Effect of Blanching and Probiotic to Eggplant (*Solanum Melongena*) Fermentation

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Abstract

The eggplant (*Solanum melongena*, L.) is a good source of minerals and vitamins. Being rich in fiber and having low lipid content, it contains a variety of phytochemicals, such as polyphenols, which provide important health benefits. However, the short shelf life of eggplant can be a major cause of postharvest losses especially during peak harvesting season. Fermentation is one of the most convenient technologies for the production of shelf stable food products. The objective of this study was to evaluate different aspects affecting to the fermentation of eggplants such as concentration of CaCl₂, temperature and time for blanching; effect of ratio *Lactobacilus acidophilus* to the antioxidant of fermented eggplant. Results showed that eggplants should be blanched in hot water 95°C in 10 seconds with the present of 2.0% CaCl₂. Moreover, the fermentation process for pickle eggplants had the best antioxidant by *Lactobacilus acidophilus* at ratio 1.5 x 10⁸ cells/ml. Blanching and fermentation had significantly affected to antioxidant capacity and firmness of pickle eggplants.

Keywords: Eggplant, Pickle, Fermentation, Blanching, *Lactobacilus acidophilus*, Antioxidant.

Introduction

Eggplant is an economically important vegetable crop of rural area in Soc Trang province, Vietnam. It has different shapes, sizes and colors [1, 2, 3]. Eggplant has received a great interest as functional food, being classified among top ten vegetables with antioxidant capacity because of its high content of phenolics. Phenolic compounds of eggplant have the potential to reduce intestinal glucose absorption and provide cellular antioxidant protection, preventing oxidation and diabetes complications [4], especially those phenolic compounds present in eggplant peel [5].

This vegetable is rich in the content of anthocyanins in the peel and also rich in the content of phenolic acids in the flesh, being delphinidin derivartives and chlorogenic acid isomers the main phenolic compounds in those anatomic parts, respectively [6]. Eggplant is characterized for its high content of phenolic compounds with antioxidant properties and according to Cao et al. [7] is among top ten vegetables with higher antioxidant activity. The eggplant flour had great fiber content in addition to good content of phenolic compounds and saponins with important antioxidant capacity [8]. In addition, eggplant is distinguished for its content of flavonoids in peel with high amounts of the anthocyanin nasunin [9, 10] and also is recognized for high levels of phenolic acids in the flesh, especially chlorogenic acid [11,12].

The eggplant peel is rich in anthocyanins and has therapeutic potential for the treatment of hyperlipidemia and prevention of atherogenic cardiovascular diseases by inhibiting lipid peroxidation [13]. A study of the anthocyanins and phenolic acids present in eggplant demonstrates that they are well metabolized and absorbed [14, 15], have a good antioxidant capacity [16, 17], a potential beneficial action on hyperlipidemia in animals [18] and a modest effect on hypercholesterolemia in humans [19]. Ajay P. Singh et al., [20] proved that eggplant pulp had high polyphenols content and...
antioxidant capacity. Health benefits and bioactive compounds of eggplant were discussed by Nergiz Gürbüz et al., [21]. Naomi N. Mbondo et al., [22] demonstrated that freeze-drying was the most effective in retaining the highest bioactive compounds in eggplants.

Not many researches mentioned to eggplant fermentation. Reyhan Irkin and Gamze Emmun Songun [23] applied probiotic bacteria to the vegetable pickle products. The effect of ratio Lactobacillus acidophilus to the antioxidant of fermented eggplant (Solanum melongena) was investigated. The health and nutritional benefits of eggplants have led to their increased demand and hence production.

However, increased production is accompanied by increase in postharvest losses due to their perishable nature. Due to the relatively short postharvest life in fresh form, eggplants can be converted to shelf stable forms through processing. One of the most commonly used processing methods is fermentation. The objective of this study was to evaluate different aspects affecting to the fermentation of eggplants such as concentration of CaCl₂, temperature and time for blanching; effect of ratio Lactobacillus acidophilus to the antioxidant of pickle eggplant.

Materials and Method

Material

We collected eggplants in Soc Trang province, Vietnam. They must be cultivated following Viet GAP to ensure food safety. After collecting, they must be conveyed to laboratory within 4 hours for experiments. They were washed under tap water to remove foreign matters. Besides eggplants we also used another material during the research such as CaCl₂. Lab utensils and equipments included digital weight balance, fermentor.

Figure 1: Eggplant (Solanum melongena)

Researching Procedure

Antioxidant in Raw Eggplant

Total 9 samples of raw eggplants were used to measure the antioxidant content (mmol TE/g) in raw material. The antioxidant activity of raw eggplant was evaluated by FRAP (Ferric Reducing Ability of Plasma) [24].

Effect of CaCl₂ Concentration for Blanching to the Antioxidant of Fermented Eggplant

Sliced eggplants were blanched with CaCl₂ in different CaCl₂ concentrations (0%, 0.5%, 1.0%, 1.5%, 2.0%, 2.5%, 3.0 %) in water at 100°C for 5 seconds. Lactobacillus acidophilus was added at ratio 1.0x10⁸ cells/ml.

The fermentation process was carried out at ambient temperature for 7 days. Antioxidant activity (mmol TE/g) and firmness (sensory score) were analyzed in the samples to verify the appropriate CaCl₂ concentration for blanching.

Effect of Temperature and Time for Blanching to the Antioxidant of Fermented Eggplant

Sliced eggplants were blanched with CaCl₂ in 2.0% of CaCl₂ in water at different time and temperature (100°C for 5 seconds, 95°C for 10 seconds, 90°C for 15 seconds and 85°C for 20 seconds). Lactobacillus acidophilus was added at ratio 1.0 x 10⁸ cells/ml.
The fermentation process was carried out at ambient temperature for 7 days. Antioxidant activity was analyzed in the samples to verify the appropriate temperature and time for blanching.

**Effect of Ratio Lactobacillus Acidophilus to the Antioxidant of Fermented Eggplant**

Sliced eggplants were blanched with CaCl$_2$ 2.0% in water at 95°C for 10 seconds. *Lactobacillus acidophilus* was added for the fermentation with different ratio: 0; 0.5 x 10$^8$; 1.0 x 10$^8$; 1.5 x 10$^8$; 2.0 x 10$^8$ cells/ml. Fermentation process was carried out at ambient temperature for 7 days. Antioxidant activity was analyzed in the samples to verify the appropriate ratio of *Lactobacillus acidophilus* for fermentation.

**Quality Assessment of the Fermented Eggplant**

Sensory score of fermented eggplant was evaluated a group of panelists. They were required to evaluate the odour, colour, taste, sweetness and overall acceptance using the 9-point hedonic scale (1 = dislike extremely, 9 = like extremely). The antioxidant activity of fermented eggplant was evaluated by FRAP (Ferric Reducing Ability of Plasma) [24].

**Statistical Analysis**

The experiments were run in triplicate with three different lots of samples. Data were subjected to analysis of variance (ANOVA) and mean comparison was carried out using Duncan’s multiple range test (DMRT) Statistical analysis was performed by the Startgraphics.

**Result & Discussion**

**Antioxidant in Raw Eggplant**

Total 9 samples of raw eggplants were used to measure the antioxidant content (mmol TE/g) in raw material. The antioxidant activity of raw eggplant was evaluated. Results were depicted in table 1.

<table>
<thead>
<tr>
<th>Sample</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
<th>#5</th>
<th>#6</th>
<th>#7</th>
<th>#8</th>
<th>#9</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antioxidant (mmol TE/g)</td>
<td>54.23</td>
<td>54.21</td>
<td>54.51</td>
<td>54.19</td>
<td>54.33</td>
<td>54.21</td>
<td>54.27</td>
<td>54.20</td>
<td>54.46</td>
<td>54.29 ±0.06</td>
</tr>
</tbody>
</table>

According to Morales-Soto et al., [25], the average antioxidant content of eggplant was 0.383-0.594 mmol TE/100 g. Meanwhile Medina et al., [26] found that antioxidant activity in five types of eggplant (Chinese, Philippine, American Hindu, and Thai) ranged from 95 to 539 µmol TE/g.

**Effect of CaCl$_2$ Concentration for Blanching to the Antioxidant and Firmness of Fermented Eggplant**

Sliced eggplants were blanched with CaCl$_2$ in different CaCl$_2$ concentrations (0%, 0.5%, 1.0%, 1.5%, 2.0%, 2.5%, 3.0%) in water at 100°C for 5 seconds. *Lactobacillus acidophilus* was added at ratio 1.0 x 10$^8$ cells/ml. The fermentation process was carried out at ambient temperature for 7 days. Antioxidant activity and firmness (sensory score) were evaluated in the samples to verify the appropriate CaCl$_2$ concentration for blanching. Results were elaborated in table 2. From table 2, the antioxidant content was not significantly different by CaCl$_2$ concentration.

However, the firmness (sensory score) of pickle eggplant had significantly different by CaCl$_2$ concentration. Among these treatments, pickle eggplant had the highest firmness by treatment at 2.0% of CaCl$_2$. So this value was selected for further experiments.

<table>
<thead>
<tr>
<th>CaCl$_2$ (%)</th>
<th>0%</th>
<th>0.5%</th>
<th>1.0%</th>
<th>1.5%</th>
<th>2.0%</th>
<th>2.5%</th>
<th>3.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antioxidant (mmol TE/g)</td>
<td>75.21±0.01$^a$</td>
<td>75.25±0.01$^a$</td>
<td>75.25±0.02$^a$</td>
<td>75.26±0.01$^a$</td>
<td>75.29±0.02$^a$</td>
<td>75.31±0.01$^a$</td>
<td>75.33±0.03$^a$</td>
</tr>
<tr>
<td>Firmness (sensory score)</td>
<td>4.25±0.02$^a$</td>
<td>4.29±0.03$^a$</td>
<td>5.33±0.02$^b$</td>
<td>6.21±0.04$^b$</td>
<td>7.45±0.02$^a$</td>
<td>7.47±0.01$^a$</td>
<td>7.50±0.03$^a$</td>
</tr>
</tbody>
</table>

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 2: Effect of CaCl$_2$ concentration for blanching to the antioxidant (mmol TE/g) and firmness (sensory score) of fermented eggplant.
Best colour values of eggplant rings were found in SO₂ and steam blanching pretreatments. The inhibitory effect of various thermal and chemical pretreatments on eggplant rings was found to decrease in the following order SO₂ > steam blanching > water blanching > coated chitosan > coated CMC > sodium chloride [27]. Controlled browning by blanching with vitamin C 0.5% in 5 minutes.

Effect of Temperature and Time for Blanching to the Antioxidant and Firmness of Fermented Eggplant

Sliced eggplants were blanched with CaCl₂ in 2.0% of CaCl₂ in water at different time and temperature (100°C for 5 seconds, 95°C for 10 seconds, 90°C for 15 seconds and 85°C for 20 seconds). Lactobacillus acidophilus was added at ratio 1.0x 10⁸ cells/ml. The fermentation process was carried out at ambient temperature for 7 days Antioxidant activity and firmness (sensory score) were evaluated in the samples to verify the appropriate temperature and time for blanching. Results were elaborated in table 3. From table 3, the eggplant should be blanched at 95°C in 10 seconds to get the highest antioxidant and firmness of pickle product. So these values were selected for further experiments.

Table 3: Effect of temperature and time for blanching to the antioxidant and firmness of fermented eggplant

<table>
<thead>
<tr>
<th>Blanching</th>
<th>100°C, 5 seconds</th>
<th>95°C, 10 seconds</th>
<th>90°C, 15 seconds</th>
<th>85°C, 20 seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antioxidant (mmol TE/g)</td>
<td>75.29±0.02c</td>
<td>83.47±0.01a</td>
<td>78.47±0.02b</td>
<td>73.28±0.03d</td>
</tr>
<tr>
<td>Firmness (sensory score)</td>
<td>7.45±0.02c</td>
<td>8.26±0.01a</td>
<td>7.89±0.03b</td>
<td>6.11±0.02d</td>
</tr>
</tbody>
</table>

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Controlled browning by blanching with vitamin C 0.5% in 5 minutes.

Effect of Lactobacillus acidophilus Ratio to the Antioxidant of Fermented Eggplant

Sliced eggplants were blanched with CaCl₂ 2.0% in water at 95°C for 10 seconds. Lactobacillus acidophilus was added for the fermentation with different ratio 0; 0.5 x 10⁸; 1.0 x 10⁸; 1.5 x 10⁸; 2.0 x 10⁸ cells/ml. Fermentation process was carried out at ambient temperature for 7 days. Antioxidant activity was analyzed in the samples to verify the appropriate ratio of Lactobacillus acidophilus for fermentation. Results were elaborated in Table 4. From Table 4, the eggplant should be fermented at 1.5 x 10⁸ cells/ml of Lactobacillus acidophilus to get the highest antioxidant in pickle product. So this value was selected for fermentation.

Table 4: Effect of Lactobacillus acidophilus ratio to the antioxidant of fermented eggplant

<table>
<thead>
<tr>
<th>Lactobacillus acidophilus (cells/ml)</th>
<th>0</th>
<th>0.5 x 10⁸</th>
<th>1.0 x 10⁸</th>
<th>1.5 x 10⁸</th>
<th>2.0 x 10⁸</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antioxidant (mmol TE/g)</td>
<td>55.11±0.02a</td>
<td>76.27±0.01c</td>
<td>83.47±0.01b</td>
<td>88.79±0.01a</td>
<td>88.85±0.0a</td>
</tr>
<tr>
<td>Firmness (sensory score)</td>
<td>6.29±0.01d</td>
<td>7.19±0.02a</td>
<td>8.26±0.01b</td>
<td>8.75±0.02a</td>
<td>8.77±0.01a</td>
</tr>
</tbody>
</table>

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

The fermentation process softened the structure of fruits and vegetables, making phenolic easily be extracted. Lactic acid fermentation increased the antioxidant activity than fermented material before. When adding lactic acid bacteria, lactic acid bacteria can produce β-galactosidase, catalyses the production of polyphenol compounds. The ratio of Lactobacillus acidophilus 1x10¹⁰ cells/ml supply to fermented eggplant have the highest level of antioxidant and higher material.

Conclusion

Eggplant is a vegetable crop that is grown around the world and can provide significant nutritive benefits thanks to its abundance of vitamins, phenolics and antioxidants. In addition, eggplant has potential pharmaceutical uses that are just now becoming recognized. It can bring potential health benefits.
References


