Production of crystallized fruit from watermelon rind

Mauro Gontero, Adriano Brandelli, and Caciano Zapata Noreña

Abstract

M. Gontero, A. Brandelli, and C. Zapata Noreña. 2010. Production of crystallized fruit from watermelon rind. Cien. Inv. Agr. 37(2): 55-60. The aim of this work was to produce crystallized fruit from watermelon rind. The following procedure was developed: the outer peel was removed; the material was sliced into 7 mm cubes, blanched for, 0, 5 and 10 minutes, and then treated with 10% sodium chloride solution. This product was treated with solutions of sucrose (30 to 72 °Brix), and dried in a hot air dryer at different temperatures (40, 60 and 80 °C). Products were then analyzed by a sensory panel. The experimental design used was randomized blocks and the results were analyzed by the Tukey’s test. The best acceptance of the sensory panel was for the product obtained by 5 minutes blanching followed by drying at 60 °C, whose intensity values for appearance, flavor and gummnosis were between 6 and 7.

Key words: osmosis, watermelon, dehydration, agricultural waste.

Introduction

Commercialization of fruits and derivatives are facing a growing demand due to improvements made in transportation systems, distribution, development of new products and processing methods. Fruits from non tropical zones are characterized by a wide edible portion and moderate amounts of residues. On the other hand, the processing of tropical and subtropical fruits like bananas, watermelons and mangos, generates a wide amount of by-products (Askar, 1998; Schieber et al., 2001). Therefore, it is necessary the development of efficient, economic, as well as environmentally correct technologies, in order to take advantage of the residues generated by these products through the whole production and commercialization chain.

A high percentage of food is currently lost due to the lack or misuse of conservation technologies and post-harvest storage, as well as damages caused during handling and transportation and rejection of products by the market, because they do not fulfill quality patterns. In order to face this challenge, the process of osmotic dehydration is being used because it is a method allowing increasing the storage life of these products. The principle of conservation consists on reducing the water activity, which allows diminishing the speed of the chemical, biochemical and microbiological reactions responsible of food decay (Berbari et al., 1992). Rastogi et al. (1997) define osmotic dehydration as a process of partial removal of free water of some food, like fruits and vegetables, when they are immersed in a hypertonic solution.
In recent years, these products have been appreciated by consumers, because they preserve their nutritive properties and are minimally processed (Torreggiani and Bertolo, 2001). Park et al. (2003) mention that this method has advantages in quality (color, flavor, texture) and for diminishing the costs in energy, distribution, packaging and storage.

Among the different products that may be obtained by osmotic processing are crystallized fruits, where there is a simultaneous water elimination and inclusion of sugars (Berbari et al., 1992). Subsequently, the product is subject to hot air drying (Southgate, 1992). Soler et al. (1995) classified fruits dehydrated osmotically by sugars like crystallized sugars, when they are not covered by a layer of sugar and glazed crystals, even when they were covered by a layer of an oversaturated sugar solution.

Alvarez et al. (1995) studied the effect of blanching and glucose concentration on the speed of air drying at 55°C in strawberries, observing that the coefficients of water diffusion were strongly affected by blanching. Nieto et al. (2001) evaluated the previous effect of blanching and osmotic dehydration by glucose, made at atmospheric pressure and vacuum, on an air drying process at 60°C, in mango. They found that the values of water diffusion decreased and, there was a higher addition of glucose and modifications in cell starch and mucilaginous substances as a consequence of blanching. Sacchetti et al. (2001) report on sodium chloride that this salt is used due to the possibility of increasing the speed of the process of osmotic dehydration in apples, using sacarose solutions, without affecting their sensorial characteristics.

The objective of this work was the elaboration of crystallized products from watermelon rinds, evaluating the effect of blanching and the temperature of drying air on the sensorial characteristics of the final product.

Materials and methods

The watermelons (Citrullus vulgaris Schrad) were purchased in the Central Market of Porto Alegre, Rio Grande do Sul, Brazil. The initial moisture of the watermelon was 95.76%. After being washed and dried, the watermelons were stored at a temperature of 20±2 ºC.

The watermelons were subject to the procedure of selection, wash and rind separation from the edible part and seeds shown in Figure 1. Then, the external green cuticle was eliminated from the rind (around 4 mm). The rind was diced in cubes of approximately 7 mm each side, and blanched in boiling water during 0, 5 or 10 minutes. After that, the samples were introduced in a NaCl solution at 10% during 5 hours. Then, the rind cubes were immersed in a sugar solution of 30 ºBrix, measured with a table refractometer, remaining in that solution during 24 hours. Subsequently, they were placed in a sugar solution of 40 ºBrix, and left to stand for another 24 hours. This procedure was repeated successively (50, 60, 70 ºBrix) until the cubes were introduced in a solution of 72 ºBrix.

Figure 1. Flow chart for crystallized fruit from watermelon rind.
In order to enable the fruit preservation, the solution of 60 °Brix was maintained at pH 4 (measured with pH-meter), for which citric acid was used.

After the process of sugars impregnation, the fruit syrup was retrieved and washed with distilled water and then drained, to eliminate the excess of solution from the surface. Subsequently, the samples were dried in hot air dryer at temperatures of 40, 60 and 80 ºC, during 4 hours. Then, the surface of those products was smeared with syrup and covered with a layer of crystallized sugar and left in a oven at 60 ºC for an hour. Finally, the cold product was packaged in high density polyethylene bags.

Sensorial analysis

The tests of flavor were made in individual cabins, illuminated with white fluorescent light. The samples were served in white porcelain dishes, coded with random 3-figure-numbers, along with a glass with water at room temperature.

The judges evaluated the samples according to the attributes (descriptive terms), established by the method of discriminating terms list: appearance (samples shine), flavor (associated to the sweet flavor of sacarose), chewiness (how easily the product is ground by the teeth and ready to consume) and gumminess (if the product is attached on the teeth during disintegration).

Eight previously selected evaluators, from 20 to 45 years old, analyzed the intensity perceived in each attribute with the help of a non structured horizontal scale. The evaluation card contained a 9.0 cm scale, between limits of totally like and totally dislike.

Statistical design

The experimental planning for the sensorial analysis was made with a completely randomized block design. The treatments evaluated are shown in Table 1. The Tukey comparison of means test was used in order to verify the existence of significant differences between the treatments (with a level of significance of 0.05). For the statistical analysis, the statistical software, SAS was used, version 9.1.3 (SAS Institute).

Table 1. Treatments applied to the samples.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Blanching time (min.)</th>
<th>Drying temperature (ºC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>80</td>
</tr>
<tr>
<td>C</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>D</td>
<td>10</td>
<td>80</td>
</tr>
<tr>
<td>E</td>
<td>5</td>
<td>60</td>
</tr>
</tbody>
</table>

Results and discussion

The results of the means of the sensorial attributes from each sample, compared by the Tukey’s test are in Table 2, with a $p \leq 0.05$.

Some significant differences were observed in this work between the results from the comparison of the treatments as a consequence of the statistical tests ($p \leq 0.05$). In regard to the appearance, the results indicated that the blanched sample during 5 minutes and dried at 60 ºC (E), which presented a higher significant intensity, in regard to the lower intensity of the treatment made with 10 minutes of blanching and drying at 40 ºC (C).

In regard to flavor, the treatments A, B and D were equal to each other, but significantly different ($p \leq 0.05$) from C and E, which were the samples obtaining the highest intensities (blanched during 10 minutes and dried at 40 ºC and blanched of 5 minutes and dried at 60 ºC, respectively), which were not different among them. In regard to the samples resulting with lower score in flavor, these were the treatments A and B, both without blanching.

When the chewiness was evaluated, the tests showing the highest intensity were subject to blanching for 10 minutes and drying at 40 ºC (C), and the sample with 5 minutes of blanching
and drying at 60 °C, without differences among
them \( (p \geq 0.05) \). On the contrary, the tests
which were less intense on chewiness were the
samples that were not blanched or subject to 80 °C.

In regard to gumminess, the tests concluded
that the treatments A, B and D were statistically
different from the treatments C (blanched for 10
minutes and dried at 40 °C) and E (blanching
during 5 minutes and drying at 60 °C), with
these two last showed a higher intensity,
and were significantly equal to each other.
On the contrary, the treatments with lower
intensity were not subject to blanching or
drying temperature of 80 °C (samples A, B
and D).

In regard to the last attributes studied
(chewiness and gumminess); it may be ob-
served that in the treatments C and E, the
panellists associated the easiness how the sam-
ple are ground and the absence of adherence
in the teeth. Souza et al. (2007) mentioned that
texture is one of the most appreciated sensorial
qualities by the fruit consumers.

It may be stated from the results obtained that
the treatment with higher acceptance by the
panellists was the treatment subject to blanching
for 5 minutes and drying at 60 °C (E). Blan-
ching, in addition to avoiding the enzymatic
darkness (fixing the color and texture), softens
the cell tissue, increases the permeability of the cell
walls, the dehydration speed and promotes the
removal of the mucilaginous substances. Nieto
et al. (2001), also state that, due to blanching,
there is a diminished diffusivity, attributed to
the shrinking tissue, the air expulsion and the
alterations of the cell content (starch gelatiniza-
tion and denaturalization of the mucilaginous
substances) and these phenomena prevail on the
damage of the cell wall structure and the rup-
ture of the cell membrane that might ease the
water transport.

The salt could also have contributed in the sen-
sorial characteristics. Studying the effect of ba-
nana soaked in sodium chloride and sacarose
solutions, Ehabe et al. (2006) found that these
solute exert a significant effect on the moisture
concentration, sugar and the color index in the
final product. The same authors mention that
the bananas improved their appearance sensori-
ally, when they were soaked in sodium chloride
solutions. Sacchetti et al. (2001) found that the
addition of salt in the process of osmotic dehy-
dration in apples increases the loss of water in
the product, and that the salt and sugar concen-
trations have a synergic effect on the impreg-
nation of the soluble solids. Lerici et al. (1985)
indicate that the addition of 1% of sodium chlo-
ride in the apples osmo-dehydration may help to
diminish the sweetness caused by the addition
of sugar in the fruit.

The sample C (blanched 10 minutes and dried
at 40 °C) had a similar acceptance similar to the
sample E, in most of the attributes, except in the
appearance. The sensorial profile is shown the
Figure 2, where it is also observed that these
treatments are also the most accepted by the
panellists, supporting the results obtained by the
Tukey’s test. Morita et al. (2005) obtained a good
acceptance in the crystallized products of melon,
in natura, obtained by the slow process of sugars
impregnation and further drying at 50 °C.

Table 2. Mean values compared by Tukey’s test.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Appearance</th>
<th>Flavor</th>
<th>Chewiness</th>
<th>Gumminess</th>
</tr>
</thead>
<tbody>
<tr>
<td>0min/40 °C (A)</td>
<td>3.15 a</td>
<td>2.59 a</td>
<td>3.45 a</td>
<td>3.77 a</td>
</tr>
<tr>
<td>0min/80 °C (B)</td>
<td>5.03 b</td>
<td>2.51 a</td>
<td>2.53 a</td>
<td>3.55 a</td>
</tr>
<tr>
<td>10min/40 °C (C)</td>
<td>1.96 c</td>
<td>6.39 b</td>
<td>5.59 b</td>
<td>7.15 b</td>
</tr>
<tr>
<td>10min/80 °C (D)</td>
<td>5.60 b</td>
<td>3.14 a</td>
<td>2.16 c</td>
<td>3.3 a</td>
</tr>
<tr>
<td>5min/60 °C (E)</td>
<td>6.96 d</td>
<td>6.38 b</td>
<td>4.91 b</td>
<td>6.93 b</td>
</tr>
</tbody>
</table>

Different letters indicate significant differences \( (p \leq 0.05) \).
Conclusion

The treatment more accepted by the sensorial panel due to the highest intensity of the attributes evaluated, was the watermelon rind subject to blanching for 5 minutes and drying at 60 °C during 4 hours. On the contrary, the treatments less accepted by the tasters were not subject to blanching or suffered drying temperatures of 80 °C.

Acknowledgment

Mauro M. Gontero was a interchange student of the ESCALA Program of Asociación de Universidades del Grupo Montevideo.

Resumen

M. Gontero, A. Brandelli y C. Zapata Noreña. 2010. Elaboración de productos cristalizados a partir de cáscaras de sandía. Cien. Inv. Agr. 37(2): 55-60. El presente trabajo tuvo como objetivo el aprovechamiento de las cáscaras de sandía en la elaboración de productos cristalizados. Para esto fue eliminada la cutícula verde externa de la cáscara, cortadas en forma de cubo de aproximadamente 7 mm de lado, escaldado con agua en su temperatura de ebullición utilizando 0, 5 ó 10 minutos y dejados inmersos en una solución de cloruro de sodio. Posteriormente fueron sometidas a concentraciones crecientes de soluciones de sacarosa (30 a 72 °Brix) y deshidratadas en un secador a diferentes temperaturas (40, 60 y 80 °C). Los diferentes tratamientos fueron evaluados por un panel sensorial. El diseño experimental empleado fue el de bloques completos aleatorios y los resultados del análisis sensorial fueron evaluados por la prueba de comparación de medias de Tukey. Fue constatado que el tratamiento con mayor aceptabilidad, por parte del panel sensorial, fue el que había sido sometida a un escaldado de 5 minutos y deshidratado a 60 °C, cuyos valores de intensidad para la apariencia, sabor y gomosidad estuvieron entre 6 y 7.

Palabras clave: Ósmosis, sandía, deshidratación, residuo agroindustrial.

References


