Evaluation of a thermal process for bottled watermelon juice

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Introduction

Watermelon (Citrullus vulgaris Schad) is popular summer fruit well known for many potential attributes. It contains appreciable amount of soluble solids and is used for quenching thirst in hot summer. The presence of fair amount of β-carotene and high content of potassium is believed to make watermelon juice to possess valuable diuretic properties. Huar et al.2 have worked out lycopene as the dominant pigment in watermelon juice. Though not much literature is available, some works on storage changes of watermelon juice such as changes in carbohydrate concentration, seed extraction, ascorbic acid losses, and use of spices are reported. But thermal process requirement for watermelon juice in bottles has not been investigated. The quality of juice is affected by enzymes as well as by microorganisms. Fruits, in general, contain enzyme system such as peroxidase, pectin methyl esterase and polyphenol oxidase which are heat resistant. The enzyme activity can be controlled by various methods like application of heat, use of chemical agents, reduction in moisture content etc. Among these methods, the thermal inactivation is extensively used as it simultaneously destroys the microorganisms. Various investigators including Bulls3 has suggested the use of enzymes as a basis for evaluating thermal processes of juice.

Watermelon in spite of being a popular fruit, data regarding thermal resistance of PME in it is inadequate. Therefore the present investigation was undertaken to study the heat penetration characteristics and to calculate the processing schedule, based on inactivation of pectinmethyl esterase of watermelon juice in glass bottles.

Experimental Procedure

Materials and Methods

Mature and ripe watermelon fruits were procured from local market. Fruits after washing were peeled manually and cut into pieces. Slices were then blended and passed through 1/32” mesh sieve to remove pulp and seeds and the juice strained through a muslin cloth. This juice was used as sample. Different physico-chemical changes of juice were studied. The total soluble solid (TSS) was determined with the help of a hand refractometer (Erma, Tokyo). Total titrable acidity, reducing sugar, ascorbic acid, cloud, and non-enzymatic browning (NEB) were determined by standard AOAC methods. Furfural, anthocyanin, total phenol were determined by the methods described by Ranganna8. Protein was estimated by the method described by Lowry et al11.

Thermal Inactivation Studies of Pectin Methyl Esterase

For thermal study juice was heated in a thermostatic water bath for various time intervals in different bath temperatures and cooled immediately in ice-chilled water. PME activity was done by titrimetric method. The minimum heating time at a particular temp which showed no activity was taken as the TIT.

Heat Penetration Studies

Heat penetration characteristics of juice in bottles (200 mL) was investigated by inserting the needle type
Table 1—Physico-chemical and bio-chemical characteristics of watermelon juice used in thermal inactivation studies

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Juice</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS (°B)</td>
<td>9.4</td>
</tr>
<tr>
<td>Reducing sugar (per cent)</td>
<td>4.9</td>
</tr>
<tr>
<td>Acidity (Citric acid) (per cent)</td>
<td>0.58</td>
</tr>
<tr>
<td>pH</td>
<td>4.24</td>
</tr>
<tr>
<td>Ascorbic acid (mg/100mL)</td>
<td></td>
</tr>
<tr>
<td>Furfural (515nm)</td>
<td></td>
</tr>
<tr>
<td>Total phenol (765 nm)</td>
<td></td>
</tr>
<tr>
<td>Cloud (660 nm)</td>
<td></td>
</tr>
<tr>
<td>Non-enzymatic browning (440 nm)</td>
<td>0.98</td>
</tr>
<tr>
<td>0.17 3.56 0.65 0.27</td>
<td></td>
</tr>
<tr>
<td>Pectin methyl esterase</td>
<td></td>
</tr>
<tr>
<td>(PEU x 10/mL)</td>
<td>7.01</td>
</tr>
</tbody>
</table>

temperature sensor positioned at low temperature. Heating and cooling data from lower point was used for calculations.

Plotting of Heat Penetration Data

To calculate the process time the temperatures corresponding to various time were plotted on rectangular coordinate graph paper.

Process Time Calculations

Process time was calculated by the graphical method. The inactivation rates on the heat penetration curves, during heating and cooling at various points were calculated using the expression:

$$I = \log_{10} \left( \frac{T - T_x}{Z} \right)$$

where $I$ is Inactivation rate at temperature $T$, $T_x$ is Temperature at which $F$ is 1 min and $Z$ is Fahrenheit temperature required for TIT curve to traverse one log cycle.

The thermal inactivation rate curve was drawn by plotting inactivation rate against time. To calculate the processing time having the desired $F$ value, cooling curves at different points were drawn parallel to the original cooling curve. Areas under these curves were found and the corresponding $F$ values were calculated. The process time was found by graphical interpolation.
Results and Discussion

The fresh juice immediately after extraction possessed highly attractive colour with characteristic flavour. Analytical data of the juice used in the TIT studies are given in Table 1.

The TIT curve of PME is shown in Figure 1. The $F$ value was 1 at 203°F with a $Z$ value of 19 and this temperature was chosen as the base temperature for process calculations. The heat penetration curve and the corresponding inactivation rate curve for bottled watermelon juice are shown in Figure 2 and 3. The graphical interpolation curve to find the process time corresponding to the desired $F$ values is shown in Figure 4. The process time required to achieve an $F$ value at 203°F was 26 min for bottled watermelon juice.

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References


