Evaluation of microwave technology in blanching of broccoli 
\textit{(Brassica oleracea L. var Botrytis)} as a substitute for conventional blanching

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Abstract

The thermic process are essentials in the procedural vegetables industry, however, these change the sensorial properties and less the nutritional content of the food. In addition to this, around the 70% of the consumed water of these process is putted as residual water, those ones had very high contaminated level. This investigation has as an objective, score the microwave technologic in a blanching broccoli, \textit{(Brassica oleracea L, var Botrytis)} as a substitute of the conventional blanched, and making new alternatives of a sustainable production. The resolves obtained show that the thermic process by microwave, offer an efficient alternative in the lost nutritional components minimizing.

Keywords: Blanching, microwave, peroxide, thermic process, warm transfer.

1. Introduction

The broccoli \textit{(Brassica oleracea L, var Botrytis)} is a vegetable comes from of the \textit{Brasicáceas}, family, those ones are extracts of nutrients, like vitamins, minerals, fibre and bioactive components do not nutritious. In the last decades, the vegetable cultivation is been growing in different places of the word, presenting a big expansion and a higher production, because of the nutrition benefits with fresh products, however, apply technologic process, like the blanched to longer its life, can be lost of those benefits.

The blanched benefits by microwave, about nutritional quality, sensorial and energetic consume were study objective in this investigation, to obtain that the water absence in the scales process with microwave makes a positive impact in the scored nutrients components, avoid the lixiviation of these to the fluids that they use as warm transfer way in the conventional methods, also to required less energy consume, it makes less process cost.

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2. Materials & Methods

2.1 Materials

The fresh broccoli Botrytis kind was obtained from a unique grow, located in Cota-Cundinamarca-Colombia, to guarantee the homogeneity of the samples, the vegetable was harvested the last day to the process and did not wash previously. Next to starts the washing in an aspersion washer on a transportation band during 3 minutes, exactly time to avoid structure wrongs and standardization the humid of the samples before to start the thermic process. The inflorescences were cutting to their post process in groups, next to the stem and were selected with a similar longitude of 5cm and a weight no less of 6 grams.

2.2 Methods

To obtain the objectives, the investigations has been development the next steps:

2.1.1. First step: Determine the excellent conditions for the two types of blanching

Conventional blanched

To this one, the established fluid with 1:2 relation (broccoli: water), was warm in a aluminum blow by a electric resistance, until to get a (±92°C) boiling temperature, when it was ready the inflorescences broccoli were blanching during times between 0.5 to 4 minutes depends of Lay [1]. Next to this, the samples were packed in polietileno reclosing bags and were taken to an ice bath during 5 minutes. For each time the qualitative peroxide enzyme test was scored, follow the Riveros and Salamanca methodology [2]

Microwave blanched

According to Chaparro [3], the microwave warm transfer makes cold points, hot points and a homogeneous temperature in the middle area of the plate. For this 100g of sample were taken, distributed on a 14, 5 cm diameter center area plate. The warm was made by a microwave (Samsung, 7996W mode, 2450 MHz, 950W) preheated for 3 minutes before starts each process, according to the Ramezanzadeh et al. (2000) method. The score powers were 10, 30, 50, 60, 70, 80 y 100%, with a times of 0.5 minutes until to obtain a negative score in the peroxide test. The less time process and required potency to inactive to enzyme was chosen, as the one to produce less loss.

2.1.2. Second step: Fresh broccoli physicochemical characterization and process.

Table 1. Evaluation parameters

<table>
<thead>
<tr>
<th>Study variables</th>
<th>Methodology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry sustance</td>
<td>Matissek [4]</td>
</tr>
<tr>
<td>Ashes</td>
<td>Matissek [4]</td>
</tr>
<tr>
<td>Chlorophyl</td>
<td>Vernon [5]</td>
</tr>
<tr>
<td>Texture</td>
<td>Leon [6]</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>Riveros y Salamanca [2]</td>
</tr>
<tr>
<td>Iron</td>
<td>AOAC 944.02</td>
</tr>
<tr>
<td>Phosphors</td>
<td>AOAC 965.05</td>
</tr>
<tr>
<td>Total protein</td>
<td>Matissek [4]</td>
</tr>
</tbody>
</table>
3. Results & Discussion

3.1. First step: Determination of optimal conditions to the two types of blanching

Through the peroxide test (Table 2) the blanching time to the conventional method (4 minutes) and for each one of the scored potencies in microwave could be determinate, higher times of 3 minutes of process in microwave were discard (in the use case of 10% and 30% potency) with the focus of optimize process and cost operations.

Table 2. Blanched time

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Microwave (% Power)</th>
<th>Conventional (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,00</td>
<td>+</td>
<td>+</td>
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<td></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>0,50</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>1,00</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>1,50</td>
<td>+</td>
<td>+</td>
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<tr>
<td>2,00</td>
<td>+</td>
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<td>2,50</td>
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<td>3,00</td>
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<td>+</td>
</tr>
<tr>
<td>3,50</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4,00</td>
<td>+</td>
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</tr>
</tbody>
</table>

The peroxide enzyme inactivation indicate the grade of vegetables blanched, however is better to do not try to eliminate, because if it is inactive in a 100% is going to show and excessive process that would deforms the vegetable, that is the reason for the project wants to conserve between 5% to 10% of the original present activity [7].

The water evaporation during the blanching was associated to the loss of turgescian in the food with also the lost of weight, making important economic profit to the company, that is why parallel to the enzyme inactivation, the loss in each one of the process (Figure 1) was evaluate show that exist, a directly and proportional relation between potency grow and loss of weight, corroborating Ruiz de Ojeda testing [8].

The blanching process applied in 50% in the total capacity potency of the equipment, makes a loss of 2.8% then to the enzyme inactivation (3.5 min). For the process with potency the loss in 80% and 100% was more than 9% in both cases, they had gotten the enzyme inactivation in 2.5 and 2 minutes respectively, also the use of high potencies, make burns in the product.
Loss during microwave blanched

The use of 60% of the total potency of the equipment after 3 minutes, make loss of 2.5% those ones were proportional to the water quantities absorbed during the washing that is why, this was the select microwave process.

3.2. Second step: physicochemical characterization of fresh broccoli and procedural

Table 3 shows the results obtunded of the physicochemical characterization of fresh broccoli (FB), washed broccoli (WB), blanched broccoli by a traditional process (CB) and blanching broccoli by microwave (MB)

Table 3. Study variables determined experimentally (x ± σ)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Ashes a</th>
<th>Chlorophyll b</th>
<th>Vitamin C c</th>
<th>Iron c</th>
<th>Phosphorus c</th>
<th>Protein c</th>
<th>Hardness (N)</th>
<th>Compression (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB</td>
<td>9.785±</td>
<td>13.189±</td>
<td>895.596±</td>
<td>9.449±</td>
<td>1075.755±</td>
<td>48.422±</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>WB</td>
<td>9.126±</td>
<td>12.526±</td>
<td>806.967±</td>
<td>7.766±</td>
<td>977.824±</td>
<td>45.814±</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CB</td>
<td>4.220±</td>
<td>7.596±</td>
<td>459.773±</td>
<td>4.188±</td>
<td>516.790±</td>
<td>42.624±</td>
<td>49.523±</td>
<td>52.323±</td>
</tr>
<tr>
<td>MB</td>
<td>9.109±</td>
<td>10.451±</td>
<td>565.564±</td>
<td>6.343±</td>
<td>905.482±</td>
<td>44.337±</td>
<td>58.016±</td>
<td>55.1±</td>
</tr>
</tbody>
</table>

a. % In dry base
b. mg/g of dry sample
c. mg/100g of dry sample

3.2.1. Ashes content

The broccoli, by ICBF [9] contents 10.8% of ashes in dry base; it is a very close result to the obtunded in (FB). After the washed process (WB) they do not show significative loss (α = 0.05). On the other hand (CB) shows 53% in compare with the microwave process (MB), it affirms that the (CB) process has very high loss of their components by lixiviation. [10]
3.2.2. Chlorophyll content

To be insoluble the water, this pigment does not loss by lixiviation, then, the wash, the soaking, etc, of fruits and vegetables, do not make the loss of warm. Badui, Op cit, however, is very important the double behavior of the chlorophyll mole where the phytol tail, is insoluble in water (hydrophobic) and the porphyrin mole, this one has a hydrophilic character, for this the losses of 5.02% in the process (WB) be attributed to this behavior.

Also existed significant differences between WB and each of the thermic process, however, its possible to affirm with a 99% of trust that the MB process conserved a high contend of chlorophyll (84.43%) in relation to the CB (60.64%). According to Mackinney and Weast [11] the color changes in green vegetables, after light thermic process, are attributed to the removing of air in the filaments of the toping food and also the expulsion of this, in the mole. Both process altered the properties of the reflectance on the surface that is why when the blanched was made it shows a nice green shine color much better and very attractive to the consumer.

3.2.3. Vitamin C determination

A first determination, It permitted established the vitamin C contended in FB, was higher to the information made by ICBF 110.5 and 100 mg/100g, broccoli respectively and also with the rest of vitamins, the ascorbic acid contended in vegetables changes its factors related with Agricola process (Genetic, fertilizer, isolation, watering, etc) with the postharvest handle (Badui, Op cit). In this way it shows the growing up in this component in respect to the theoric, all the results were expressed around the vitamin C, reduced in dry base; because of the presence of O₂ oxidation it makes losses in the vitamin C activity (oxidized dehydroascorbic acid).

The losses of vitamin C during the washing were significant in percents (9.89%), during the CB had been a percent just in 51.33. (α=0.05), Sullivan et al [12], evaluated this vitamin loss during the blanched, determining that it produces a higher lixiviation and a less grade in the thermic process, this is why although the vitamin C contended Lessing in MB, can be a good trust of 99% that its higher contended compared with CB (565,56 y 459,77 mg/100g broccoli respectively

3.2.4. Iron and phosphors determination

The minerals are organic elements, and they always keep their chemistry structure, they have many significant differences (α= 0.05) in the iron contended between FB and WB (17.8% loss) and at the same time between WB and CB show a big loss of 55.72% during all the process. In MB is easy to check to significant losses again, but these are 18%, showed that the process effect is less noxious on the mineral.

![Fig. 2. Differences between the treatments for iron analysis](image-url)
A very similar process shows to the phosphors, with a 98% of trust, it can affirm the next: 
\[ \text{FB} > \text{WB} > \text{MB} > \text{CB} \]. The losses are less (9.10%); in respect of the thermic process, the losses in CB and MB are 51.97 and 15.82 respectively.

3.2.5. Protein determination

The wash stage does not affect, the contented of protein in the food, statistics are not presenting significant differences between the samples \((\alpha = 0.05)\), and do not exists a complete statistics evidence to affirm that the percent of proteins in MB changes significantly in percent of protein in WB, however the differences in contented of proteins between CB and WB they are. It possible happens because of the solubilization in the warmer fluid process, in effect of higher temperatures. Baltes [13] says, the extreme cold and the extreme warm, have a big effect, this process needs the temperature and also the time is an essential tool.

3.2.6. Texture determination

The texture determination as an indicator to the modification in broccoli, after the thermic process in microwave was compared in respect with the conventional process, in this way we had some significant differences between results in pure and compression \((\alpha = 0.05)\). These differences get higher in the CB process, happened and reform in structures, because the cell wall brokes with a high temperature \((92^\circ\text{C})\), affecting the permeability and flexibility. León. Op, cit.

4. Conclusion

In all the physicochemical parameters scored, the blanching microwave sample conserved a higher nutritional contented compared with a traditional process sample, because the lixiviation of components or because the thermic process effect on the components thermolable. Through the wash process standard is possible to get that the water loss in the microwave process can be balance with the quantities in retender water. The consume energy by the equipment in thermic process was of 264000J y 102600J for conventional blanching process respectively, these values defer principally in the process time, and from a economic point of view, is better by microwave because the consume and energy cost of production is almost of the half in compare with the conventional.

References


Valladolid. Escuela técnica superior en ingenierías agrarias.


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