Effect of Four Fats on Muffin Texture and Color

FN 453
Final Project Report

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11/23/2009
Abstract

Coronary heart disease is the leading cause of death in the United States. Among many things that increase the risk for heart disease, high level of cholesterol and saturated fat is strongly correlated with coronary heart disease. Due to bad health effects of cholesterol and saturated fat, there is a growing number of people who concern about these effects. Butter gets a bad reputation, because as an animal fat, it is high in both saturated fat and cholesterol. One of the main ingredients in baked goods is butter. So, baked goods get a bad reputation as well. The purpose of this experiment is to substitute butter in muffins with different types of fat low in saturated fat and cholesterol to make muffins healthier but still full of flavor. 4 different types of fats were used; butter, margarine, corn oil, and peanut oil. Vanilla flavored muffins were used to compare the data, since vanilla did not have strong flavor that could interfere with flavor of muffins.

The baking properties of the muffins were measured in three separated trials. In each trial, the texture of the muffins was measured by a texture analyzer and the color was measured by Hunter Colorimeter. The sensory panels tasted the muffins to rate flavor and overall preference of muffins. There was no significant difference with the overall preference, appearance, or texture of all the four kinds of muffins based on the sensory level. And the panels regarded the margarine muffins had the same browning color with the butter ones. However, the objective test showed a different result that the texture given by butter could not be substituted by any of the other fat, as well as the L and a value of muffins. Only the b value had no significant difference with margarine. Baked goods that have been baked with different types of fat, other than butter, can only be full
of flavor, texture, and color by sensory and still healthier than muffins with butter which is high in saturated fat and cholesterol.

**Introduction**

Among countless life threatening diseases, heart disease is the number one cause of death in the United States. According to centers for disease control and prevention, the most common heart disease in the United States is coronary heart disease. In every 25 seconds, an American suffers from a coronary event and in every one minute, a person dies from the event.

The chance of developing coronary heart disease can be reduced by taking steps to prevent and control factors that put people at greater risk. High cholesterol, high blood pressure, obesity, diabetes, tobacco, and secondhand smoke are indentified as factors associated with heart disease. Also, a research shows that consumption of high-fat dairy products such as butter and ice cream is correlated with an increased risk of coronary heart disease due to high content of saturated fat (Hu and others 1999). Higher cholesterol concentrations have consistently been found to be strongly associated with higher risks of coronary disease (Collins and others 2004).

Fats can be primarily divided into three different categories- saturated, unsaturated, and trans fats. Saturated fat is fat that is naturally solid at room temperature and comes from mainly animal sources that include butter, cheese, and the marbling in beef. Unsaturated fat is naturally liquid at room temperature and generally comes from mainly plants sources that include olive oil, canola oil, and the oils in nuts. Unsaturated fat is considered as the most healthful fats to consume, because it tends to increase HDL
levels and to lower LDL levels. Trans fats are fats which are normally liquid at room temperature, but have been chemically modified to be solid at room temperature through the process of hydrogenation.

Cholesterol is not bad as it sounds. Actually, it is essential for all animal life to produce cell membranes and some hormones, and serves other needed bodily functions. But, it becomes an enemy when too much cholesterol is circulating in the blood and it can be a major risk for coronary heart disease. Since cholesterol cannot be dissolved in the blood, it needs special carriers called lipoproteins to be transported in and out of the cells. Low-density lipoprotein, or LDL, is known as “bad” cholesterol. When too much LDL (bad) cholesterol circulates in the blood, it can slowly build up in the inner walls of the arteries that feed the heart and brain. Together with other substances, it can form plaque, a thick, hard deposit that can narrow the arteries and make them less flexible. This condition is known as atherosclerosis. If a clot forms and blocks a narrowed artery, heart attack or stroke can result. High-density lipoprotein, or HDL, is known as “good” cholesterol. HDL cholesterol is known as “good” cholesterol, because high levels of HDL seem to protect against heart attack.

Since heart disease is the leading cause of death in United States, there is a growing number of people who concern about their saturated fat and cholesterol intake level. Butter becomes an enemy to those people because it is both high in saturated fat and cholesterol. Not only butter gets a bad reputation but also do many other products that contain butter get a bad reputation as well. One of the main ingredients in baked goods is butter. Fat portion in baked goods is essential for its unique texture, aroma, and
flavor. Substituting the butter with other sources of fat can lower saturated fat and cholesterol level and still keeps softness and flavor.

The main reason for performing this experiment is to create muffins that are healthier but still with lots of flavor. The independent variable is different types of oil. Three substituted fats are tested; corn oil, peanut oil, and margarine. Since corn oil, peanut oil, and margarine are from plant sources, they do not contain cholesterol at all. Also, they are low in saturated fat…Average a tablespoon of butter contains 7grams saturated fat which is 36 percent of daily value. Also, it contains 30mg of cholesterol which is 10 percent of daily value. By replacing butter with other types of fat, it can lower saturated fat to 1 to 2 grams of saturated fat and eliminate cholesterol. The dependent variables that will be measured are texture, color, volume, and the taste preference. These variables will be gathered using the Texture Analyzer, Seed-Volume apparatus, Hunter Colorimeter, and taste panels. The experiment explores the changes in texture, volume, color and preference in flavor.

Materials and methods

Preparing sample

The muffins are prepared with the following recipe (500g scale):

- Flour: 150g
- Brown sugar: 85g
- Baking powder: 6g
Salt: 7.5g
Eggs: 30g
Vanilla extract: 6.5g
Oil (Butter, Margarine, Corn oil, Peanut oil): 75g
Milk (skim milk): 140g

Dry ingredients (flour, baking powder and salt) and wet ingredients (eggs, vanilla extract, oil, milk and brown sugar) were firstly mixed separately. When the two portion were well mixed, combined them together. Stirred the mixture for 2min using medium speed on the hand mixer. Use paper muffin cups as the container of the mixture and weighed 50 g of the mixture for each muffin. One bench contained 4(kinds)x6(pieces) muffins. Baking the muffins for 17min, and turn the tray ones at 8min.

**Objective test:**

Once the muffins cooled, they were removed from their paper cups for the sensory analysis. One muffin from each variable was saved to be used for the objective testing. The cut up pieces were put onto a paper plate, labeled with a 3-digit number, and set out on a table with sensory evaluation score cards to be tested by other classmates. An example of the sensory score card used can be seen as follows:

Dislike extremely ____1____
Dislike slightly _____2_____  
Neither like or dislike ___3_____
Like slightly ___4____
Like extremely ____5____

Please taste each of the samples in front of you and answer the questions.

1. Rate samples (512, 354, 482, 843) in order of overall preference against the descriptive terms below.
   
   512___________
   
   354___________
   
   482___________
   
   843___________

2. Rate samples (512, 354, 482, 843) in order of appearance preference against the descriptive terms below.
   
   512___________
   
   354___________
   
   482___________
   
   843___________

3. Rate samples (512, 354, 482, 843) in order of texture preference against the descriptive terms below.
   
   512___________
   
   354___________
   
   482___________
   
   843___________

4. Ranking the 4 samples (512, 354, 482, 843) in descending order for color in the spaces provides.
   
   Most brown  ______
   
   ______
The participants of the sensory analysis were unaware of which variation was being sampled to provide randomization. The cards were collected afterwards and dated for each trial.

**Subjective tests**

The guide to the use of equipment in this experiment can be found in the Food Chemistry Laboratory Manual, C. Weaver and J. Daniel, 2003, pages 107-132.

1. **Texture analysis:**

The muffin textures of all kinds were analyzed by Stable Micro Systems Texture Analyzer with cylinder attachment. Choose the model for muffins in the sample style file. The paper cups were peeled off the muffins before test and the muffin stood with top upside.

2. **Color**

The muffin color was evaluated by Hunter Colorimeter. The muffin cups was peel off. Three muffins of each kind were used for one test. Put three muffins in a zip-bag and mash them with hand. Homogenize the muffin crumbs. Put the muffin crumbs in the
testing cup and cover the entire bottom. Color was expressed in L, a, and b CIELab scaled parameters. The test was repeated for three times to have the duplications.

**Statistical analysis**

ANOVA was applied to detect factor effect so as to determine statistically significant differences among means. A level of confidence \( p = 0.05 \) were used.

**Result**

Table 1. The average texture analyzer values of 3 trials of muffins using four different kinds of fat.

<table>
<thead>
<tr>
<th></th>
<th>corn oil</th>
<th>peanut oil</th>
<th>butter</th>
<th>margarine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>188.2(^a)</td>
<td>196.37(^{a,c})</td>
<td>116.63(^b)</td>
<td>229.2(^c)</td>
</tr>
<tr>
<td>SD</td>
<td>17.06</td>
<td>12.26</td>
<td>16.05</td>
<td>13.49</td>
</tr>
</tbody>
</table>

Average not bearing the same superscript are statistically significant different, \( p<0.05 \).

Figure 1. Effects of four kinds of fat on texture of muffins.
Table 2. The average lightness value for 3 trials of muffins using four different kinds of fat.

<table>
<thead>
<tr>
<th>Kind of Oil</th>
<th>Average</th>
<th>SD</th>
<th>Average</th>
<th>SD</th>
<th>Average</th>
<th>SD</th>
<th>Average</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn oil</td>
<td>56.69^a</td>
<td>0.48</td>
<td>51.53^b</td>
<td>0.05</td>
<td>55.20^c</td>
<td>0.27</td>
<td>52.15^d</td>
<td>0.22</td>
</tr>
<tr>
<td>Peanut oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Margarine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Average not bearing the same superscript are statistically significant different, p<0.05.

Figure 2. Effects of four kinds of fat on lightness of muffins.

Table 3. The average a value of color for 3 trials of muffins using four different kinds of fat.

<table>
<thead>
<tr>
<th>Kind of Oil</th>
<th>L value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn oil</td>
<td>56.00</td>
</tr>
<tr>
<td>Peanut oil</td>
<td>51.00</td>
</tr>
<tr>
<td>Butter</td>
<td>55.00</td>
</tr>
<tr>
<td>Margarine</td>
<td>52.00</td>
</tr>
<tr>
<td>Kind of oil</td>
<td>Corn oil</td>
</tr>
<tr>
<td>-------------</td>
<td>----------</td>
</tr>
<tr>
<td>Average</td>
<td>19.86(^a)</td>
</tr>
<tr>
<td>SD</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Average not bearing the same superscript are statistically significant different, \(p<0.05\).
Figure 4. Effects of four kinds of fat on \( b \) value in \( L, a, b \) system (red color) of muffins.

Table 5. The average degree of browning of sensory evaluation for 3 trials of muffins using four different kinds of fat.

<table>
<thead>
<tr>
<th></th>
<th>Corn oil</th>
<th>peanut oil</th>
<th>butter</th>
<th>margarine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>3.33(^a)</td>
<td>3.33(^a)</td>
<td>2.11(^b)</td>
<td>1.33(^b)</td>
</tr>
<tr>
<td>SD</td>
<td>0.87</td>
<td>0.50</td>
<td>0.78</td>
<td>0.71</td>
</tr>
</tbody>
</table>

Average not bearing the same superscript are statistically significant different, \( p < 0.05 \).
Figure 5. Effects of four kinds of fat on brown color in sensory evaluation of muffins.

Table 6. The average overall preference result of sensory evaluation for 3 trials of muffins using four different kinds of fat.

<table>
<thead>
<tr>
<th></th>
<th>Corn oil</th>
<th>peanut oil</th>
<th>butter</th>
<th>margarine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>3.56&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.78&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.56&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>SD</td>
<td>1.13</td>
<td>1.00</td>
<td>1.48</td>
<td>1.01</td>
</tr>
</tbody>
</table>

Average not bearing the same superscript are statistically significant different, p<0.05.
Figure 6. The overall preference of muffins using different kinds of oil.

Table 7. The average appearance result of sensory evaluation for 3 trials of muffins using four different kinds of fat.

<table>
<thead>
<tr>
<th>Kind of oil</th>
<th>Corn oil</th>
<th>peanut oil</th>
<th>butter</th>
<th>margarine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>4.22\textsuperscript{a}</td>
<td>3.00\textsuperscript{a}</td>
<td>3.78\textsuperscript{a}</td>
<td>3.56\textsuperscript{a}</td>
</tr>
<tr>
<td>SD</td>
<td>0.97</td>
<td>1.00</td>
<td>1.48</td>
<td>1.01</td>
</tr>
</tbody>
</table>

Average not bearing the same superscript are statistically significant different, $p<0.05$. 
Figure 7. Effect of different kinds of fat on sensory appearance of muffins.

Table 8. The texture preference result of sensory evaluation for 3 trials of muffins using four different kinds of fat.

<table>
<thead>
<tr>
<th>Kind of Oil</th>
<th>Corn oil</th>
<th>Peanut oil</th>
<th>Butter</th>
<th>Margarine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>3.89a</td>
<td>3.33a</td>
<td>2.67a</td>
<td>3.78a</td>
</tr>
<tr>
<td>SD</td>
<td>1.27</td>
<td>1.41</td>
<td>1.22</td>
<td>0.83</td>
</tr>
</tbody>
</table>

Average not bearing the same superscript are statistically significantly different, p<0.05.
Figure 8. Effects of 4 kinds of fat on texture preference of muffins.

**Discussion**

Overall, the purpose of this experiment is to test whether there are significant differences between the muffins baked by four different types of oil. These four different kinds of oil are corn oil, peanut oil, butter, and margarine. Two of them are liquid oil and two of them are solid oil. The ideal result for this experiment is that there is no significant difference in texture, appearance, and taste. These properties were tested by sensory test, Hunter Colormeter, and texture analyzer. The sensory test also supports the panel preference to the color and texture. Based on the objective tests data we got from the three trials, there are significant differences between these four recipes. But the sensory test result did not show significant result of these four muffins.
Fat contribute to the crumb texture, mouth feel and lubricity quality. And some of the fat characteristics contribute to aeration of muffins. From the data showed in table 1 and figure 1, the muffin made that contains butter is the softest one, and the one with margarine is the hardest one. Both the corn oil and peanut oil made muffins have the medium hardness of these four kinds of muffins, and they don’t have significant difference between each other. From the data collected in table 8 and figure 8, the muffins made by corn oil were the most favorite one. But the result of the ANOVA showed there is no significant difference between the preferences of the muffins. Therefore, although the texture analyzer values showed there are significant differences among the four muffins, the panelist could not detect the texture difference.

The results of the appearance of the four different kinds of muffins refer to table 2, 3, and 4, and figure 2, 3, and 4. The a-value of this test is the most important property, because it can indicate the degree of browning. The muffins made by corn oil and peanut oil have no significant difference and have the lowest browning degree. The muffins made by butter and margarine have significant higher browning degree to the other two oils made muffins and between each other. But the degree of browning tested by panel has a totally different result. From the opinions of panels, the muffins made by corn oil and peanut oil are the darkest ones. And referring to the result of sensory tests, the rank value showed that the panelists like the corn oil made muffins best, but the ANOVA value showed that there are no significant differences of the preference to the appearance. Thus, the difference in color might not be visible to human beings.

The browning color of muffins caused by Maillard browning reaction occurred during the baking. And the major factors that can influence the degree of browning includes the
temperature, pH, water content, reducing sugar, and protein and amino acid types (Hui, 2007). In this experiment, only the type of oil was changed in the recipe. Thus, the other factors were not changed except the temperature of baking. And the baking temperature might be changed due to the different oil kinds under the same oven condition.

For the taste of these muffins, it can be referred to the result showed in table 6 and figure 6 of the overall preference of the muffins. Although the ANOVA value showed that there is no significant difference of the preference to the muffins. But from the average value showed in the table and figure, it can be concluded that people prefer the one made by butter. For the other test of the panel, people did not prefer the texture and color of the butter. That means, the taste of one food product is much more important than other properties.

Based on the above discussion, it can be concluded that corn oil and margarine can produce better texture. And the objective test showed that these two oils produced harder texture. Thus, we can see that people prefer harder texture of muffins. For the color test, the browning differences among these muffins are not really visible to human. Thus, we don’t need to care about the influence of oils to color change of the muffins. From the conclusion showed above, the recipe can be changed to a combination of two different kinds of oils, like combine the corn oil and butter together. Then, the product can have the best texture and taste.

Error sources:

The data of objective tests and sensory tests showed very different results to these four kinds of muffins. There might be some errors occurred during the experiments. Firstly,
the objective test showed totally different result compare to the sensory test. The muffins were tested in different days. The sensory test was run right after the muffins were baked. And the objective test of color was run the second day due to the equipment problem. Therefore, the color might change during the storage (Baixauli and others, 2008). What’s more, during the color test, the muffins were chopped and mixed to fill the bottom of the test cup. Thus, there might be another error that the muffins were not chopped enough and not mixed very well. That will cause the color is not uniform. And for the sensory test, people only observed the outside of the muffins, and the colormeter tested both outside and inside of the muffin. That might be another reason why the objective test and panel test showed totally different results.

Secondly, for the sensory test different panelists have different preference to the color, taste, and texture. And the color might be different in their vision. The conditions of the test room might also influence the result. For example, the brightness inside the room might influence the observation of the color. And the health condition of the panelists may also influence their response to the food. For example, if they got a cold on that day, their response to the flavor and softness will be totally different. Also, the sensory test was run in the baking kitchen, there are lots of other foods like cookies and cakes. The flavor of other baking products would influence the panelists. And among these 9 panelists, there was only one trained panel. That might be another error source of the sensory test. Last but not least, the population of the panel might be another error source to the result of sensory test. A successful sensory test need large enough panel population to ensure the result is reliable.

References:

