Cookies from composite wheat-mesquite flours: characterization during storage

R.P. Gusmão¹, T.A.S. Gusmão¹, M.E.R.M. Cavalcanti-Mata¹, M.E.M. Duarte¹

1- Unidade Acadêmica de Engenharia de Alimentos – Universidade Federal de Campina Grande – CEP: 58429-900 – Campina Grande – PB – Brasil, Telefone: 55 (83) 2101-1987 – e-mail: (renningsmao@gmail.com.br)

ABSTRACT – This study aimed to assess the water activity, firmness, fracturability and color of cookies formulated with different mesquite flour concentrations (5, 15 and 25 %), sugar content (30, 40 and 50 %) and palm fat content (25, 35 and 45 %) during storage for 120 days, with an interval of 15 days between measurements. It is concluded that after the 120 days of storage, the cookies had their water activity, fracturability and brightness increased, and their firmness with reduced yellowness and redness, due mainly to mesquite flour variation in the formulation. Cookies showed similar behavior to the products made with other existing materials on the market during storage.

KEYWORDS: Prosopis juliflora; cookies; storage.

RESUMO – O objetivo deste trabalho foi avaliar a atividade de água, firmeza, fraturabilidade e cor de biscoitos formulados com diferentes percentuais de farinha de algaroba (5, 15 e 25%), teor de açúcar (30, 40 e 50%) e teor de gordura (25, 35 e 45%) durante o armazenamento por 120 dias, com 15 dias de intervalos entre as medições. Conclui-se que após o período 120 dias de armazenamento, os biscoitos tiveram sua atividade de água, fraturabilidade e luminosidade aumentadas e sua firmeza, intensidade de amarelo e vermelho reduzidas, devido, principalmente, a variação de farinha de algaroba na formulação. Os biscoitos apresentaram comportamento similar ao de produtos elaborados com outras matérias-primas já existentes no mercado, durante o armazenamento.

PALAVRAS-CHAVE: Prosopis juliflora; biscoitos; armazenamento.

1. INTRODUCTION
Cookies are widely consumed in the world with their eating convenience and long shelf life (Agama-Acevedo et al., 2012). Cookies are a baked product characterized by a low final water content. Their three major ingredients are typically flour, sugar and fat; other ingredients which can be included in the cookie dough formula are chemical leavening agents, syrups, salt and emulsifiers, though these ingredients are usually only used at low levels (Pareyt and Delcour, 2008).

The development of new products is an alternative for adaptation of technologies using raw materials that have not been explored. Mesquite tree, known in several countries as “algarrobo”, belongs to genus Prosopis and it is widespread in semiarid regions of America. Mesquite flour is a product obtained from the whole pods milled. The pods of the mesquite tree are among the oldest foods used in human food. The fruits of mesquite trees are yellow, long, flat pods and usually slightly curved, palatable, aromatic and sweet. These fruits are in pods and have considerable nutritional value, being good sources of carbohydrates, fiber, proteins, lipids and minerals, such as calcium and iron. The protein content can present values ranging from 7 to 11 g 100g⁻¹ (Bigne, Puppo, and Ferrero,
The cultivation of mesquite has a great potential for employment generation and income for small farmers. (Lopez-Franco et al., 2013).

According to Robertson (2006), many are the reactions of the transformation of food processed in their working life. Even though microbial deterioration is under control, other reactions such as changes in color, taste, texture, nutritional and functional quality, can compromise the food; factors that influence the speed of transformation reactions are many: temperature, water content, water activity, acidity, oxygen content, solid matrix state, presence of catalysts and others.

Depending on the conditions of storage, cookie can suffer alteration due to water adsorption, which will result in a higher mobility of molecules, passing from the glassy state to gummy (glass transition), characterized by a high molecular mobility. In this state, there are changes in product quality as the loss of the characteristic crispness, in addition to become a more conducive way for microbial growth.

Given the above this study aimed to evaluate the quality parameters (water activity, firmness, fracturability and color) of cookies made with different mesquite flour concentrations (5, 15 and 25 %), sugar (30, 40 and 50 %) and palm fat (25, 35 and 45 %) during storage for 120 days.

2. MATERIAL AND METHODS

2.1 Site of the experiments

The experiments were performed in Food Engineering Laboratories of Federal University of Campina Grande and in Laboratory of Bread Making – SENAI-PB.

2.2 Reception and grind of mesquite

Samples of mature mesquite [Prosopis juliflora, (Sw.) DC.] obtained in the city of Serra Branca – Paraiba, were received and sanitized with chlorinated water to 30ppm. Then, mesquite was subjected to convective drying process using a temperature of 60°C. After drying, the product was subjected to grinding operation unit in batch process (10g) in the slicer (Tecnal), with knives set to 1mm, using 10 Mesh sieve. After grinding, mesquite flour with 7 % moisture content (wet basis) was packed in polyethylene hermetic packaging, kept at room temperature of 25°C ± 3.0°C.

2.3 Production of cookies

Three formulations were developed of cookies with 25% mesquite flour, 30% sugar and 45% palm fat (experiment 1), 5% mesquite flour, 50% sugar and 45% palm fat content (experiment 2) and 15% mesquite flour, 40% content sugar and 35% of palm fat (experiment 3), using mesquite flour with a water content (7% w.b). The ingredients used for the preparation of cookies were wheat flour without yeast (M. DIAS BRANCO SA, Fortaleza - CE), sugar (ALEGRE, Mamanguape - PB), corn starch (MAIZENA, Igarassu - PE), baking soda (KITANO, São Bernardo do Campo - SP), ammonia bicarbonate (PANTEC, São Paulo - SP), sodium pyrophosphate (PLURY QUÍMICA, São Paulo - SP), vegetable fat of palm (AGROPALMA, Belém - PA), soybeans lecithin (PLURY QUÍMICA, São Paulo - SP), oats (NESTLÉ, São Paulo - SP) and filtered water. The percentages of ingredients are calculated taking as basis the amount of wheat flour.

2.4 Production of cookies

The mixture of ingredients was performed in two stages in the planetary mixer, BP-18 model (Practice Technipan); total mixing time was 10 minutes. The dough was laminated with flat rolling cylinder (Perfecta), until a thickness of 0.5 ± 0.05 cm. The dough was formatted by a matrix that defines the dimensions: 5 mm thick, 34 mm in diameter and circular shape of the cookie, by cutting. The cooking was done in an industrial furnace, Millenium model (Perfecta); in this step it was used temperature at 200°C ± 5°C in the central zone of the furnace; after stabilization of the oven temperature, cookies were placed in metal conveyor inside the oven, the time of 20 minutes. The
cooling of cookies was performed at room temperature on stainless steel trays for approximately 2 hours.

2.5 Monitoring of quality parameters during storage

The cookies were packaged in primary packaging metallized bioriented polypropylene (BOPP) and polyethylene secondary packaging, kept at room temperature of 25 °C ± 3.0 °C. The water activity was measured using an Aqua Lab water activity meter (Decagon Devices Inc., Pullman, WA, USA), firmness and fracturability were obtained using texturometer TA-XT2 (Stable Micro Systems, Surrey, UK) and the color of cookies was measured with a Hunter Lab spectrocolorimeter (Labscan XE, Hunter Associates Laboratory Inc., Reston, VA, USA). The colorimeter was calibrated using the standard white plate. The color values L* (brightness), a* (redness), b* (yellowness) were measured with the illuminant C and a 10 standard observer. The monitoring of these parameters was performed during 120 days of storage with 15 days intervals between measurements.

2.6 Statistical processing of data

A factorial design with two factors was used: 9 storage periods (0, 15, 30, 45, 60, 90, 105 and 120 days) and three preparations of formulated cookies (experiment 1, 2 and 3) to analyze the water activity, firmness, fracturability and color parameters: (L*), (b*) and (a*). The Assistat software version 7.7 was used for all statistical analyzes.

3. RESULTS AND DISCUSSION

3.1 Monitoring of quality parameters

In Table 1 are the behaviors of the variables: water activity, firmness, fracturability, brightness of three preparations of cookies formulated with 25 % mesquite flour, 30 % content sugar and 45 % palm fat (experiment 1), 5 % mesquite flour, 50 % sugar and 45 % palm fat content (experiment 2) and 15 % mesquite flour, 40 % sugar and 35 % palm fat content (experiment 3) during storage for 120 days.

Analyzing the results in Table 1, it is clear that there was an increase in the value of the variable water activity, for all experiments; the water activity values at the start of the storage were 0.263 to 0.271 and after 120 days storage they were 0.342 to 0.356 to cookies formulated with 25 % mesquite flour, 30 % sugar and 45 % palm fat (experiment 1), 5 % mesquite flour, 50 % sugar and 45 % palm fat content (experiment 2) and 15 % mesquite flour, 40 % sugar and 35 % palm fat content (experiment 3) during storage for 120 days.

Comparing the three preparations of cookies with each other, it can be observed that there was statistical difference in the water activity to 5% probability according to Tukey's test. In general, the behavior of the water activity was increased for all cookie formulations; analyzing, individually, the three cookie formulations or comparing each other, it can be observed different behavior of water activity during storage for 120 days, which can be explained by variations in the physical parameters of the cookies (thickness, mass, specific volume, diameter) and random overlap thereof within the packaging; another factor must be taken into consideration is the difference of the initial water activity of the cookies.

In Table 1, it is clear that there were significant changes in the firmness of cookies to a level of 5% probability by Tukey test; for experiments 1, 2 and 3, the strength of the cookies decreased from 25.89N to 19.38N, 23.74N to 18.76N and 26.65N to 19.42N, respectively.
Table 1 – Behavior of variable water activity, firmness, fracturability and brightness during storage for 120 days

<table>
<thead>
<tr>
<th>Storage time (days)</th>
<th>Water activity</th>
<th>Firmness (N)</th>
<th>Fracturability (mm)</th>
<th>Brightness (L*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exp.1</td>
<td>Exp.2</td>
<td>Exp.3</td>
<td>Exp.1</td>
<td>Exp.2</td>
</tr>
<tr>
<td>0</td>
<td>0.263fB</td>
<td>0.264gB</td>
<td>0.271gA</td>
<td>25.89aB</td>
</tr>
<tr>
<td>15</td>
<td>0.264fB</td>
<td>0.271fA</td>
<td>0.274fgA</td>
<td>23.51bB</td>
</tr>
<tr>
<td>30</td>
<td>0.278eA</td>
<td>0.276eA</td>
<td>0.279fA</td>
<td>23.06bB</td>
</tr>
<tr>
<td>45</td>
<td>0.293dA</td>
<td>0.285dB</td>
<td>0.292eA</td>
<td>20.86cC</td>
</tr>
<tr>
<td>60</td>
<td>0.303cB</td>
<td>0.289dC</td>
<td>0.317dA</td>
<td>20.77cC</td>
</tr>
<tr>
<td>75</td>
<td>0.332bA</td>
<td>0.312cC</td>
<td>0.322cB</td>
<td>20.47cdb</td>
</tr>
<tr>
<td>90</td>
<td>0.345aA</td>
<td>0.332bB</td>
<td>0.347bA</td>
<td>19.68deB</td>
</tr>
<tr>
<td>105</td>
<td>0.345aB</td>
<td>0.342aB</td>
<td>0.353aA</td>
<td>19.52eB</td>
</tr>
<tr>
<td>120</td>
<td>0.347aB</td>
<td>0.342aC</td>
<td>0.356aA</td>
<td>19.38eAB</td>
</tr>
</tbody>
</table>

Means followed by the same lower case letter in columns and capitalized on the lines do not differ statistically by the Tukey test at 5% probability.

Exp.1 - cookie made with 25 g 100g−1 mesquite flour, 30 g 100g−1 sugar and 45 g 100g−1 palm fat; Exp.2 - cookie prepared with 5 g 100g−1 mesquite flour, 50 g 100g−1 sugar and 45 g 100g−1 palm fat; Exp.3 - cookie made with 15 g 100g−1 mesquite flour, 40 g 100g−1 sugar and 35 g 100g−1 palm fat content.
Still analyzing Table 1 and comparing the three preparations of cookies with each other, it appears that the average values of firmness were statistically different for most of the storage period, with a decreasing behavior during 120 days of storage. It must take into account the initial difference in firmness between the three formulations of cookies, which can be attributed to the quantitative difference in the mesquite flour content, the palm fat content and sugar content in the formulations.

The variation of the initial and final firmness of cookies during storage for 120 days, was 25.14% for the experiment 1, 20.98% for the experiment 2, and 27.13% for experiment 3. In general, with the increase of storage period, firmness of cookies was decreasing for all three cookie formulations, which can be explained by the increase of water activity.

Analyzing the results in Table 1, it is clear that the variable fracturability showed statistical significance during storage for 120 days, for cookies made from the experiments 1, 2 and 3; there was an increase in the fracturability of 0.41mm to 0.53mm, 0.41mm to 0.52mm and 0.42mm to 0.52mm, for cookies made from the experiments 1, 2 and 3, respectively.

For the cookies prepared with 5 % of mesquite flour (experiment 2), the values of fracturability were statistically different up to 90 days of storage; after this period until 120 days of storage, there was a nonsignificant increase.

The cookie made with 15 % of mesquite flour, 40 % sugar and 35 % of palm fat content (experiment 3) had a non-significant increase in fracturability up to 15 days of storage; after this period the increase in fracturability increases significantly until 75 days of storage; however, from this period until 120 days of storage, there is the maintenance of fracturability of cookies.

The variation of initial and final fracturability during storage for 120 days was 29.27%, 26.83% and 23.81% for Experiments 1, 2 and 3, respectively; with the increase of storage time, fracturability of cookies was increasing in three preparations of cookies which can be explained by the increase of cookie water activity. According to Reed et al. (2002), water activity between 0.3 and 0.4 at room temperature is sufficient to cause structural changes, such as lumps at the dough and loss of crispness of cookies.

The variation of initial and final brightness during 120 days of storage were 11.90%, 12.83% and 14.31% for Experiments 1, 2 and 3, respectively; with the increase of storage period, brightness parameter (L*) was increased, i.e., cookies have acquired a less intense staining. Due to the replacement of wheat flour by mesquite flour, there is a reduction between the connections of the components present in the mixture, resulting from the decrease of gluten content, occurring detachment of some lighter colored particles from the interior to the surface of the cookies, which justifies the increase in brightness parameter (L*) (lighter color). This behavior could be reduced with increasing amounts of soybean lecithin stabilizer in the formulation of cookies. UMESHA et al. (2014) found by studying the storage of cookies enriched with omega-3 microencapsulated, for 120 days, brightness parameter variation (L*) from 61.1 to 69.2.

It was noted a reduction in yellowness (b*) and redness (a*), showing no definite trend in relation to the storage period of 120 days for cookies made with 25 % of mesquite flour (experiment 1), 5 % of mesquite flour (experiment 2) and 15 % of mesquite flour (experiment 3).

4. CONCLUSIONS
The research results showed that after the end of 120 days of storage, cookies formulated with 25% mesquite flour, 30% sugar and 45% of palm fat content (experiment 1), 5% mesquite flour, 50% sugar and 45% palm fat content (experiment 2) and 15% mesquite flour, 40% sugar and 35% palm fat content (experiment 3) had their water activity values, fracturability and brightness increased and reduced firmness, and the main reason is the replacement of 25, 15 and 5% wheat flour by mesquite flour due to high hygroscopicity and low brightness value of this raw material. Cookies had similar behavior to the products made with other existing materials on the market during storage.

5. REFERENCES