Effects of Substituting Pawpaw Fruit Puree for Fat on the Sensory Properties of a Plain Shortened Cake

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ADDITIONAL INDEX WORDS. *Asimina triloba*, panel evaluation

**SUMMARY.** The pawpaw (*Asimina triloba*) is a 3- to 6-inch (7.6 to 15.2 cm) edible fruit that contains two rows of almond-size seeds surrounded by yellow to orange-colored flesh, with the skin ranging from green to yellow when ripe. The custard-like texture of the pawpaw fruit and its nutrient composition makes it an excellent candidate as a fat-reducing agent in baked goods. Given the properties of the pawpaw fruit, it may prove to be a favorable replacement for fat in various food formulations. The objective of this study was to investigate the sensory properties of plain shortened cake (PSC) using pawpaw fruit puree as a partial replacement for fat in the food formulation. The cakes were prepared by replacing about 25%, 50%, and 75% of the fat with pawpaw fruit puree and were compared to a control using 100% vegetable shortening. The PSC samples were evaluated using untrained panelists (n=105) with a scorecard using a hedonic scale to measure sensory characteristics. Mean scores suggested that panelists liked all cake samples slightly to extremely. Panelists did not detect differences between the control and 25% fat replacement sample for all sensory attributes. However, notable preference differences were detected between the control and 25% samples and the 50% and 75% samples for the attributes of color, texture, tenderness, and overall acceptability. Panelists indicated that 25% fat replacement with pawpaw fruit puree is acceptable in a PSC formula. The notable differences in color, texture, tenderness, and overall acceptability attributes may be overcome with further research and product development. Higher levels of fat replacement may prove to be acceptable in other types of cake formulations and further testing of the various varieties of pawpaw fruit as a fat-replacement in baked goods is warranted.

The pawpaw fruit is an oblong fruit ranging from 3 to 6 inches in length and contains one or two rows of almond-size seeds surrounded by a soft, custard-like flesh ranging in color from yellow to orange when ripe. The pawpaw is the largest tree fruit native to the United States and demonstrates potential as a fruit crop with commercial value (Layne, 1996; Peterson, 1991; Pomper et al., 1999). This hardy plant is well adapted to replace old crops that are currently losing value with a new high-value crop. One example of this is that pawpaw orchards could help tobacco (*Nicotiana tabacum*) farmers to diversify and enhance continued, long-term viability (Layne, 1996). The growing interest in the pawpaw amongst enthusiasts, entrepreneurs, and consumers is raising a demand for more information about uses for the fruit and agricultural production (Cosby, 2001).

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Duffrin et al. (2001) used pawpaw fruit puree as a fat-reducing agent in muffins, compared to muffins made with applesauce and fat. These authors found that muffins made with pawpaw puree (~91% fat replacement) were equally acceptable to the other muffins for all characteristics, with the exception of appearance. The study concluded that pawpaw fruit puree had the potential as a carbohydrate-based fat reducing agent in muffins and suggested that it had the potential to be used as a fat reducing agent in other types of baked goods. Continued investigation of pawpaw fruit puree as a fat-reducing agent in baked goods develops an area of potential use for this product and provides consumers with another product option that could be used to lower dietary fat intake.

Hydrogenated vegetable oil is used in a plain shortened cake food formulation (Penfield and Campbell, 1990) and contributes to the sensory qualities of flavor, tenderness, and color (Swanson and Munsayac, 1999) in the finished cake product. Although these characteristics are desired in the finished cake product, the trans fatty acid intake associated with the use of hydrogenated vegetable oil is not a desirable component of a heart healthy diet. Trans fatty acids have been found to be a contributor to heart disease by increasing blood cholesterol levels (Jacobs and Murtaugh, 2000; Weisburger, 1997).

Many fruit such as apples (Malus x sylvestris var. domestica), prunes (Prunus domestica), (Swanson and Munsayac, 1999) and pawpaws (Duffrin et al., 2001) have been used as a fat-reducing agent in baked goods. Using a carbohydrate-based fat-reducing agent in a plain shortened cake would produce a food formulation lower in trans fatty acids, total fat, and calories. The objective of this study was to investigate the effects of substituting varying levels of hydrogenated vegetable oil with pawpaw fruit puree on the sensory properties of a plain shortened cake.

Materials and methods

Cakes were prepared using a plain shortened cake recipe modified from Penfield and Campbell (1990). The conventional method of mixing was used to prepare the cake batter. The cakes were prepared by replacing about 25%, 50%, and 75% of the fat with pawpaw fruit puree (Integration Acres, Albany, Ohio) and compared to a control using 100% vegetable shortening. With the exception of the pawpaw, all ingredients were obtained from a local supermarket. The cake formulations are listed in Table 1.

All dry ingredients and eggs were weighed using an electronic scale (Acculab Inc., Newton, Pa.) accurate to 0.1 g. The milk was measured in a 50-mL graduated cylinder and the vanilla was measured in a 10-mL graduated cylinder. The flour, baking powder, and salt were sifted together in a medium-mixing bowl. The vanilla was added to the milk. A handheld electric mixer (model 62520; Hamilton Beach, Picton, Ont., Canada) was used at a speed of 3 for all mixing. The shortening was creamed for 1 min and the sugar was added and mixed for an additional min. Egg was then added to the creamed mixture and mixed for an additional 2 min. One-third of the flour mixture and one-third of the milk was added and mixed for 45 s, this was repeated twice. The mixing times were kept consistent for each sample preparation. The batter was poured into aluminum anodized round cake pans [5.1 cm (2 inches) deep and 20.3 cm (8 inches) diameter (Marpol Inc., Rock Falls, Ill.) that were lightly coated with vegetable oil spray. The samples were baked at 176.7 °C (350 °F) for 35 min and were removed from the pans after cooling for 15 min.

Cake samples [2.5 cm (1 inch) square] were placed on individually coded, square sampling dishes. The four samples were placed on a tray and simultaneously presented to the panelists. Samples were tasted in random order. Participants were provided with tepid (room temperature) water to cleanse the palate between samples. A scorecard with a hedonic scale was used to rate each cake sample for color, flavor, texture, tenderness, aftertaste, and overall acceptability. The scale was composed of eight choices ranging from 1 = like extremely, to 8 = dislike extremely.

A sample of untrained, volunteer, adult consumer panelists (n = 105) were invited from the university campus to participate in sensory evaluation of the cake samples. Panelists were given information, both verbally and in writing, about the expectations of their participation in the study. After signing a participation consent form, panelists were seated at individual testing stations with standard fluorescent light and given a scorecard with written instructions asking them to rate their cake samples. Descriptive statistics, analysis of variance (ANOVA), and post hoc analysis (Tukey’s honestly significant difference) were completed using the Statistical Package for the Social Sciences (SPSS, Chicago); P < 0.05 was considered significant.

Results and discussion

Mean scores suggested that panelists liked all cake samples to some degree (slightly to extremely) (Table 2). The 25% sample received more favorable mean ratings in the categories of flavor and texture, although panelists detected no differences between the control and 25% fat replacement sample for all sensory attributes. ANOVA of

Table 1. Formulations and nutrition analysis of the full-fat plain shortened cake (100%) and the three variations (25%, 50%, and 75%) of fat replacement with pawpaw fruit puree.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Control</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shortening</td>
<td>120 g (1/2 cup)</td>
<td>90 g (3/8 cup)</td>
<td>60 g (1/4 cup)</td>
<td>30 g (1/8 cup)</td>
</tr>
<tr>
<td>Pawpaw puree</td>
<td>---</td>
<td>32 g (1/8 cup)</td>
<td>64 g (1/4 cup)</td>
<td>96 g (1/8 cup)</td>
</tr>
<tr>
<td>Nutritional analysis</td>
<td>Energy (kcal)</td>
<td>213</td>
<td>186</td>
<td>173</td>
</tr>
<tr>
<td>Energy from fat (%)</td>
<td>44.4</td>
<td>35.1</td>
<td>29.2</td>
<td>18.6</td>
</tr>
</tbody>
</table>

1Ingredients which did not change: cake flour 156 g (1 1/3 cup); baking powder 5.8 g (1 3/4 teaspoon); salt 3 g (1/2 teaspoon); vanilla 2.4 mL (1.2 teaspoon); milk 158 mL (2/3 cup); shortening 120 g (1/2 cup); sugar 200 g (1 cup); egg 56 g (1 large).

2Calculated based on a 59 g (2.1 oz) serving using Nutritionist Pro 2002 (First Data Bank, San Bruno, Calif.); 1 kcal = 4184.2 J.
made with a higher percentage of fat

The nutrient composition and the
color, texture, tenderness, and overall
acceptability. The differences were
notable between the control and 25%
samples and the 50% and 75% samples.
Sensory evaluation scores are summed
rized in Table 2.

Overall data suggested that a 25%-fat-replacement with pawpaw fruit is ac-
ceptable in a plain shortened cake food
formulation. The majority of significant
differences detected were between the
control and 25% samples and the 50% and 75% samples. The increased re-
placement of fat in the cake samples resulted in a reduced preference for
the categories of color, texture, tenderness, and overall acceptability. This is
consistent with Swanson and Munsayac’s (1999) description of the functionality
of fat in baked products.

The nutrient composition and the
color of the pawpaw fruit contribute to the
color of the final cake product. The results showed that the preference for
the color of the cake decreased with the greater addition of the pawpaw
fruit. This is consistent with Duffrin et
al. (2001) findings in muffins. A dif-
cerence was detected in the panelists’ appearance ratings of the muffins made
with pawpaw. Because pawpaws range
in color from yellow to orange based
on the variety type of the fruit, test-
ing different varieties of pawpaw fruit
(Pomper et al., 1999) particularly those
lighter in color, as a fat replacement is
warranted.

The decreased preference for the
texture and tenderness of the samples
made with a higher percentage of fat
replacement was due to the decrease
in the amount of fat in this particular
food formulation. Fat is a vital ingredi-
ent in baked goods, providing flavor
and mouthfeel as well as contributing to
appearance, texture, and tenderness of
the product (Zoulas et al., 2000). The
expectation for this product was a light
and fluffy cake, the higher percentages of
fat replaced resulted in a reduction of
these characteristics. The influence
on the color, texture, and tenderness
appeared to influence the preference
ratings for the category of overall ac-
ceptability. Participants preferred the
control and 25% samples in this food
formulation.

A high percentage of fat replace-
ment with pawpaw fruit puree in a plain
shortened cake recipe did not produce
an ideal product. In examining Duf-
frin et al. (2001) muffin formulation, it
appears that some fat is required in a
food formulation along with pawpaw
fruit puree for a desirable product. This
point warrants further investigation in
determining appropriate proportions
of fat substitution using pawpaw fruit
puree in a variety of baked good food
formulations.

In conclusion, the results obtained
from this study are useful for informing
consumers about the potential uses of
pawpaw fruit as a carbohydrate-based
fat-reducing agent in baked products.
Food and nutrition professionals can
educate their clients about the added
benefits of substituting some of the
hydrogenated vegetable oil in recipes
with pawpaw fruit puree. The benefits
of using pawpaw as fat-reducing agent
include: less trans fatty acids and total
fat in the baked good, less calories, and
added nutritional benefits.

Table 2. Consumer evaluation of sensory characteristics of plain shortened cakes with 25%, 50%, and 75% of the fat substi-
tuted with pawpaw puree and a control cake.\(^1\)

<table>
<thead>
<tr>
<th></th>
<th>Color</th>
<th>Flavor</th>
<th>Texture</th>
<th>Tenderness</th>
<th>Aftetaste</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>2.5 a</td>
<td>3.2 ab</td>
<td>3.2 b</td>
<td>3.0 b</td>
<td>3.2 a</td>
<td>3.1 b</td>
</tr>
<tr>
<td>25% pawpaw</td>
<td>2.6 a</td>
<td>3.1 b</td>
<td>3.0 b</td>
<td>3.0 b</td>
<td>3.3 ab</td>
<td>3.1 b</td>
</tr>
<tr>
<td>50% pawpaw</td>
<td>3.3 b</td>
<td>3.7 a</td>
<td>4.5 a</td>
<td>4.4 a</td>
<td>3.7 ab</td>
<td>4.0 a</td>
</tr>
<tr>
<td>75% pawpaw</td>
<td>3.5 b</td>
<td>3.4 ab</td>
<td>4.1 a</td>
<td>4.0 a</td>
<td>3.7 b</td>
<td>3.7 a</td>
</tr>
</tbody>
</table>

\(^1\) *1 = like extremely, 2 = like very much, 3 = like moderately, 4 = like slightly, 5 = dislike slightly, 6 = dislike moderately, 7 = dislike very much, 8 = dislike extremely.

\(^2\) *n = 105.

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muffins made with applesauce and fat.

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