The Effect of Replacing Fat with Avocado in Oatmeal Cookies

Brianna Jenison

F&N 453

November 2007
ABSTRACT

Dietary fat-intake is a major concern for researchers, health care professionals, and every health conscious individual in the United States. Over the past decade obesity rates have risen over 60% in this country. Butter is a commonly used lipid and source of energy in various baked goods. However, it is high in saturated fatty acids and cholesterol. Avocado pulp could be an ideal better-for-you butter substitute due to its naturally high oil content, nutrient profile, and texture. The objective of this experiment was to investigate the use of avocado as a fat-replacer in baked goods while maintaining product flavor, texture, and color. This experiment involved substituting different amounts of avocado pulp for butter in oatmeal cookies. Objective and subjective data was collected. The results of this study show that over 75% of panelists indicated liking the variations of cookies containing avocado pulp to some degree. It was clear most panelists thought the control cookies had the best flavor. Although objective data gathered from the Texture Analyzer showed a large discrepancy between the force needed to break the control cookies and the much softer cookies which contained avocado pulp, sensory tests proved that 64% of panelists thought the texture of the softer avocado-containing cookies was best. Hunter colorimeter values of control vs. variation cookies showed that cookies containing more avocado pulp in place of butter were lighter and more yellow in color than control cookies and were marginally more green. The use of avocado in place of butter produces a likeable product that is lower in saturated fat and cholesterol than traditional products with many additional nutritional benefits.
INTRODUCTION

Fat intake from American is a major concern for researchers, health care professionals, and every health conscious individual. Consumption of foods high in dietary fat has been linked to a wide variety of health problems such as obesity, coronary heart disease, hypertension, insulin resistance, caners, and gall bladder disease. Obesity has become so common in the United States that it is considered an epidemic. With the last ten years, obesity rates have risen by more than 60% among the nation’s adults with about 59 million adults considered obese. (Jonnalagadda and Jones 2005). Prevalence of childhood obesity is also on the rise. Obesity not only affects a person physically, emotionally, and socially, but economically as well. Health care costs, diet pills, and other weight reducing aids can be very expensive. (Wardlaw and Hampl 2007). A person puts themselves at risk for obesity he or she consumes more calories than they burn though exercise. The American Dietetic Association’s research shows that a high intake energy-dense foods, soft drinks, increased portion sizes, and lack of exercise lead to a positive energy balance, which leads to weight gain and eventually obesity.

Despite hype of the evils of dietary fat, lipids are an essential component of our diets. Fat is a major source of energy, without which people may develop serious energy deficiency diseases such as kwashiorkor and marasmus disease. Lipids are also vital for cell growth and development and are stored in adipose tissue. These stores help to maintain homeostasis functions such as internal temperature regulation and protect internal organs from injury (Mattes 1998). Furthermore, lipids have many indispensable
functions in baked goods. They affect tenderness, moist mouth feel, lubricity, flavor, and structure of these products (Stauffer 1996).

Not all lipids are created equally, nor do they have the same health implications. Today’s researchers realize the composition of lipids within a food can make all the difference. Lipids are composed of fatty acids which are divided into two main categories; saturated and unsaturated fatty acids. Saturated fatty acids are mainly derived from animal sources which often also contain cholesterol. Diets that are high in saturated fatty acids can contribute to high blood cholesterol which is a risk factor for cardiovascular disease. This disease is the number one cause of death for North Americans (Wardlaw and Hampel 2007). The American Dietary Association recommends lowering the intake of saturated fatty acids, trans-fatty acids, and cholesterol as much as possible and to increase the daily intakes of fruits and vegetables to help reduce health problems of Americans (Jonnalagadda and Jones 2005). Unsaturated fatty acids are generally derived from non-animal sources. Alvizouri-Munoz and others (1992) through research found that diets rich in mono-unsaturated fatty acids assisted in reducing cholesterol levels in blood.

Butter is one of the main sources of lipids in the American diet and is commonly used in baked goods. Butter is comprised of a high level of saturated fatty acids and cholesterol. 23 grams of butter yields approximately 204 calories, 23 grams of fat, 61 mg of cholesterol, and 164 mg of sodium. For years, scientists have challenged themselves to find ways to limit intake of saturated fatty acids and cholesterol in foods to make them healthier while still retaining quality. Researchers have thought of such things as water, starch derivates, fibers, protein-derived fat replacers and engineered fats to substitute for
fats such as butter (Wardlaw and Hampl 2007). For example, margarine was created as a substitute for butter. Yet this alternative still does not satisfy researchers. Margarine contains trans-fatty acids, a hydrolyzed fat. Numerous credible studies have shown that trans-fatty acids correlate with a risk of coronary heart disease (Subramanaim 2004).

The avocado has many qualities that make it an ideal candidate to replace fat in baked goods. It is a fruit with unusually high oil content: 15-30% (Elez-Martinez 2005). Avocados also have custard like consistency with a similar color to butter. Cholesterol, calories, fat, saturated fat, and sodium intake is reduced in foods when avocado is substituted for butter. Compared to the 204 calories in 23 grams of salted butter, there are merely 50 calories in the same amount of fresh avocado (www.avocados.org). Not only does substituting avocado for butter reduce intake of undesirable constituents of butter, but it actually adds nutritional value to foods. Avocados are high in monounsaturated fatty acids. Ledesma and others (1996) studied the affects of consuming a diet high in monounsaturated fatty acids on levels of cholesterol in blood serum by giving participants an avocado enriched diet. This study measured serum total cholesterol, LDL-cholesterol, HDL-cholesterol and triglyceride concentrations before and after the 7-day diet plan. The result was a 16% decrease of serum total cholesterol in healthy individuals. Avocados also contain over 20 vitamins along with phytochemicals which have been shown to induce cell cycle arrest, inhibit growth, and induce apoptosis in precancerous and cancerous cells. Studies have shown that avocado fruit could be a dietary strategy of cancer prevention. (Ding and others 2007). Avocados, due to their high moisture content, nutritional value, and color could be a great better-for-you alternative to butter.
The purpose of this study is to investigate the possibility of using avocado-pulp as a fat-replacer while developing a cookie that is lower in saturated fat and cholesterol than traditional cookies made with butter. The independent variable being altered to perform this experiment is the proportion of butter being replaced by avocado in oatmeal cookies. The first batch (Batch 1) of cookies will be the control, using 100% butter. Batch 2 will use 50% butter and 50% of the fat will be replaced by fresh avocado pulp. In Batch 3, fresh avocado pulp will completely replace butter called for by the recipe. The dependent variables being measured are texture, appearance, and flavor of oatmeal cookies. The texture of the oatmeal cookies will be evaluated objectively with the Texture Analyzer and subjectively tested by a sensory evaluation. The appearance will be objectively evaluated by the Hunter Colorimeter and the flavor is to be evaluated subjectively by a taste panel.
METHODS

Lipids affect the tenderness, moist mouthfeel, lubricity, flavor, and structure of baked goods (Stauffer 1996). The design of this experiment is to create three batches of cookies, each with various proportions of butter being substituted with avocado to comprise the 56g of fat which is called for by the recipe for oatmeal cookies. These cookies will be evaluated objectively and subjectively to determine the quality and palatability of baked goods made with avocado pulp as a fat-replacer.

MATERIALS

- **Fat**
  - Control: Batch 1: 56g Butter
  - Variable 1: Batch 2: 28g Butter & 28g Avocado pulp
  - Variable 2: Batch 3: 56g Avocado pulp
- **7g Water**
- **24g Blended Egg**
- **248g Better Crocker Oatmeal Cookie Mix**

PROCEDURE

1. Preheat oven to 190°C
3. Drop dough by rounded 16g balls onto cookie sheet approximately 5 cm apart.
4. Bake for 10 minutes at 190°C.
5. Remove from oven and allow cookies to cool for 10 minutes on cooling racks.
6. Repeat Steps 1-5 for Batch 2 *make sure to use appropriate butter to avocado ratio. Then continue to Step 7.
7. Repeat Steps 1-5 for Batch 3 *make sure to use appropriate butter to avocado ratio.
8. Save 1 cookie from each batch to use to gather objective data using the Texture Analyzer (cookie setting with knife probe) and Hunter Colorimeter.
9. Break up remaining cookies into four pieces and administer subjective evaluation.
10. Perform objective analysis.

This procedure was carried out three times for a total of three trials. Avocado pulp was prepared by cutting the avocado in half, removing the seed and using a spoon to scoop and weigh out the appropriate amount of avocado pulp. To ensure the least amount of variation between batches and trials, Betty Crocker Oatmeal Cookie Mix was used. This reduces the amount of ingredients that must be added to the dough and therefore smaller room for error in measuring ingredients. One cookie from each batch was set aside to be used to gather objective data using the Texture Analyzer and the Hunter Colorimeter. To conduct the texture analysis, the knife probe was used on the cookie
setting. Color was measured objectively by the Hunter Colorimeter which was standardized using black glass and white tile. The remaining cookies were broken up into four pieces and placed on individual paper plates to administer the subjective evaluation. In order to insure randomization and to reduce sample bias, each batch was assigned a random three-digit number. Batch 1 was assigned # 893, Batch 2 was assigned # 473 and Batch 3 was assigned # 231. Panelists tasted each of the three samples and completed the sensory scorecard (Figure 1).

<table>
<thead>
<tr>
<th>Please Taste Each Sample in Front of You</th>
</tr>
</thead>
<tbody>
<tr>
<td>On the line below please circle the words that correspond to your feelings of each sample.</td>
</tr>
</tbody>
</table>

**893**
- Dislike Extremely
- Dislike Very Much
- Dislike Moderately
- Dislike Slightly
- Neither nor dislike
- Like Slightly
- Like Moderately
- Like Very Much
- Like Extremely

**231**
- Dislike Extremely
- Dislike Very Much
- Dislike Moderately
- Dislike Slightly
- Neither nor dislike
- Like Slightly
- Like Moderately
- Like Very Much
- Like Extremely

**473**
- Dislike Extremely
- Dislike Very Much
- Dislike Moderately
- Dislike Slightly
- Neither nor dislike
- Like Slightly
- Like Moderately
- Like Very Much
- Like Extremely

Please circle which sample has the best texture: 893 231 473

Which sample has the best flavor: 893 231 473

Figure 1: Sensory Scorecard
DISCUSSION

The use of avocado pulp as a butter substitute in oatmeal cookies showed to effect cookie texture, color, and flavor from the beginning. It was noted that the dough made with avocado pulp in place of butter was stickier and more moist than the control dough. Table 1 shows the sensory evaluation of each of the batches of cookies. The average ranking for the control batch of cookies was 2.73 indicating most panelists liked this one the most. Surprisingly, the average ranking of the complete substitution of avocado for butter was only 0.64 points behind the control as being liked the best. The average of the responses indicated that they liked the partial-substitution the least. These numbers are also portrayed graphically in Figure 2. As shown in Figure 3, over half of the panelists thought the control had the best flavor. Nearly 30% felt the full-substitution had the best flavor, while the least amount of panelists preferred the partial substitutions flavor. The batches of cookies made with avocado pulp most likely scored lower due to off-flavors such as bitterness that develop when pulp is subjected to high temperatures (Whiley 2002).

Texture was analyzed subjectively by the taste panel and objectively by the Texture Analyzer. The data gathered by the Texture Analyzer is shown by Table 2 and Figure 4. There is a large discrepancy between the amount of force the knife probe used to break the control cookie and the cookies with partial or full substitution of avocado for butter. This is due to the fact that type of fat used in a baked good has a profound effect on texture (Stauffer 1996). The average force the Texture Analyzer used to break the control cookies was nearly 16,000g higher than batch two cookies. The average force the Texture Analyzer used to break the partial-substitution cookies was only about 100g
higher than the full-substitution oatmeal cookies. Despite the large difference in texture reported by the Texture Analyzer, the same number of panelists preferred the partially-fat-replaced cookies’ texture as the control cookies’. Figure 3 shows the subjective, sensory evaluation of texture. The amount of responses indicating the full butter-replacement had the best texture was merely 2 responses short of the other two variations. This is reassuring evidence that avocado pulp has properties that can uphold important mouth-feel qualities of oatmeal cookies when used as a butter substitute. As an avocado ripens, it develops higher oil content (Whiley 2002). This could account for some of the variation of texture between batches.

The color and appearance of the oatmeal cookies were analyzed objectively by the Hunter Colorimeter. As amount of avocado substituted for butter increased in the cookies, the L-value increased, a-value decreased slightly, and the b-value increased. The higher L-value of cookies which contained avocado rather than butter shows that these cookies were lighter than the control cookies. The decreased a-value indicates that the cookies containing avocado had more of a green color than the redder control cookies. The increase of the b-value signifies the control cookies were more blue than the avocado cookies which were more yellow. The green plant pigment chlorophyll is present in avocado pulp (Whiley 2002). This is a possible explanation for the decreased a-value of cookies containing avocado pulp in place of butter. Also, fats differ in there color depending on their origin (Stauffer 1996). This is another reason color change was noted.

Figure 6 shows one cookie from each batch of Trial 1. Oatmeal cookies in the control group were more golden brown and symmetrical than the variations which contained avocados. This shows the addition of avocado in oatmeal cookies may hinder
the Maillard Reaction. The cookie made with 100% avocado in place of butter had a more a-symmetrical shape with a greener hue and the partial substitution cookies showed characteristics between the two extremes. It was also noted that in oatmeal cookie dough formation, as the amount of avocado pulp increased in the cookies, so did the stickiness and moisture of the dough. If I were to perform this study again I would use a water activity meter to determine the water activity in cookies with various amounts of fat replacers.

Further research of the use of avocado as a fat-replacer in baked goods should be conducted. One idea is to puree the avocado pulp to create a more blended and uniform cookie dough and cookie. This would eliminate some of the small lumps of avocado pulp which were noticeable in a few of the cookies. A source of error in this experiment could have occurred when avocado pulp was spooned out of the whole fruit. Perhaps pulp nearest to the seed has different qualities than pulp nearer to the skin of the fruit. Another source of error in this experiment could be the variation the amount of time each batch of cookies were allowed to cool before collecting objective data. Cookies that have been sitting out longer may be harder and require more force from the texture analyzer to break them. To reduce the amount of off-flavors that develop from the cookie, perhaps variations of longer cooking times at lower temperatures could be studied. The use of avocado oil as a replacement for fat in brownies is another area that could also be studied. The use of avocado in place of butter should be further studied because it produces a likeable product that is lower in saturated fat and cholesterol than traditional products with many additional nutritional benefits.
RESULTS

TABLE 1

Effects of Proportion of Avocado used as Fat-Replacer on Sensory Attributes of Oatmeal Cookies

<table>
<thead>
<tr>
<th></th>
<th>Control-100% Butter</th>
<th>50% Butter &amp; 50% Avocado</th>
<th>100% Avocado</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial 1</td>
<td>Trial 2</td>
<td>Trial 3</td>
</tr>
<tr>
<td>Rating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-Like Extremely</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2-Like Very Much</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>3-Like Moderately</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4-Like Slightly</td>
<td>4</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>5-Neither Like nor Dislike</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>6-Dislike Slightly</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>7-Dislike Moderately</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8-Dislike Very Much</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9-Dislike Extremely</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Average Rating</td>
<td>3.3</td>
<td>2.6</td>
<td>2.3</td>
</tr>
<tr>
<td>Best Texture</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Best Flavor</td>
<td>7</td>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>

*This table indicates the number of panelists that scored the sample each rating number; 1 being highest rating
*This table also indicated the number of panelists that ranked each variable as having the best texture or flavor out of all three

Figure 2: Average Rating of Each Variation of Oatmeal Cookie

*Sensory Rating Scale: 1 = Likes Extremely, 9 = Dislikes Extremely
Figure 3: Effect of Proportion of Fat Replaced by Avocado Pulp on Sensory Evaluation of Texture and Flavor of Oatmeal Cookies

*Y-axis values indicate the number of panelists that indicated they preferred the variable’s Texture and Flavor

TABLE 2
Effects of Substituting Avocado for Butter on Oatmeal Cookie Texture (Force (g)) as determined by Texture Analyzer

<table>
<thead>
<tr>
<th>Variation</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% Butter</td>
<td>12474.4</td>
<td>18873.6</td>
<td>19764.0</td>
<td>17037.3</td>
</tr>
<tr>
<td>50% Butter and 50% Avocado</td>
<td>766.9</td>
<td>760.1</td>
<td>1612.6</td>
<td>1046.5</td>
</tr>
<tr>
<td>100% Avocado</td>
<td>846.0</td>
<td>1076.9</td>
<td>918.0</td>
<td>946.9</td>
</tr>
</tbody>
</table>

Figure 4: Effect of Substituting Avocado for Butter on Texture of Oatmeal Cookies Measured by Texture Analyzer
TABLE 3
Effects of Substituting Avocado for Butter on Oatmeal Cookie Color as determined by Hunter Colorimeter

<table>
<thead>
<tr>
<th>Variation</th>
<th>L-value</th>
<th>a-value</th>
<th>b-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% Butter</td>
<td>23.76</td>
<td>10.22</td>
<td>10.02</td>
</tr>
<tr>
<td>50% Butter, 50% Avocado</td>
<td>38.22</td>
<td>9.79</td>
<td>16.97</td>
</tr>
<tr>
<td>100% Avocado</td>
<td>946.9</td>
<td>9.45</td>
<td>17.35</td>
</tr>
</tbody>
</table>

Figure 5: Effects of Substituting Avocado for Butter on Color of Oatmeal Cookies determined by Hunter Colorimeter

*Data corresponds to average values collected from three trials.

Figure 6: Photograph of One Cookie from Each Batch of Trial 1.
REFERENCES


www.avocado.org