Lipid-Based Fat Replacer in Cookies: The Effect On Taste and Texture

Meagan Moyer
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F&N 453 Individual Project Report
Abstract
Dietary fats are an important topic in today’s American society. High fat consumption has been linked to heart disease, obesity, diabetes, cancer, and many other health problems. Fat replacers have been developed to reduce the amount of fat in foods we enjoy. This study looks at a lipid-based fat replacer named salatrim or Benefat™ and its acceptance in cookies. Taste and texture using a taste panel was evaluated and a texture analyzer and water activity meter were used as objective methods of evaluation. The experiment included a full fat control variable, a 25% reduced-fat variable, and a 50% less fat variable. It was found that the full fat cookies were the most acceptable to panelists and that fat-replaced cookies were harder in texture and lower in water activity. Overall, fat is a difficult ingredient to mimic in foods and often many types of fat replacers are needed in one food. More research is needed to develop the best formulas in fat replacement.

Introduction
Heart Disease is the leading killer of men and women in the United States (CDC 2005). The CDC estimates that in the year 2006, $258 billion will be spent on the treatment of heart disease, which includes health care services, medications, and lost productivity (American Heart Association 2005). A high consumption of dietary fats is associated with a person’s increased risk for developing heart disease and stroke along with other diseases such as obesity, diabetes, hypertension, high blood pressure, respiratory diseases, and cancer (Hayes 2003). Consuming more calories than one needs leads to weight gain. Fat is an important macronutrient that contributes more energy, in the form of
calories, than carbohydrates and protein (Akoh 1998). Therefore, it is relatively easy to consume a greater amount of calories when there is a lot of fat in the diet. The purpose of this experiment is to determine what amount of fat can be replaced in cookies while still maintaining a pleasing taste and texture. The independent variable in this study is the amount of fat replaced with salatrim. The dependent variables in this study are taste, texture, and water activity of the cookies.

The presence of fat in foods, particularly baked goods, contributes to taste and texture of the final product. Fat is therefore an important component in the sensory of foods. Fats also work to emulsify mixtures, absorb moisture, aerate batters, and transfer heat (Mattes 1998). The public’s demand for lower fat foods have lead food scientists to create chemical compounds called fat replacers. There are three classifications of fat replacers, which include fat substitutes, fat “mimetics”, and fat barriers. Mattes (1998) defines fat substitutes as compounds that are designed to replicate the functional and sensory properties of fats, but are not chemically classified as fat and contain less energy than fats. He goes on to define fat “mimetics” as compounds that replicate a portion of the properties that fat contributes to the final product. Fat barriers are defined as compounds that are added to fried foods to reduce the absorption of fat during cooking (Mattes 1998).

The chemical structures of fat replacers are highly differentiated depending on what macronutrient the fat replacer has been derived from. Fat replacers can be carbohydrate-based, lipid-based, or protein-based. Each type
of fat replacer contributes certain characteristics to foods. In the interest of this study, a lipid-based fat replacer called salatrim, or Benefat™ was used. Salatrim stands for short and long acyl triglyceride molecule and is composed of 30-67% short chain fatty acids and 33-70% long chain fatty acids (mostly stearic acid) that are attached to a glycerol backbone (FAO 1997).

![Figure 1: Structural formula of salatrim (FAO 1997)](image)

Salatrim has a caloric value of 55% of regular fats or 4.05 kilocalories per gram (Akoh 1998). According to Akoh, salatrim is to be used in chocolate-flavored coatings, caramels and toffees, baked goods, peanut spreads, savory dressings, dips and sauces, dairy products, and cheeses (1998). Lipid-based fat replacers should serve the general function of emulsification, providing cohesiveness, tenderization, replacement of shortening, flavor, prevention of staling, prevention of starch retrogradation, and conditioning of dough (Akoh 1998).

**Methods**

Three separate trials were performed in this study. For each trial, batches of Butterball cookies were made with varying amounts of Benefat™. The first variable served as a control and contained the full amount of fat. The second
variable had 25% of the fat replaced with Benefat™ and the third variable had 50% of the fat replaced with Benefat™. The control variable was given the number 417. The 25% lower fat cookie was assigned the number 230 and the 50% lower fat cookie was given the number 808. The recipe is as follows.

Butterball Cookies:

Ingredients:
- 277 grams of butter*
- 172.5 grams of chopped walnuts
- 85 grams of honey
- 242 grams of flour
- 1.15 grams of salt
- 1 ½ tsp vanilla extract

Procedure: Cream butter and honey until well blended. Add vanilla and salt. Add flour gradually. Fold in walnuts. Form dough into small balls. Bake at 162.7° C for 25 minutes until golden brown. When cookies have cooled, shake in a bag with powdered sugar.

*Trial 2: 69 grams of Benefat™ and 208 grams of butter
*Trial 3: 138.5 grams of Benefat™ and 138.5 grams of butter

After trial preparation, the cookies were given to between 8-9 taste panelists who completed a hedonic scale-based sensory test. A total of 24 taste panelists were polled. The panelists were fellow lab mates, faculty and staff of the F&N department, and family and friends. The samples were given three digit numbers for identification and arranged in a triangle before the panelist to prevent sample bias. Participants were asked to complete the forms and rank the cookies on a 1 to 9 point hedonic scale. Participants ranked the cookies on taste and texture. A score of 1 was least desirable and a score of 9 was the most desirable. The participants were also given the chance to make any written comments that they had about the variables. The form used is given below.

Please rate each cookie in regards to taste and texture with one being the least desirable and 9 being the most desirable.
After the cookie batches were prepared and cooled, a texture analysis was performed using a stable micro systems texture analyzer. This machine measures the force needed to compress various foods (Weaver and Daniel 2003). For this particular experiment, a texture analyzer was used to determine fracturability or brittleness as well as cohesiveness. The machine was set to the cookie setting and a cone probe was used in all trials. A water activity system meter was also used to measure the amount of water that is available in the cookie variables (Weaver and Daniel 2003).

Discussion

The replacement of fat in these cookies resulted in a differential in taste preference. Overall, panelists ranked the full-fat variable as their favorite in taste and texture. Their preference for the variables decreased as the amount of fat replacement increased. As seen in table 1, variable 417 was given an average of 7.4 on taste and 7.2 on texture. Table 2 shows that variable 230 was given an average of 6.8 on taste and a 6.5 on texture and table 3 shows that variable 808
was given an average of 5.5 on taste and 5.7 on texture. Figure 2 compares all three variables to each other in terms of taste and texture. The graph represents a clear preference to the control cookie. A similar study by Swanson (1998) on fat replacers in cookies was conducted to evaluate the acceptance of reduced-fat peanut butter cookies in schools. Similarly, the reduced-fat cookies were rated less acceptable than the control cookies. The cookies used in this experiment depend greatly on the taste, texture and mouthfeel that butter contributes to baked goods. Further studies should be conducted using cookie recipes with more flavors other than butter.

Butter is an important ingredient in many baked goods. The fat replacer used in this experiment was meant to mimic as many of butter's functions as possible. Two functions of butter that are important in this experiment are water retention and tenderization. The texture analyzer readings are shown in table 4 with the averages of the readings. As the results show in figure 3, more force was needed to break variable 808, which contained the least amount of butter. The trend is not consistent with variable 230, which needed the least amount of force to penetrate. This may be due to many things such as the temperature of the cookies when tested, the thoroughness of mixing in ingredients during the preparation of the dough, and the location that the probe penetrated the cookie.
A study conducted by Zoulias and others (2002) studied the effect of fat replacers and sugar replacers in cookies and observed that with increasing amount of fat replacer, the cookies became more brittle. This may be due to the fact that they also observed higher water activity in the lower fat cookies than the
control cookies. Both of these findings conflict with the results shown in this experiment. This may be as a result of the use of sugar substitutes along with fat replacers, as well as the nature of the cookie recipes used.

Butter is 20% water and therefore contributes water to baked goods (Charley H and Weaver CM 1998). Salatrim does not contain any water (FAO 1997). Table 5 illustrates that the lowest amount of water activity was in the variables with the least amount of butter and the highest amount of salatrim. These characteristics can be seen graphically in figure 4. The highest amount of water activity was in the full fat cookie. As the amount of butter in the variables decreased, the water activity also decreased. This may have contributed to the decrease in texture desirability with the taste panelists.

Fat replacers are a widely researched area in food technology. Reduced fat products often contain more than 100 different fat replacers in varying amounts to achieve the desired taste and effect on texture (Mattes 1998). Therefore, much more experimentation and research is needed to determine the best formulas for each type of food.

In conclusion, reduced-fat foods can be an important part of a healthy diet when consumed in moderation. Much work is being done and still needs to be done to develop the “optimal” fat replacer in foods. This experiment shows that there are many factors that go into the choice of which fat replacer to use in foods. The type of food being made also matters in the final reduced-fat product. The type of fat replacer used and recipe used in this experiment did not yield the best results in creating a reduced-fat cookie.
**Results**

Table 1: Average hedonic scale rating for full-fat cookie (variable #417)

<table>
<thead>
<tr>
<th></th>
<th>Taste</th>
<th>Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average for variable 1</td>
<td>7.4</td>
<td>7.2</td>
</tr>
</tbody>
</table>

Table 2: Average hedonic scale rating for 25% less fat cookie (variable #230)

<table>
<thead>
<tr>
<th></th>
<th>Taste</th>
<th>Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average for variable 2</td>
<td>6.8</td>
<td>6.5</td>
</tr>
</tbody>
</table>

Table 3: Average hedonic scale rating for 50% less fat cookie (variable #808)

<table>
<thead>
<tr>
<th></th>
<th>Taste</th>
<th>Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average for variable 3</td>
<td>5.5</td>
<td>5.7</td>
</tr>
</tbody>
</table>

**Figure 2: Average taste and texture sensory score given to variables**
**Figure 3:** Average force needed to penetrate variables using a texture analyzer

**Table 4:** Force needed to penetrate cookies using a texture analyzer

<table>
<thead>
<tr>
<th>Variable</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>417 (#1)</td>
<td>274.2</td>
<td>195.3</td>
<td>308.3</td>
<td>259.3</td>
</tr>
<tr>
<td>230 (#2)</td>
<td>261.6</td>
<td>164.3</td>
<td>198.2</td>
<td>208.0</td>
</tr>
<tr>
<td>808 (#3)</td>
<td>587.9</td>
<td>145.3</td>
<td>230.3</td>
<td>321.2</td>
</tr>
</tbody>
</table>
Table 5: Water activity in variables using a water activity meter

<table>
<thead>
<tr>
<th>Variable</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>417 (#1)</td>
<td>0.663</td>
<td>0.567</td>
<td>0.596</td>
<td>0.609</td>
</tr>
<tr>
<td>230 (#2)</td>
<td>0.451</td>
<td>0.592</td>
<td>0.539</td>
<td>0.527</td>
</tr>
<tr>
<td>808 (#3)</td>
<td>0.380</td>
<td>0.418</td>
<td>0.481</td>
<td>0.426</td>
</tr>
</tbody>
</table>

Figure 4: Average water activity of variables using a water activity meter

References


