The Effect of Replacing Eggs with Chia Seeds on the Texture, Moisture, Appearance and Flavor of Banana Bread

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Abstract

According to the Center for Disease Control in 2013, 35.7% of American adults are obese costing an average of $147 billion U.S. dollars in medical costs every year. Contributing to this problem is the fact that Americans only receive about half of the recommended fiber intake (Anderson 2009) and also have a low intake of omega-3 fatty acids which reduce the risk of heart disease, obesity and inflammatory conditions. The chia seed, *Salvia Hispanica L*., can serve as a functional food with high nutritional values and a mild flavor that is easy to add to various food items. 20.4 grams of chia seeds contains five grams of omega-3 fatty acids (66% of the daily recommended value for a 2,000 calorie diet) and 10 grams of fiber (USDA 2012). This experiment substituted whole chia seeds combined with water in place of eggs to a standard banana bread recipe to test the effects it would have on texture, moisture, flavor, and color. There was a control variable with no chia seeds, variable 1 with 1.5 eggs and 15.3 grams of chia seed, and variable 2 with no eggs and 30.6 grams of chia seed. Objective testing included Texture Analyzer, water activity machine, and hunter colorimeter and also a consumer preference test and a 9 point hedonic scale for texture, flavor, appearance, and overall experience. Overall, substituting chia seeds for eggs in banana bread does not have a significant effect on the texture, appearance, moistness, or palatability while at the same time adds nutritional value.

Introduction

The issue of obesity in America has become a serious epidemic with currently 35.7% of adults considered obese. This current obesity epidemic is the leading cause of preventable disease and costs an estimated $147 billion U.S. dollars in medical expenses (CDC 2013). One area that Americans are sufficiently low in is fiber, with the average American only consuming half of the recommended fiber intake (Anderson 2009). A healthy intake of dietary fiber reduces the risk for developing coronary heart disease, stroke, hypertension, diabetes, obesity, and certain gastrointestinal disorders. Other benefits of increased dietary fiber intake include improved serum lipid concentrations, lower blood pressure, improved blood glucose control in individuals with diabetes, better regulation of the digestive system, and immune system promotion (Anderson 2009).

Research also suggests that a healthy intake of alpha-linolenic fatty acid (omega-3) can reduce the risk of heart disease, and possibly reduce the likelihood of behavioral problems, depression, and inflammatory conditions like rheumatoid arthritis (Ruxton 2004). Fats are important in foods because they enhance taste and acceptability. They strongly contribute to texture, flavor, and aroma of foods (Aranceta 2012). It is important to be conscious of adding these healthy fatty acids into one’s diet because fats such as the omega-3 are essential but cannot be synthesized by the body and must be obtained through food (Cassileth 2010). It is also equally important to be conscious of the types of fats in the American diet. Fatty acids are a healthier choice than a fat source such as butter because they are in an unsaturated form.

The chia seed is from the species of flowering plant in the mint family, native to central and southern Mexico and Guatemala. Chia seeds have been cultivated and integrated in the Mexican diet for thousands of years but they have recently gained world-wide popularity for its super food nutritional qualities. It is the quintessential food item to utilize when trying to reduce the problem America’s commonly experience of consuming insufficient amounts of fiber and healthy fatty acids. Chia seeds contain the highest percentage of alpha-linolenic fatty acid
(omega-3) of any plant source. This alpha-linolenic fatty acid constitutes an average of 56.9%-
64.8% of the composition of a chia seed (Ayerza 2011). 20.4 grams (approximately two
tablespoons or two “chia eggs”) of chia seeds contain five grams of omega-3 fatty acids which
accounts for 66% of the daily recommended value for a 2,000 calorie diet. Chia seeds also
contribute a noteworthy amount of fiber for its weight size with 20.4 grams of seeds containing
10 grams of dietary fiber (USDA 2012). Chia seeds also contain a number of antioxidant
substances such as tocopherols (238-437 mg/kg), cholorgenic and caffeic acid, myricetin,
aqercetin, and kaemperol. These compounds are proven to have stronger antioxidant properties
than those in Vitamin C and Vitamin E (Munoz 2013). Along with chia seeds’ significant
amount of alpha-linolenic fatty acids, antioxidants and fiber, 20.4 grams also include 4 grams of
protein, 140 mg potassium, 143 mg calcium, and 78 mg of magnesium (Sandoval-Oliveros
2012). With complete substitution of chia seeds for eggs the banana bread will also be
successfully made into a vegan-friendly food item.

Not only are chia seeds a nutritionally superior food, but they also contain specific
functional qualities that allow them to form a gel when combined with water. Combing 10.2
grams of chia seeds to 44.28 grams of water creates a gooey gel that can act as an efficient egg
substitute. The mild, slightly nutty flavor of the chia seeds aids in making this substitution rather
unnoticeable to the general consumer (Borneo 2010). Replacing the total amount of three eggs
with three “chia eggs” will successfully reduce the cholesterol content of banana bread by 561
mg, reduce sodium content by 180 mg, reduce the saturated fat content by 3.7 grams, will
increase the alpha-linolenic fatty acid content by 8 grams, increase the fiber content by 15 grams,
increase the protein content by 6 grams, increase the magnesium content by 24.6%, and increase
the calcium content by 14.4% (USDA 2012).

The overall purpose of this experiment is to accept the null hypothesis that replacing eggs
with chia seeds in banana bread will not negatively affect the texture and flavor of the bread. The
independent variable for this study is the varying amount of chia seeds, 0 grams, 15.3 grams, and
30.6 grams, in replacement of 118.3 ml, 59.2 ml, and 0 ml of eggs. The dependent variables are
the resulting texture, flavor, color, and moisture content values of the banana bread. The overall
objectives of this experiment are to increase the nutritional value of the banana bread by
replacing cholesterol dense eggs with high fiber and heart-healthy fatty acid chia seeds. Further
objectives are to avoid negatively altering the texture, flavor, color, and moisture content of
regular banana bread. In order to test these important objectives the Texture Analyzer, water
activity machine, Hunter Colorimeter, and 9-point hedonic scale were utilized for each variable
in triplicate.

Methods

The banana bread recipe was a recipe from Sam Martinez’s grandmother, Cora Monda.
This recipe has been altered by preference, but will be standardized for the purposes of this
experiment. There are three separate variables for this experiment; the control, and variables 1
and 2. The control has all eggs, variable 1 uses half of the amount of egg and half of the amount
of chia seeds, and variable 2 has all chia seed and no egg. The recipes for each variable are as
follows:

-Banana Bread Control:
3 whole, extra-large eggs (118.3ml)
600 grams granulated sugar
180ml vegetable oil
10ml vanilla extract
3,600 grams wheat flour
6 grams salt
5 grams baking soda
3.5 grams baking powder
2.3 grams ground cinnamon

-Banana Bread with 1 ½ Parts Egg and 1 ½ Parts Chia Seed Substitute (variable 1):

All ingredients are identical to the control minus the eggs and chia seeds:
59.2ml eggs
15.3 grams chia seeds (in 66.51 grams of water)

-Banana Bread with No Eggs and 3 Parts Chia Seed Substitute (variable 2):

All ingredients are identical to the control minus the eggs and chia seeds:
30.6 grams chia seeds (in 133.02 grams of water)

Procedure:

To create the “chia egg” for variables 1 and 2 some preparation was done before starting the recipe. For variable one, 15.3 grams of chia seeds were combined with 66.51 grams of warm water in a small bowl and left to sit for 20 minutes. For variable two, 30.6 grams of chia seeds were combined with 133.02 grams of warm water and left to sit in a small bowl for 20 minutes. In preparation for baking, the focus was on performing tasks in a uniform and exact way so that replication could be exact for all replications. A total of three trials were done for each of the three variables. The procedure is as follows:

1. Preheat oven to 177 degrees Celsius (350°F)
2. Prepare the two chia seed substitutes in warm water (allowing to soak for 20 minutes)
3. Mix 3 eggs (118.3ml) (or chia substitutes), 600 grams sugar, 180 ml vegetable oil, and 10 ml of vanilla extract in a medium sized bowl
4. Sift 3,600 grams wheat flour, 6 grams salt, 5 grams baking soda, 3.5 grams baking powder, and 2.3 grams cinnamon together in a bowl separate from the wet ingredients
5. Blend 720 ml of ripe bananas together to make a puree
6. Gradually mix the dry ingredients into the wet ingredients, using an electric hand mixer on medium speed for approximately two minutes
7. Once batter is mixed, the 720ml of banana puree will be added and once again mixed on medium speed until smooth, approximately 30 seconds
8. At this point each batter will be poured into a bread pan lightly greased with butter
9. Each pan is then placed as close to the center of the oven as possible and left to bake for 1 hour or until a toothpick comes out clean
10. Upon removal, let cool in the bread pan for 20 minutes before any subjective or objective testing is done

At the end of the cooling time, each loaf of bread will be cut into 1 inch thick slices, and the ends will be discarded in order to remove the variable of extra crust to a subjective tester or objective machines. Other lurking variables that were controlled for are as follows: in order to control the consistency of the bread slices for objective tasting, the second slice from the outside of the bread (not the crust, but the next one in) was used. The loaves were all baked in the middle rack of the oven in the same order every trial, just so there is as little variance in the baking conditions as possible. Before baking, the same cooking utensils at room temperature were used in every batch and trial.

It should be noted that during the first trial of experiments there were 3 loaves made per variable. In the second and third trial, there was just as much batter, but not enough large bread pans. Instead, multiple small pans were used, making 5 small loaves per variable, rather than the 3 large loaves.

Objective Testing

For the objective analysis of the banana bread, the Texture Analyzer, water activity machine, and Hunter Colorimeter were utilized in triplicate for each variable. For the Texture Analyzer, there are various setting that can be made in order for a more accurate reading. Upon choosing the cone probe and the bread setting, these were the values used:

- Pre-Test Speed: 2.0mm/s
- Test Speed: 5.0mm/s
- Post-Test Speed: 50mm/s
- Distance: 5.0mm
- Force: 2.000g
- Time: 5sec
- Rupture Test Distance: 1.0mm

Upon approving these parameters and choosing “apply”, these are the final values given prior to running a test: 0.000N, 17.010s, -8.990mm. By using all of these values for all the trials, it helps guarantee that the data is consistent among the different readings, helping to avoid any inconsistencies in data and statistics. Next, the designated, objective testing slice from each loaf of bread was then tested in the water activity meter by filling the plastic sample dish no more than half full and inserting into the water activity machine. Finally, the Hunter Colorimeter machine was used by completely filling the Petri dish with the banana bread so no light could be seen through.

Subjective Testing
The subjective tests used in this experiment were a 9 point hedonic rating scale and a consumer preference test. Each of these sensory tests was performed with all three trials by a group of 27 Nutrition 453 students. Each variation was represented by a random three digit number and place in no particular order for sampling. The samples were all places on the same, white ceramic plates. For the consumer preference test, the panelist simply marked how much they enjoyed the sample. For the 1-9 rating scale, 1 represent a hard texture, bad flavor, unappealing appearance, and poor overall experience while 9 represented a soft texture, good flavor, appealing appearance, and good overall experience. The sensory scorecards for the two subjective tests are shown below.

<table>
<thead>
<tr>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Average</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Egg</td>
<td>47.50</td>
<td>37.50</td>
<td>53.60</td>
<td>46.20</td>
</tr>
<tr>
<td>Half &amp; Half</td>
<td>53.70</td>
<td>38.40</td>
<td>31.40</td>
<td>41.17</td>
</tr>
<tr>
<td>All Chia</td>
<td>49.30</td>
<td>38.10</td>
<td>34.80</td>
<td>40.73</td>
</tr>
</tbody>
</table>

*No statistical difference was found based on a P value of <0.05*
Table 2: Effects of chia seed on banana bread as measured by water activity (A_w)

<table>
<thead>
<tr>
<th></th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Average</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Egg</td>
<td>0.90</td>
<td>0.85</td>
<td>0.91</td>
<td>0.89</td>
<td>0.03</td>
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<tr>
<td>Half &amp; Half</td>
<td>0.77</td>
<td>0.86</td>
<td>0.87</td>
<td>0.83</td>
<td>0.06</td>
</tr>
<tr>
<td>All Chia</td>
<td>0.90</td>
<td>0.84</td>
<td>0.85</td>
<td>0.86</td>
<td>0.03</td>
</tr>
</tbody>
</table>

*No statistical difference was found based on a P value of <0.05*
Table 3: Effects of chia seed on banana bread as measured by the Hunter Colorimeter

<table>
<thead>
<tr>
<th>Variable</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Average</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Egg</td>
<td>L 36.56</td>
<td>41.54</td>
<td>41.59</td>
<td>39.90</td>
<td>2.89</td>
</tr>
<tr>
<td></td>
<td>A 6.69</td>
<td>9.61</td>
<td>9.61</td>
<td>8.64</td>
<td>1.69</td>
</tr>
<tr>
<td></td>
<td>B 12.57</td>
<td>22.50</td>
<td>22.50</td>
<td>19.19</td>
<td>5.73</td>
</tr>
<tr>
<td>Half &amp; Half</td>
<td>L 33.72</td>
<td>37.07</td>
<td>38.62</td>
<td>36.47</td>
<td>2.50</td>
</tr>
<tr>
<td></td>
<td>A 5.89</td>
<td>8.64</td>
<td>8.61</td>
<td>7.71</td>
<td>1.58</td>
</tr>
<tr>
<td></td>
<td>B 10.68</td>
<td>18.91</td>
<td>19.92</td>
<td>16.50</td>
<td>5.07</td>
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<tr>
<td>All Chia</td>
<td>L 32.58</td>
<td>39.12</td>
<td>39.63</td>
<td>37.11</td>
<td>3.93</td>
</tr>
<tr>
<td></td>
<td>A 6.30</td>
<td>8.74</td>
<td>8.70</td>
<td>7.91</td>
<td>1.40</td>
</tr>
<tr>
<td></td>
<td>B 11.18</td>
<td>20.16</td>
<td>19.83</td>
<td>17.06</td>
<td>5.09</td>
</tr>
</tbody>
</table>

*No statistical difference was found based on a P value of <0.05
Table 4: Effect of chia seed on average 9-point hedonic scale ranking for texture, flavor, appearance, and overall experience

<table>
<thead>
<tr>
<th></th>
<th>Texture</th>
<th>Flavor</th>
<th>Appearance</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Egg</td>
<td>7.26</td>
<td>7.93</td>
<td>7.85</td>
<td>8.04</td>
</tr>
<tr>
<td>Half &amp; Half</td>
<td>6.41</td>
<td>7.11</td>
<td>7.00</td>
<td>7.15</td>
</tr>
<tr>
<td>All Chia</td>
<td>6.56</td>
<td>7.04</td>
<td>7.37</td>
<td>7.30</td>
</tr>
</tbody>
</table>

*No statistical difference was found based on a P value of <0.05*
Table 5: Overall consumer preference of varying banana breads

<table>
<thead>
<tr>
<th></th>
<th>Dislike Extremely</th>
<th>Dislike Very Much</th>
<th>Dislike Moderately</th>
<th>Dislike Slightly</th>
<th>Neither Like Nor Dislike</th>
<th>Like Slightly</th>
<th>Like Moderately</th>
<th>Like Very Much</th>
<th>Like Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Egg</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Half &amp; Half</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>All Chia</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>
Table 6: Overall consumer preference of varying banana breads (data from Table 5 with number assigned 1-9 to calculate averages and standard deviation)

<table>
<thead>
<tr>
<th></th>
<th>Average Rating</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Egg</td>
<td>6.89</td>
<td>1.85</td>
</tr>
<tr>
<td>Half &amp; Half</td>
<td>7.74</td>
<td>1.13</td>
</tr>
<tr>
<td>All Chia</td>
<td>7.15</td>
<td>1.66</td>
</tr>
</tbody>
</table>
Discussion

The results of this experiment indicate that there is no significant difference in both the objective and subjective analysis between the control banana bread, variable one with half egg and half chia seed, and variable two with all chia seeds. Between these three variables there was no statistical difference for water activity, texture, color, or subjective preference.

The Texture Analyzer using the cone probe was utilized in order to test if there were any potential differences in texture between the control banana bread and the variables containing chia seeds. The texture analyzer measures the specific force involved in compression and tension interaction of a probe (cone) and a food (banana bread) (Weaver and Daniel 2003). Texture is a very important component to study because consumers frequently associate a specific food item with its expected texture and they base their opinion of quality off of texture (Altamirano-Fortoul 2013). For example, avocado is supposed to feel smooth and soft when consumed but if it were to feel crunchy it would not be appealing even if it had the same flavor profile as a regular avocado. It was important that the banana bread containing chia seed had the same mouth feel and consistency as the control bread. It may be hypothesized that the addition of chia seeds to bread would make the texture softer. The primary explanation for this potential alteration in texture is that chia gel can also be used as a fat replacer, so when combined with the oil that is already present in the bread this further tenderizes and moistens the product (Borneo 2010). However, the program InStat reported that there was no significant difference in texture between any of the three variables with a resulting P value of 0.7329 (which is greater than the test value of 0.05).

As illustrated in Table 1, the average force required to penetrate the control bread with all egg was 46.20 grams, 41.17 grams for the bread with half chia seed half eggs, and 40.73 grams for the bread with all chia seeds. There is very little variance between these three variables when related to texture and not enough to be statistically significant. The control bread did have the highest grams of force which implies it is the hardest of the three breads, which is explained by chia seeds being a fat replacer while the original source of fat is still being added to the bread. From Figure 1 the texture analyzer results can also be seen and from this graph it might possibly look like the difference is more drastic than it really is, but it is still not statistically significant. The fact that there is no statistically difference in texture between the three variables is a desired result because now the banana bread containing chia seed can successfully replace the control banana bread on a textural basis while at the same time creating a more nutritionally beneficial product in the end.

The second objective test measured the effect of chia seed as an egg replacer in terms of water activity. Water activity is the energy status of water in a system and is important to study because it is the major determinant of a food’s shelf-life and texture. It would be undesirable for the water activity to be higher than the control because this would imply a shorter shelf-life and poorer texture (Theory 2011). There was no anticipated negative change in water activity or
moisture because chia seeds have been shown to promote good water retention during shelf-life (Pizarro 2013). Table 2 shows the results from the water activity machine for this experiment. The average water activity for the all egg variable was 0.89. For the half and half variable, the average of the three trials was 0.83. Finally, the average water activity of the all chia seed variable was 0.86. Figure 2 shows a visual representation of the data. These results show that the half and half variable had the lowest water activity, meaning it was the driest variety. The highest water activity came from the all egg variable, meaning it had the highest moisture content. These results, however, were not statistically significant. The P-value was 0.4291 which is greater than the significance value of 0.05. This shows that there is not a significant difference between the different varieties of banana bread as measured by water activity which is a desirable attribute.

The Hunter Colorimeter is used to measure the color of different products quantitatively. In banana bread, the color should neither be too light, nor too dark. The control bread, with all eggs, provides a standard color measure to compare with the other variables. These values are L: 39.9, A: 8.64, and B: 19.19, after being averaged from three trials with standard deviations of L: 2.89, A: 1.69, B: 5.73, as seen in table 3. The “L, A, and B” are the standards of Hunter Notation. They allow colors to be specifically identified and differentiated from other colors. The A-axis identifies a green-red color spectrum, the B-axis identifies the yellow-blue spectrum, and the L-axis identifies the black-white spectrum. On the L-axis, 0 is black, and 100 is white. For the A-axis, any negative number is green, and any positive is red. For the B-axis any negative is blue, and any positive is yellow. The results of this experiment show that the L-value becomes slightly lower with the addition of chia seed (36.47 in variable 1 and 37.11 in variable 2) meaning that the product because slightly darker with the addition of chia seeds which was to be expected. The A-value became also became lower with the addition of chia seed (7.71 for variable 1 and 7.91 for variable 2) meaning chia seeds made the product slightly greener. For the B-value the addition of chia seeds continued to make the values lower (16.50 for variable 1 and 17.06 for variable 2), indicating that the addition of chia seeds made the product somewhat more blue. These are very similar results to a study done by Barrientos and colleagues where chia seeds were added to sugar cookies. Overall, the biggest difference in all the variables was that the addition of chia seeds made the breads slightly darker. Even with this being true, none of the differences were statistically significant when tested at a P value of <0.05. This is a very desirable result when considering that major changes in appearance raise concern in consumers. Perhaps if the bread had been too light, or too dark, these characteristics would raise skepticism in consumers. As reported by Popov-Raljic in 2009, the quality of bread greatly depends on the ingredients used in its preparation and this becomes evident in the final product.

Two subjective tests were conducted in this experiment. A total of 27 untrained panelists participated in the subjective tests. The objective of the first test was to determine consumer acceptability of texture, flavor, appearance, and overall experience for the three different variations of banana bread. Each variable was given a random three-digit number to prevent the panelists from knowing which variation they tasted. A 9-point hedonic scale was used to rate
each of the four qualities. Table 4 shows the average ratings for each variable. The P-values for
the different qualities of banana bread were as follows; texture- 0.3229, flavor- 0.3229, color,
0.1360, overall experience- 0.1254. There was no significant difference for any of the subjective
ratings. The all egg variable did receive slightly higher marks than the other two variables for
each of the four factors, however it was not significant. The addition of chia seeds does not
appear to significantly reduce consumer preference for the banana bread. The second subjective
test asked the panelists to choose a statement that described how much they liked each variation
of banana bread. The options ranged from dislike extremely to like extremely. The same random
three-digit number assignments were used for this test. The P-value for this test was 0.1321.
According to this P-value, consumers do not show a significant preference for a certain variation
of the banana bread. In fact, for this subjective test the all egg variation had the lowest rating for
likability and the half and half variation had the highest rating. An article from the American
Dietetic Association (2010) on chia seeds as an egg or oil replacer had relatively similar results.
This study the control variable also received the highest overall ratings. The other qualities that
were ranked (color, texture, and taste) all showed a decrease in likability as the amount of chia
seed was increased.

The untrained panelists provide a small possibility of error in the subjective testing. One
of the major concerns of having a completely untrained panel is that not only will it create
skewed results, but they are also inconsistent. Typically, untrained panels are used when there is
a large quantity of panelists, but in the case of this experiment, there were only 27 panel
members. An untrained or consumer panel should contain 100 members minimum. The group of
27 in the lab provided enough for a semi-trained panel, which is not what was actually had. The
reason why more panelists are encouraged in an untrained group is so that the number of results
removes the inconsistency of their responses, but for the resources available to for this
experiment, 27 is a fairly large group. Another source of error in the experiment specifically is
the use of different bread pans during baking. While the same quantity of bread was made in
each, the size of the pans did change between variables. A major concern is that the smaller pans
baked quicker than the regular pans, almost a full half hour quicker. While this should not make
a significant difference in total doneness, it does need to be taken into consideration. This
corresponds with the use of two different ovens in order to bake all the loaves simultaneously.
While both ovens were set to the same temperature (177 °C), there is still the possibility of
different hot spots within the ovens. All racks were set to the same height, but the arrangement of
the pans did change in each oven. Some possible sources of error in measuring water activity
could be the two different water activity machines used in the lab, the varying amount of banana
bread that was loaded into the machine and the differences in temperature and cooling time of
each variation of banana bread. If one variable had more cooling time, it also had more time for
moisture to escape from the bread. Other than these few sources, error was kept very low during
testing in order to create the highest quality of results possible.
Further research can be done on the topic of chia seeds and egg replacers. Because there was no significant difference between the banana bread with chia seed and the regular banana bread, it would be important to know if the addition of chia seeds makes a difference in the shelf life of the breads. Another possible topic to investigate in the future would be if substituting chia seeds for eggs would also be successful in less sweet items such as meatballs or fritters. In savory foods the taste and appearance of chia seeds might possibly be more apparent and it would be interesting to discover if it is a negative quality. A final suggestion for future work on this subject may be to test this egg substitution on another baked good that is not as hearty as bread such as cake or cookies.

Overall, this experiment showed that the substitution of chia seeds for eggs in banana bread did not statistically alter the bread objectively or subjectively. The null hypothesis is accepted and adding chia seeds do not alter the texture, color, moisture, or flavor of banana bread. The addition of chia seeds furthermore increased the nutritional value of the bread by eliminating the cholesterol from the eggs and increasing the fiber and omega-3 content.

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Barrientos VA, Aguirre A, Borneo R. 2012. Chia (Salvia hispanica) can be used to manufacture Sugar-snap cookies with an improved nutritional value. International Journal of Food Studies 1:135-143


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