The Effect of Replacing Cake Flour with Ground Pumpkin Seeds in Cake

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NUTR 453 Research Project
Title

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Abstract

The problem with many cakes and baked products is that they lack nutritional value. Most Americans consume high amounts of refined grains on a daily basis, which is associated with increasing risk for chronic diseases such as obesity, diabetes, and cardiovascular diseases (USDA 2010). Our goal of this project was to produce a frequently consumed baked good with enhanced nutritional value while still retaining high palatability. Replacing flour with ground pumpkin seeds will add nutritional value including linoleic acids, B vitamins, fiber and antioxidants. The methods of this experiment will include substituting flour with 33%, 50%, and 100% ground pumpkin seeds in white cake, while controlling of all the other ingredients. The methods for evaluation include the Brooksfield Viscometer to evaluate viscosity, texture analyzer to evaluate changes in texture, and the water activity machine to observe any change in moisture. Results from the Brooksfield Viscomter show that with more pumpkin seed the viscosity decreased, the texture analyzer showed that when the cake was half cake flour and half ground pumpkin seeds the texture was the hardest, and finally the water activity machine showed that all moistures turned out to be quite similar, although the one with all flour replaced should be the moistest. The experiment also used a nine point hedonic rating scale, and had ranking tests to rate the samples on moisture content and color intensity. The overall findings were that the taste panel found the 50% replacement of cake flour with ground pumpkin seeds had the best overall desirability, the 50% of ground pumpkin seeds was also rated the lightest in color and the 100% replaced with ground pumpkin seeds the moistest. Based on these results, a nutritionally enhanced product was successfully created without decreasing acceptability.

Introduction

Consumption of high refined grains intake on a daily basis has been shown to relate to increase risks for chronic diseases such as obesity, type 2 diabetes, coronary heart diseases (Liu, and others 2000) and prostate cancer (Drake and others 2012). In contrast, consumption of fibers has been shown to associate with decreasing of these diseases (Steffen and others 2003). In the last two years, the United States has spent approximately $1.9 trillion each year on treating and
managing preventable chronic illnesses such as type 2 diabetes, heart disease, obesity and cancers (Padula 2012). American Diabetes Association reported that without major changes, 1 out of 3 babies born today will develop diabetes in their lifetime (ADA). As a result, the trend of demanding high nutrients, low sugar and low calorie products has been increasing drastically over this decade. In order to help to reduce refined grain intake and increase nutrients intake in a typical American dessert, ground pumpkin seeds are used in this experiment to replace the cake flour in a classic white cake, a cake which is commonly used in cake baking with different icing toppings.

Pumpkin belongs to the family Curbitacea and has a chemical name of Cucurbita maxima or Curcurbita pepo and the seeds of pumpkin have been studied worldwide for their health benefits and nutrient composition. Seeds of pumpkin are especially rich in unsaturated oil such as linoleic acid and oleic acid which contribute to 52.4% and 26.3% of the seeds composition (Funck and others 2006). Linoleic acid is associated with prevention of cardiovascular disease, diabetes and various types of cancers, particularly breast cancer (Bialek A 2013). Besides, pumpkin seeds are an excellent source of proteins that have good digestibility, anti-diabetic (Quanhong and others 2003), anti-inflammation, antibacterial and antioxidant effects (Caili and others 2006). Furthermore, pumpkin seeds are also rich in dietary fiber which is associated to decrease the risk of obesity, Type II diabetes and cardiovascular cancer (Bernaud & Rodrigues 2013.). In a study done by Pumar and others (2008) treating rats with pumpkin seeds flour was done to investigate the physiological effects of pumpkin seed flour and they found that the group treated with pumpkin seed flour presented more compact fecal matter with more volume of feces compared to the control group rats. Excreted feces were associated to the higher content of insoluble fibers which implied that there was physical impact of the dietary fiber present in pumpkin seed flour. Moreover, a group of Brazilian researchers investigated the nutrients composition of pumpkin seeds found that a cake added with pumpkin seed flour and cornstarch turned out to be a cake which is gluten-free, less expensive, less calories and higher in dietary fiber than a standard cake.

Regarding the moisture, texture, and taste of modified cake with pumpkin seed flour, a research team from Ciência e Tecnologia de Alimentos found that when flour was replaced with pumpkin seed flour, the higher the fiber content of their product and the lower the moister loss (Gorgonio and others 2013). For this reason it will be important to test the texture of our cake by using the texture analyzer. Large changes in the texture may propose problems in other areas.
such as consumer acceptability. Another research group reported that a flour replacement is found to be only accepted up to 20% in a product (Krishnan and others 2011). It is assumed that different flour sources may produce different results. While we are developing a new modified product, it is important to find out if the taste and appearance of modified products can be accepted and liked by the general population.

The main objective of this experiment to improve the nutritional value in a traditional white cake by replacing with grounded pumpkin seeds which can produce a product that is reduced in refined grain and contains good source of unsaturated fats, various essential amino acids and fibers. In addition, another aim of this experiment is to investigate what percentage of replacement of cake flour the consumers accept in the context of the texture, color and moisture of the modified cake.

**Methods:**

Three trials were performed for the experiment and each trial had a different amount of ground pumpkin seed substituted for cake flour. The trials included 33% (½ cup), 50% (¾ cup), and 100% (1 ½ cup) ground pumpkin seed substituted for cake flour. The recipe used came from an online recipe magazine called Countryliving.com. It is a simple white cake recipe. The full recipe which makes one 8x8 cake, is given below. The recipe was given in US measurements.

1 ½ cup(s) sifted cake flour  
1 ½ teaspoon(s) baking powder  
¼ teaspoon(s) salt  
½ cup(s) (1 stick) unsalted butter, softened  
1 cup(s) sugar  
2 large eggs, room temperature  
½ teaspoon(s) vanilla extract  
½ cup(s) whole milk

The recipe used in this experiment will be 633.5 grams at a time and the recipe in grams is as follows.
Sifted cake flour (60 g pumpkin seed/127.5 g cake flour, 90 g pumpkin seed/97.5 g cake flour, 187.5 g pumpkin seed/no cake flour) – 187.5 g
Baking powder – 6.9 g
Salt – 1.5 g
Unsalted butter, softened – 113 g (1 stick)
Sugar – 200 g
Large eggs, 2 at room temperature
Vanilla extract – 2.1 g
Whole milk – 122.5 g

The online magazine provided the following directions which were followed for each variation of each trial. We altered the directions to fit our variables.

Before mixing any ingredients together the oven needs to be set to preheat to 400 degrees Fahrenheit. An 8-inch cake pan needs to be lightly coated with butter and dusted with all-purpose flour to prevent sticking. The cake flour needs to be sifted, with the baking powder, and salt into a large mixing bowl (ground pumpkin seed when applicable). Next the butter needs to be beaten in 25.25 grams at a time, using an electric mixer set on low speed, until the mixture resembles coarse sand. Beat in the sugar 12.5 grams at a time, until the mixture looks like damp sand. Beat in the eggs one at a time. Add the vanilla and milk, and beat the ingredients all together on medium-high, just until blended. Do not overbeat the ingredients. Then pour the mixture into the prepared pan and bake until a toothpick comes out of the center clean – 30 to 35 minutes. Cool the cake on a wire rack for 5 minutes, then remove from pan and cool completely.

All variables were started at the same time each day of the experiment. This is so the cake was the same temperature when evaluated by the taste panel and the objective methods were performed. All of the ingredients used were at room temperature when beginning the experiment except for the eggs which came straight out of the refrigerator.

The first objective method used was to evaluate the viscosity of the batter by using the Brooksfield Viscometer. Once the product was finished baking, the water activity was tested using the water activity machine. The firmness of the product was also being measured using the
texture analyzer, with the cone probe and “cake” setting. The finished products were evaluated on desirability by a panel using the Hedonic Scale. The panel was also asked to rank each variation on texture and appearance. We had ten panelists evaluate each trial because they were semi-trained in sensory analysis. Attached is the sensory evaluation given to the taste panel. Each variation was given a random three digit number so the panelists would not know which variation they were sampling.

Discussion and Results

Graph one shows the averaged results of the triplicated process from the Brookfield Viscometer. It is shown that all three variables seem to have a reduction in viscosity as the experiment progressed. Initially the variable with half the cake flour replaced started at 19,617 mm and then dropped to 11700mm after 5 minutes. Replacing half cake flour with ground pumpkin seeds causes the batter to decrease in viscosity after five minutes, as well as the third variable. This could mean that the cake batters are a Bingham plastic, which changes with applied force into a less viscous consistency.

Graph 1: Average of Triplicate Trials of the Brookfield Viscometer Readings with use of No. 6 Spindle at 20RPM.
**Texture Analyzer**

As can be seen in table one, variable two had the highest texture analyzer reading in grams than the other trials. This indicates that it had a firmer texture than the other two variables with less and more pumpkin in them. Graph two shows a visual representation of this data. The bars are all at different heights indicating that the three different amounts of pumpkin replacing cake flour does have an effect on the texture and firmness of the cake. The standard deviations noted are within a range of ten grams of each other. This does imply that there could be some error in the variables during the triplicate process. Further statistical work could be done to determine the significance of this. However, variable one with the least amount of cake flour replaced shows a low standard deviation and indicates accuracy.

**Table 1: Texture Analyzer Date for Cake variables in grams**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable 1</th>
<th>Variable 2</th>
<th>Variable 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average</strong></td>
<td>50.76</td>
<td>80.28</td>
<td>32.14</td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td>6.364654</td>
<td>16.11911</td>
<td>10.08695</td>
</tr>
</tbody>
</table>

**Graph 2: Average of Triplicate Trials of Texture Analyzer Readings with Cone Probe use**
**Water Activity**

Table two shows the averaged results from the triplicated data of the water activity machine. This measures the free water available in the cake which helps to determine the shelf life of the product. One can see that table three shows variable three had the highest water activity. Like discussed in the procedure, whole pumpkin seeds were ground in to a meal then used to replace the cake flour. This process allowed for more water content into the recipe. Due to the fact that variable three had all the cake flour replaced with ground pumpkin seeds, it seems fitting that these results would be collected. However, in graph three, the height of the bars does not show much difference in the level of free water available. This can be interpreted as the shelf life between the three variables should not differ due to the free water content. Also, with all fairly low standard deviations, between 0.0168 and 0.069, there was little error between the triplication.

Table 2: Water Activity in Cake Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable 1</th>
<th>Variable 2</th>
<th>Variable 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>0.737</td>
<td>0.726333</td>
<td>0.755</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.016872</td>
<td>0.066032</td>
<td>0.069027</td>
</tr>
</tbody>
</table>

Graph 3: Average of Triplicate Trials of Water Activity
**Sensory Panel**

Thirty random and willing participants were given a one inch by one inch sample of each variable. The participants marked on an evaluation card what hedonic ranking was thought suitable for each sample. Results for this can be seen in graph five. Second on the card was a scale to rank the three samples according to preference on moisture content and lightness of the cake. The average of these results and in comparison can be viewed in graph four. The graph shows that most panelists preferred the moistness of variable three, but did not care for the color of the cake. The bar for variable two on graph four shows that panelists choose the color of this sample over the other two but the moisture content was their least chosen. Variable one had the best averages of the three samples. Taste testers choose variable one, second on moistness and in color. It can be seen in graph five that this was rated the highest of the three variables on the 9-point hedonic scale, with an overall average of acceptance of seven out nine.

![Graph 4](image-url)

**Graph 4:** Average of Thirty Panelists Ranking Moistness and Lightness of Samples in Comparison to One Another.
Graph 5: Average of Ranking on a 9-Point Hedonic Scale from Thirty Panelists.

A sample of sensory evaluation card given to the thirty panelists for the sensory evaluation of the three variables is attached at the next page.
This is a sample of sensory evaluation card:

**Sensory Evaluation:**

<table>
<thead>
<tr>
<th></th>
<th>512</th>
<th>204</th>
<th>843</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like extremely</td>
<td>I like extremely</td>
<td>I like extremely</td>
<td></td>
</tr>
<tr>
<td>I like very much</td>
<td>I like very much</td>
<td>I like very much</td>
<td></td>
</tr>
<tr>
<td>I like moderately</td>
<td>I like moderately</td>
<td>I like moderately</td>
<td></td>
</tr>
<tr>
<td>I like slightly</td>
<td>I like slightly</td>
<td>I like slightly</td>
<td></td>
</tr>
<tr>
<td>I neither like nor dislike</td>
<td>I neither like nor dislike</td>
<td>I neither like nor dislike</td>
<td></td>
</tr>
<tr>
<td>I dislike slightly</td>
<td>I dislike slightly</td>
<td>I dislike slightly</td>
<td></td>
</tr>
<tr>
<td>I dislike moderately</td>
<td>I dislike moderately</td>
<td>I dislike moderately</td>
<td></td>
</tr>
<tr>
<td>I dislike very much</td>
<td>I dislike very much</td>
<td>I dislike very much</td>
<td></td>
</tr>
<tr>
<td>I dislike extremely</td>
<td>I dislike extremely</td>
<td>I dislike extremely</td>
<td></td>
</tr>
</tbody>
</table>

Please taste each samples in front of you.
Rate samples (512, 204, and 843) for moisture content and color intensity.

**Moisture Content:**

Very Dry  
Slightly Dry  
Moderate  
Slightly Moist  
Very Moist

**Color Intensity:**

Very Light  
Slightly Light  
Medium  
Slightly Dark  
Very Dark

Comments:
Discussion and Results (cont.)

As the results of the previous research, cakes made with more ground pumpkin seed meal were found to be more viscous, less firm, with higher water activity, and least preferred by consumers than cakes made with lower amounts of pumpkin seed meal in place of the cake flour. With this information the null hypothesis of “the pumpkin seed meal replacing the flour in the White Cake will not have an effect on the texture or the viscosity of the cake” can be rejected.

The results of the Brookfield Viscometer show that all three variables are a Bingham plastic. This implies that the cake batter decreases in viscosity as force is applied to it. If this cake recipe were ever to be mass produced this would be important to know for production set-up. We can also see that the water content must be slightly higher in variable three, 100% pumpkin, since the overall viscosity during the trials was lower. This is also indicated with the results from the water activity tests.

All three variables had relatively close water activity levels. The highest was the sample with no cake flour in it at all. This should be accurate due to the amount of extra moisture in the freshly ground pumpkin seeds used in the experiment. This would cause an extra amount of water activity to be present. This is something that should be looked at further in a later experiment. A high water activity level may cause the product to spoil sooner thus having a shorter shelf life. However, a similar result can be seen in graph four. The sensory panel ranked the third variable with the highest moisture. This indicates that a very moist cake would be preferred in the market by consumers.

The results from the texture analyzer were varied. It would seem that the cake should have consistently either increased in firmness or decreased in firmness. Graph two shows that firmness increases in the order of all the flour being replaced to 33% to 50% the flour being replaced. This is where there may have been an error in the execution of the procedure. The baking times in the oven may have been varied in terms of “doneness”. Some cakes may have come out of the oven sooner than variable two resulting in a firmer textured cake. This variable also had the largest standard deviation of the three. Also the consistency throughout the cake was varied. The edge pieces seemed to be much more firm than the center portion of the cake. With all three variables this was the case. It is possible that the samples taken from the cakes to be tested by the texture
analyzer were not always a center or edge piece and this could have affected the outcome of the results.

Consumers of the cake chose the sample with the least amount of flour replaced (33%) when ranking on a 9-point hedonic scale. This may have been due to the grittier texture of the fully replaced cake flour in variable three and with half of the cake flour replaced in variable two. One panelist also suggested “more sugar” to be added to the recipe. When repeating the experiment a basic frosting could be added to the samples for a more normal experience of cake for the consumer. A variable to be looked at in future experimenting could be using the pumpkin seed flour in place of the ground pumpkin seeds. This would allow for more consistency in texture and result in a lower water activity due to the use of drier flour. If pumpkin seed flour was not available, further variation of the experiment could be to grind the pumpkin seeds and let them sit out to dry for a period of time before use or the use of something to tie up the extra water in the cakes.

References:


