Suggested Reference


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Bacterial spore inactivation at 45-65°C using High Pressure Processing (HPP)

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Eng Keat
Mohammed Farid

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Auckland
Thermal pasteurization

MICROORGANISMS

VEGETATIVE CELLS
60°-80°C for inactivation

SPORES CELLS
100°-120°C for inactivation
Can cause illness in humans

Microorganisms in foods

Food pasteurization

Food deterioration
Can cause illness in humans

Microorganisms in foods

Food pasteurization

Food deterioration
The process of reducing the numbers of microorganisms in foods

PASTEURIZATION

- Increase food shelf-life
- Promotes food safety
Food pasteurization

Why non-thermal methods?

Higher food quality

✓ More flavour/aroma
✓ More vitamins
✓ More bioactive and health related compounds
Non-thermal pasteurization

High Pressure Processing (HPP)
Alicyclobacillus acidoterrestris
Alicyclobacillus acidoterrestris

- Thermoacidophilic bacteria identified in the 80s (Deinhard et al., 1987)
- Associated with juice spoilage incidents and economic losses in fruit juice industry
- Target microorganism for the design of pasteurization processes in fruit juices (Silva and Gibbs, 2001; 2004)
Objective

200-600 MPa
45-65°C
1-15 min

*Alicyclobacillus acidoterestris* spore inactivation in orange juice
Spore production

Potato dextrose agar (PDA) with pH 5.6

Incubation at 45ºC for 18 days

Spore enumeration before and after HPP

PDA adjusted to pH 4.0

Incubation at 45ºC for 3 days
HPP - thermal process cycle

Pressure history for a 600 MPa process
HPP - thermal process cycle

Temperature history for a 1.5 min process at 600 MPa - 55°C
Thermal resistance of microorganisms at constant pressure

\[ \frac{N}{N_0} = 10^{-\frac{t}{D_T}} \]

\[ \log N = \log N_0 - \frac{t}{D_T} \]

\( D_T \)-value (min)

1st order microbial inactivation
Thermal resistance of microorganisms

$D_T \div D_{T_{ref}} = 10 \left( \frac{T_{ref} - T}{z} \right)$

$z$-value (°C)

1st order microbial inactivation
Spore survivor in orange juice after HPP at 45°C

Results

-3
-2.5
-2
-1.5
-1
-0.5
0
2 4 6 8 10 12 14 16
Log10 (N/N₀)
Time (min)

45°C

200 MPa
600 MPa

Silva et al. 2012
## D-values at high pressure

<table>
<thead>
<tr>
<th>T (°C)</th>
<th>D-value (min)</th>
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<th>D-value (min)</th>
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<tbody>
<tr>
<td>45</td>
<td>44</td>
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<td>55</td>
<td>29</td>
<td>55</td>
<td>7</td>
</tr>
<tr>
<td>65</td>
<td>5</td>
<td>65</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Silva et al. 2012
**Results**

z-values at high pressure

\[ y = -0.047x + 3.852 \]

\[ R^2 = 0.8893 \]

\[ y = -0.0291x + 2.4274 \]

\[ R^2 = 0.9977 \]

\[ z_{200\text{MPa}} \text{-value} = \frac{1}{0.047} = 21.3^\circ \text{C} \]

Silva et al. 2012
### Results

**z-values at high pressure**

<table>
<thead>
<tr>
<th></th>
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<th>600 MPa</th>
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<tr>
<td><strong>D-value (min)</strong></td>
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</tbody>
</table>

Silva et al. 2012
### Comparing HPP with thermal processing at atmospheric pressure

#### Thermal 0.1 MPa

<table>
<thead>
<tr>
<th>T (°C)</th>
<th>D-value* (min)</th>
</tr>
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<tbody>
<tr>
<td>85</td>
<td>50 - 95</td>
</tr>
<tr>
<td>90</td>
<td>10 - 21</td>
</tr>
<tr>
<td>95</td>
<td>3 - 9</td>
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</tbody>
</table>

#### HPP 200 MPa

<table>
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#### HPP 600 MPa

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<td>7</td>
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<tr>
<td>65</td>
<td>3</td>
</tr>
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*Eiroa et al., 1999; Komitopoulou et al., 1999; Silva et al. 1999

Silva et al. 2012
Conclusion

Bacterial spore inactivation at much lower temperatures (45-65ºC) is possible when using High Pressure Processing (HPP)
Acknowledgements

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