Stability of bioactive compounds in minimally processed beet according to the cooking methods

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Abstract
The current study aimed to determine the functional propriety of fresh beets under different cooking methods through the quantification of bioactive compounds. Beets were chosen for uniformity of size, color and absence of defects. They were thoroughly washed in running water to remove dirt, manually peeled with a knife, sliced through a stainless-steel food processor (5 mm slicing disc) and submitted to four different cooking methods: steaming, pressure, oven-baked and hot-water immersion. Analysis were performed in both uncooked and cooked beets to evaluate antioxidant activity, total phenolic content, carotenoids, flavonoids and betalains. The experiment was completely randomized design (CRD). Data were subjected to analysis of variance (F test) and means were compared by Tukey test (p < 0.05). Oven-baked beets preserve most of the bioactive compounds, maintaining better levels of carotenoids, flavonoids, betacyanin and betaxanthin than the other cooking methods. The antioxidant activity was similar between the treatments, except in the pressure. Moreover, different cooking methods did not affect phenolic compounds concentration in beets.

Keywords: Beta vulgaris L.; antioxidants; betalains.

Practical Application: Bioactive compounds of minimally processed beet in different cooking methods.

1 Introduction

In addition to providing important nutrients, vegetables have functional compounds that favor organic functions, bringing health benefits and lower disease risk (Del-Vechio et al., 2005; Carvalho et al., 2006). In this way, the interest in studying the stability of bioactive compounds (Campos et al., 2008).

In cooking, those methods that transfer heat; high temperatures; cooking for a long period and different cooking techniques are responsible for chemical and physical changes that may affect nutritional value of food (Scheibler et al. 2010).

The betalains are colored nitrogenous pigments, soluble in water and responsible for the dark red color of the beets. It has a function similar to anthocyanins, however never appears together this pigment (Schiozer & Barata, 2007).

Beets are the main source of betalains, which is an important natural antioxidant. Studies indicate that betalain potentially inhibits lipid oxidation and cholesterol synthesis, as well as skin and lung cancer in rats (Volp et al., 2009). Betalains also show antiviral and antimicrobial activities (Lila, 2004). Therefore, studies have shown free radical antioxidant power of beet, which is among the top ten most potent antioxidants found in nature to date (Volp et al., 2009).

It is known that cooking induces significant changes in physicochemical properties and structural characteristics of the food; therefore, different results are achieved at various time and temperature by destroying enzymes/microorganism and affecting sensory/nutritional properties. Cooking also disaggregates plant structures since both palatability and digestibility become better. All these changes are influenced by heat transfer, temperature intensity, duration and cooking methods applied (Alves et al., 2011).

Given all the above, the current study aimed to determine the nutritional properties of minimally processed beets under different cooking methods through the quantification of bioactive compounds.

2 Materials and methods

The hybrid Borus cultivar was used, purchased at the following geographical coordinates: 21°35'45"S and 46°53'23"W. Subsequently, beetroots were selected for uniformity of size, color and absence of defects. They were then washed thoroughly in running water to remove dirt.

Afterwards, tuberous roots were manually peeled with a knife and sliced into a stainless-steel food processor (5mm slicing disk) and submitted to four cooking methods: steaming, pressure, oven-baked and immersion in hot water. With regards to the oven-baked method, it took 15 minutes to preheat the oven to 200 °C, sliced beetroots were wrapped in aluminium foil.
to cook evenly, as well as avoiding excessive dehydration. In the other methods, beets were placed in boiling water.

All cooking methods expressed in Table 1 were tested before the experiment began to establish the correct cooking time until beets were “al dente” (Copetti et al., 2010).

Once cooked, the samples were immediately frozen in liquid nitrogen; then macerated and kept in a freezer for biochemical analysis.

The extract used for the analysis of antioxidant activity and total phenolic compounds was made with ethanol and water extractor (70:30), using ultrasonic bath (20 min) and centrifuged, 6000 rpm (50 min). The following analysis were performed: antioxidant activity was measured by DPPH (Mensor et al., 2001), expressed as reduction of %DPPH; total phenolic content was determined by Folin-Ciocalteau’s spectrophotometric method (Singleton et al., 1999), expressed in mg of gallic acid 100 g⁻¹ sample. Carotenoid content was determined, as described by Linder (1974), expressed in mg 100 g⁻¹ of beetroot.

Flavonoids were determined by the spectrophotometric method adapted from Santos & Blatt (1998). 0.1 g of sample was weighed, 4ml of acidified methanol solution was added, homogenized and placed in an ultrasonic bath for 30 minutes, 1ml of 5% aluminium chloride solution in methanol was added and left to stand in the dark for 30 minutes; afterwards, it was centrifugated for 20 minutes in 6000 g and read in a spectrophotometer at 425 nm, results in mg of rutin 100 g⁻¹.

Betalain content was determined, as described by Stintzing et al. (2005) adapted, expressed in mg 100 g⁻¹. It was weighed around 1g of sample using extractor of water and ethanol (1: 1), passing through shaking and centrifugation, then the supernatant was mixed with buffer solution (Mcllvaine) and then spectrophotometric reading. The calculation used was: BLC [mg/L] = [(AxDFxMWx1000)/(ex1)], where A is the maximum absorption value corrected for reading at 600 nm; DF is the dilution factor and 1 is the optical path of the cuvette.

### Table 1. Time used for each cooking method.

<table>
<thead>
<tr>
<th>Cooking method</th>
<th>Time in minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steaming</td>
<td>30</td>
</tr>
<tr>
<td>Pressure cooking</td>
<td>10</td>
</tr>
<tr>
<td>Oven-baked</td>
<td>40</td>
</tr>
<tr>
<td>Hot-water immersion</td>
<td>24</td>
</tr>
</tbody>
</table>

### Table 2. Total antioxidant activity (TAA %), phenolic compounds (PC mg of gallic acid/100 g⁻¹), carotenoids (CT mg 100 g⁻¹), flavonoids (FV mg of rutin 100 g⁻¹), betacyanin (BTCY mg 100 g⁻¹), betaxanthin (BTXT mg 100 g⁻¹), betalain (BTL mg 100 g⁻¹), under different cooking methods.

<table>
<thead>
<tr>
<th>Cooking</th>
<th>TAA (%)</th>
<th>PC</th>
<th>CT</th>
<th>FV</th>
<th>BTCY</th>
<th>BTXT</th>
<th>BTL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steaming</td>
<td>52.63 ab*</td>
<td>94.41 a</td>
<td>0.68 bc</td>
<td>174.56 b</td>
<td>30.59 ab</td>
<td>20.88 ab</td>
<td>51.48 a</td>
</tr>
<tr>
<td>Pressure cooking</td>
<td>28.05 b</td>
<td>59.22 a</td>
<td>0.38 c</td>
<td>63.19 c</td>
<td>12.40 c</td>
<td>8.09 d</td>
<td>20.48 c</td>
</tr>
<tr>
<td>Oven-baked</td>
<td>66.48 a</td>
<td>96.94 a</td>
<td>0.94 ab</td>
<td>267.64 a</td>
<td>35.49 a</td>
<td>25.34 a</td>
<td>60.83 a</td>
</tr>
<tr>
<td>Hot-water immersion</td>
<td>53.41 b</td>
<td>65.91 a</td>
<td>0.61 bc</td>
<td>149.50 b</td>
<td>21.37 bc</td>
<td>14.67 c</td>
<td>36.04 b</td>
</tr>
<tr>
<td>Uncooked</td>
<td>57.63 a</td>
<td>77.81 a</td>
<td>1.31 a</td>
<td>290.64 a</td>
<td>31.63 a</td>
<td>17.88 bc</td>
<td>49.51 ab</td>
</tr>
<tr>
<td>CV%</td>
<td>18.40</td>
<td>34.18</td>
<td>22.4</td>
<td>16.92</td>
<td>13.84</td>
<td>10.97</td>
<td>1265</td>
</tr>
</tbody>
</table>

*Means followed by equal letters in the column do not differ from each other by the Tukey test (p < 0.05).
Regarding to flavonoids content, there was no statistically difference in oven-baked carrots and uncooked. However, there was significant reduction among other methods, such as hot-water immersion, steaming and pressure cooking, whose flavonoids reduction was of 78.2% at the end. In a study conducted with broccoli in hot-water immersion, there was a decrease in flavonoid concentration (50%) when compared to uncooked broccoli; the current study highlights a similar result (Pellegrini et al., 2010).

Betalains concentration, which is the sum of betacyanin and betaxanthin, in steamed beets did not differ from uncooked and oven-baked beets; since there was an indirect contact of beetroots with water when submitted to steaming and baking methods. Additionally, steam moisturizes the food and slows down the fibers, as well as enhancing appearance and reducing losses in hot-water immersion caused by water-soluble vitamins, minerals and bioactive compounds due to surface coagulation (Dal Bosco & Conde, 2013).

Picoli et al. (2010) found betalain contents between 13 and 23 mg 100 g⁻¹ in minimally processed fresh beets, such values are lower than those found in the current study. Probably, due to the beetroots in different cut thickness and contact surface, as they cut 2 mm thick. In accordance with Vitti et al. (2003), pigments extravasation during food preparation and/or pigments degradative processes that occur soon after minimal processing are probably due to lower thickness, as they presented greater contact surface to the ambient lighting; which resulted in greater pigment degradation. In a study with beet and betalain stability, Drunkler et al. (2006), reported that the pigment formation was found to be highly influenced by environmental conditions, since the absence of light resulted in greater stability of these compounds.

4 Conclusions

Oven-baked beets preserve most of the bioactive compounds, maintaining better levels of carotenoids, flavonoids, betacyanin and betaxanthin than the other cooking methods. The antioxidant activity was similar between the treatments, except in the pressure. Moreover, different cooking methods did not affect phenolic compounds concentration in beets.

References


Bioactive compounds in beet


