After soaking each one separately, we found that the 100% flax seed replacement, had the most moisture retention with 26.6 grams. However, we noticed the control, which only uses eggs, had a higher wettability with 25.5 grams as compared to the 50/50 sample which weighed 24.6 grams. The control sample may have weighed more because it was the first sample we tested, and may have absorbed more water while trying figure it out the way to measure it on the scale. The 50/50 sample may have weighed less due to possibly a shortened timing period during the water steeping process.
Pictures from Experiment #4

Effecting wettability test

Wettability results
Cake Samples ready for testing evaluation
## Evaluation Template

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</table>
Original Recipe List
- 2 cups all-purpose flour
- 1 tablespoon ground cinnamon
- 2 teaspoons baking soda
- 1/4 teaspoon salt
- 1 cup vegetable oil
- 1 cup sugar
- 1 cup firmly packed golden brown sugar
- 4 large eggs
- 1 1/2 cups finely grated carrots (about 1 1/2 large)
- 1 cup drained canned crushed pineapple in juice
- 1/2 cup mashed ripe banana
- 3/4 cup chopped pecans

Adjusted Recipe List
- 2 cups all-purpose flour
- 1 tablespoon ground cinnamon
- 2 teaspoons baking soda
- 1/4 teaspoon salt
- 1/2 cup vegetable oil*
- 1/2 cup sugar*
- 1/2 cup firmly packed golden brown sugar*
- 4 large eggs
- 1 1/2 cups finely grated carrots (about 1 1/2 large)
- 1 cup drained canned crushed pineapple in juice
- 1/2 cup mashed ripe banana
- 3/4 cup chopped pecans

Experimental Ingredients List
- 2 cups all-purpose flour
- 1 tablespoon ground cinnamon
- 2 teaspoons baking soda
- 1/4 teaspoon salt
- 1/2 cup vegetable oil*
- 1/2 cup sugar*
- 1/2 cup firmly packed golden brown sugar*
- Flaxseeds
- 1 1/2 cups finely grated carrots (about 1 1/2 large)
- 1 cup drained canned crushed pineapple in juice
- 1/2 cup mashed ripe banana
- 3/4 cup chopped pecans

Retrieved from:
http://www.epicurious.com/recipes/food/printerfriendly/Carrot-Banana-Cake-2527?printPhoto=true
Banana-Carrot Pineapple Cake; Color Preferences

Graph # 1

568 (Control) Color Preferences

Values:
From 1-7; being #1 less acceptable and #7 most acceptable

Graph #2

763 (50/50) Color Preferences

Values:
From 1-7; being #1 less acceptable and #7 most acceptable

Graph #3

985 (100%) Color Preferences

Values:
From 1-7; being #1 less acceptable and #7 most acceptable
Banana-Carrot Pineapple Cake; Texture Preferences

Graph # 4

568 (Control) Texture Preferences

- Graph # 4

Values:
From 1-7; being #1 less acceptable and #7 most acceptable

Graph # 5

763 (50/50) Texture Preferences

- Graph # 5

Values:
From 1-7; being #1 less acceptable and #7 most acceptable

Graph # 6

985 (100%) Texture Preferences

- Graph # 6

Values:
From 1-7; being #1 less acceptable and #7 most acceptable
Banana-Carrot Pineapple Cake; Flavor Preferences

**Graph # 7**

**568 (Control) Flavor Preferences**

Values: From 1-7; being #1 less acceptable and #7 most acceptable

**Graph # 8**

**763 (50/50) Flavor Preferences**

Values: From 1-7; being #1 less acceptable and #7 most acceptable

**Graph # 9**

**985 (100%) Flavor Preferences**

Values: From 1-7; being #1 less acceptable and #7 most acceptable
Banana-Carrot Pineapple Cake Overall Acceptability

Graph # 10

568 (Control) Overall Acceptance

Values:
From 1-7; being #1 less acceptable and #7 most acceptable.

Graph # 11

763 (50/50) Overall Acceptance

Values:
From 1-7; being #1 less acceptable and #7 most acceptable.

Graph # 12

985 (100%) Overall Acceptance

Values:
From 1-7; being #1 less acceptable and #7 most acceptable.
Table # 1

Volume comparison among Control, 50/50 and Experimental cakes

<table>
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<tr>
<th>Name of the Product</th>
<th>Volume before Baking (Inches)</th>
<th>Volume after Baking (Inches)</th>
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<tbody>
<tr>
<td>Control Cake (100% eggs)</td>
<td>56 in.³</td>
<td>88 in.³</td>
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<tr>
<td>50/50 Cake (50% eggs &amp; 50% Flax seeds)</td>
<td>56i</td>
<td>96 in.³</td>
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<tr>
<td>Experimental Cake (100% Flax Seeds)</td>
<td>60 in.³</td>
<td>96 in.³</td>
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Table # 2

Wettability Test Results

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<tr>
<th>Cake Sample</th>
<th>Weight before soaking (grams)</th>
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<tbody>
<tr>
<td>Control Cake (100% eggs)</td>
<td>20 grams</td>
<td>25.5 grams</td>
</tr>
<tr>
<td>50/50 Cake (50% eggs &amp; 50% Flax seeds)</td>
<td>20 grams</td>
<td>24.6 grams</td>
</tr>
<tr>
<td>Experimental Cake (100% Flax Seeds)</td>
<td>20 grams</td>
<td>26.6 grams</td>
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