FAT CONTENT EVALUATION IN PHYSICAL PROPERTIES and TEXTURE PROFILE of CAKES

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ABSTRACT - The objective of this study was to evaluate the influence of different concentrations of fat in the physical properties and texture profile of cake. It was prepared four cake formulations containing 64.5g, 32.25g, 16.12g and 0g of hydrogenated vegetable fat corresponding respectively to amounts of 100% - Control (G-100), 75% (G-75), 50% (G-50) and 0% (G-0) respectively. The technical characteristics of the cakes were evaluated by the specific gravity and microscopic analysis of the distribution of air bubbles in the batter. After 4h of cooling the cakes, the specific volume and symmetry and uniformity index were evaluated. The water activity (Aw) and Texture Profile Analysis (TPA) were evaluated at 1, 3 and 5 days of storage. The fat reduction induced significant differences (P <0.05) with the increase of specific density, which was followed by a decrease in incorporation of air, as well as significant increase in the hardness and chewiness of cakes.

PALAVRAS-CHAVE: microscopy, incorporation of ar, densidade especifica

KEYWORDS: microscopy, air incorporation, specific density

1. INTRODUCTION

The consumption of foods high in fat has been a constant concern in recent times. The ingestion of fat on large quantity will provide more calories, weight gain, as well as contribute to the onset / worsening of some diseases such as dyslipidemia, obesity, diabetes mellitus and hypertension (VAN HORN et al., 2008).
In cakes, a food greatly appreciated, fat has some functions such as aeration in creaming, intervention in the physical properties by the interaction between particles of starch and protein, and emulsifiers, thus contributing to the necessary softness properties (SOWMYA et al., 2009).

Preferences for healthier items, new flavors and convenience consumption are some of the current trends (ABIP, 2015). In this sense, the aim of this study was to evaluate the influence of different concentrations of hydrogenated vegetable fat in the physical properties and texture profile of cakes, in order to develop a healthier formulation and with good technological characteristics.

2. METHODOLOGY

2.1. Preparation of cakes

It was prepared four cake formulations containing 64.5 g, 32.25 g, 16.12 g and 0 g of hydrogenated vegetable far with 60% of fat (margarine) corresponding respectively to amounts of 100% -Control (G-100), 75% (G-75) 50% (G-50) and 0% (G-0), as described in table 1. The formulations were prepared in a planetary mixer, 3.5 liter capacity, with a globe beater in high speed, for 5 minutes blending sugar, fat and eggs. Then the sifted dry ingredients and water were added, mixing at slow speed for 4 minutes. Finally, 500g of the mixture of each formulation were placed in a cake pan without cover and taken to bake in a 180 °C preheated oven for 50 min. After cooling the cakes were packed in polypropylene bags and stored for five days at room temperature (± 28 °C). All cake samples were performed in triplicates.

Table 1 - Formulations of cakes.

<table>
<thead>
<tr>
<th>INGREDIENTS (g)</th>
<th>G-100</th>
<th>G-50</th>
<th>G-75</th>
<th>G-0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flour</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Sugar</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Salt</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>Fresh eggs</td>
<td>75</td>
<td>75</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Vegetable fat</td>
<td>64.5</td>
<td>32.25</td>
<td>16.12</td>
<td>-</td>
</tr>
<tr>
<td>Milk (powder)</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Baking powder</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Water</td>
<td>82.5</td>
<td>82.5</td>
<td>82.5</td>
<td>82.5</td>
</tr>
</tbody>
</table>

G-100 control sample (100% vegetable fat formulation), G-50 (reduction of 50% vegetable fat formulation), G-75 (reduction of 75% vegetable fat formulation) e G-0 (absence of vegetable fat in the formulation).

2.2. Specific density and mass of microscopy

The specific density of the cake dough at 28 °C was calculated by dividing the weight of a mass standard measure by the weight of an equal volume of water, according to the methodology described by Jia et al., (2014).

The microscopy of the cake batter was performed by optical microscopy, analyzed from the distribution of air bubbles, according to Jyotsna et al. (2007). Briefly, a thin layer of the fresh cake doughs were spread on glass slides and carefully covered with coverslips, in order to avoid the inclusion of air bubbles and deformation of the sample structure. After that it observed under an optical microscope with a magnification of 10X and capture images of the slides with USB Digital Electronic Eyepiece and microscope software (Mias2008-Electronic Eyepiece).

2.3. Specific volume
The specific volume was calculated after 4 hours of cooling, according to the methodology described by AACC 10-05.01 (AACC, 2010), obtained by dividing the volume and mass of each cake formulation in g/cm³, by seed displacement.

2.4. Symmetry and uniformity index

After 4h of cooling, rates of symmetry and uniformity were calculated according to the AACC 10-90.01 method (AACC, 2010).

2.5. Water activity (Aw)

The water activity (Aw) was determined in the center of five cake slices of each formulation. The analyses were performed in days 1, 3 and 5 of storage using the Aqualab equipment, model TE 3 (Braseq, Brazil).

2.6. Texture of cakes

The Texture Profile Analysis (TPA) was evaluated at times 1, 3 and 5 days of storage, by the AACC 74-09.01 method (AACC, 2010), using "Stable Micro Systems" software provided by TA.XT plus Texture Analyser instrument. After the crust was removed, the cake was cut into samples of 40 x 40 x 20 mm size, and a cylindrical probe of 36 mm diameter was used in double compression test to penetrate a depth of 50% with speed of 1 mm/s, with a 5s delay between the two cycles. The parameters obtained from the curves were firmness (maximum force during the first compression cycle), elasticity (recovery after the delay between compressions), cohesiveness (ratio between positive force area during the second and first compression) and chewiness (product firmness x cohesiveness x elasticity). Eight determinations for each formulation were held.

2.7. Statistical analysis

Statistical analysis was performed using analysis of variance (ANOVA) using the statistical program Graphpad Prism 5 Demo. The Tukey test was used. Values P > 0.05 are considered significant.

3. RESULTS AND DISCUSSION

3.1. Microscopy and specific gravity of the cake batters

The low specific density is desired in the cake batter, as it indicates that more air is incorporated into the dough, and it indicates the retention volume of air that was initially incorporated in the dough during mixing (ASHWINI et al., 2009).

The results presented in Table 2 indicate that reducing the fat percentage significantly influenced (P < 0.05) the specific density of the dough with an increase of 0.10 g/ml for samples with reduction of 50% and 75% and 0.22 g/ml for samples with reduction of 100% compared the control sample. Similar values of specific gravity increase were obtained by Sowmya et al. (2009), by replacing 50% of sesame oil margarine, obtaining 0.13 g/ml density difference compared with the control. Bedoya-Perales and Steel (2014), analyzing cakes with 60, 40 and 20 g of fat, obtained an increase of density ranging from 0.79 to 0.90 respectively.

Table 2 – Effect of the percentage of hydrogenated vegetable fat in cake for the specific density, specific volume, symmetry index, uniformity and Aw.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Water activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
With the reduction of the hydrogenated vegetable fat levels, a decrease in the number of air bubbles was observed, as well as their distribution and non-uniformity in size (Fig. 1). It can also be noted that the amount of bubbles due to fat concentration is inversely proportional to the specific density (table 2). Similar results were reported by Sowmya et al. (2009) and Indrani and Rao (2008) by replacing hydrogenated fat in cakes. According to Sahi and Alava (2003) the incorporation of air depends both on the aeration process, which in this study was the same for all treatments, and the physicochemical properties of the cake batter, which are determined by the formulation.

Figure 1 - Microscopy of cake batter (10X magnification).

### 3.2. Specific volume

As seen in Table 2 the results for the specific volume ranged from 2.29 ± 0.04 to 2.49 ± 0.11 ml/g, showing no significant change (P <0.05). Similar results were also reported by Felisberto et al. (2015), with specific volumes of 2.48 ± 0.02 and 2.35 ± 0.10 ml/g, in cakes with 50% and 25% of fat reduction, respectively. The non-interference of the fat on the specific volume determination of the cake can be related to influences during the cooking phase, since as Lostie et al. (2002) during the cake dough baking all physical and structural changes, that determine the quality of the final product, such as starch gelatinization and volume expansion, are related to the internal heating and heat transfer.

### 3.3. Symmetry and uniformity index

The symmetry and uniformity indices showed no significant differences between the samples (Tab.2). All cakes showed positive and low values of symmetry indices, indicating that the reduction of fat did not affect this parameter. The symmetry index is a surface contour indicator, and high values indicate that the cake has more height in the center than at the sides, which is an undesirable characteristic (GOMEZ et al., 2007). The uniformity index, which measures the difference between the heights of the two ends of the cake, should be as close as possible to zero, indicating uniform growth and structural maintenance of the cake during baking and cooling (FELISBERTO et al., 2015).

<table>
<thead>
<tr>
<th>Specific density of the mass (g/ml)</th>
<th>Specific Volume (ml/g)</th>
<th>Symmetry Index (cm)</th>
<th>Uniformity Index (cm)</th>
<th>Days storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>G-100</td>
<td>0.91 ± 0.01c</td>
<td>2.37 ± 0.07a</td>
<td>1.2 ± 0.28a</td>
<td>0.89a</td>
</tr>
<tr>
<td>G-50</td>
<td>1.01 ± 0.0b</td>
<td>2.49 ± 0.11a</td>
<td>0.9 ± 0.15a</td>
<td>0.89a</td>
</tr>
<tr>
<td>G-75</td>
<td>1.01 ± 0.02b</td>
<td>2.35 ± 0.09a</td>
<td>1.2 ± 0.26a</td>
<td>0.89a</td>
</tr>
<tr>
<td>G-0</td>
<td>1.13 ± 0.02a</td>
<td>2.29 ± 0.04a</td>
<td>1.0 ± 0.20a</td>
<td>0.89a</td>
</tr>
</tbody>
</table>

*The averages followed by the same letters do not differ statistically among themselves, according to Tukey's test (P<0.05).*

G-100 control sample (100% vegetable fat formulation), G-50 (reduction of 50% vegetable fat formulation), G-75 (reduction of 75% vegetable fat formulation) e G-0 (absence of vegetable fat in the formulation).
3.4. Water activity (Aw)

The Aw is an important reference for the shelf life of foods, once it strongly influences the growth of microorganisms. Table 2 shows that the water activity levels in the formulations showed no significant differences during storage. Similar results were observed by Felisberto et al. (2015) and Hesso et al. (2015), by reducing the percentage of fat in cakes, even substituting other ingredients. All formulations showed critical stability on shelf life during the analysis time, since it had Aw values at or greater than 0.88, making it suitable for spoilage yeasts development, with a 0.88 limit, and molds with 0.7 limit. To maximize the shelf life of foods, it is required knowledge of the sorption/desorption of food or components, storage conditions and packaging parameters (FONTANA, 2008).

3.5. Texture Profile Analysis

Figure 2 shows the texture profile of different formulations of the cake during the five days of storage. It can be seen significant changes between the 1st and 5th day of storage for all formulations, demonstrating the importance of fat to retard the hardening of the cake. The formulation free of fat showed a firmness increased of 50% on the 5th day compared to the control (100% fat), however there was no difference in firmness between the G-50 and G-75 samples in the 3rd day of storage. Similar behaviors were reported by Zahn et al. (2010) by replacing 75% of fat for inulin (3.38 to 5.68 N) and Felisberto et al. (2015), by replacing 50% of fat for chia gel, obtaining values of (8.88 to 12.62 N).

The chewiness, which is related to the number of chews required for food to be swallowed (Szczesniak, 2002), also showed a significant difference during the days of storage, as well as between the different formulations. For cohesiveness and elasticity there were no significant differences between the samples, as well as on days of storage, ranging from (0.53 to 0.72) and (0.79 and 0.89), respectively (data not shown). Similar results were reported by Grigelmo-Miguel et al. (2001), by substituting vegetable fat for fiber on muffins.

Figure 2- Effect of hydrogenated vegetable fat reduction in cake texture.

4. CONCLUSION

The results showed that the hydrogenated vegetable fat reduction in cakes increases the specific density of the mass, reduces the volume of air bubbles incorporated to the mass, and increases firmness and chewiness of cakes. Therefore the hydrogenated vegetable fat, with 60% of fat, is an ingredient with an important role in the formation of the batters, directly influencing the texture of the cakes.
5. REFERENCES


