Evaluation of the Heat Resistance of *Salmonella enterica* ser. Enteritidis PT30 on Honey/Syrup-Coated Almonds and Uncoated Almonds after Exposure to Hot Oil Treatment

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**Introduction**

The Almond Board of California (ABC) has conducted many years of research to study the efficacy of hot oil on the reduction of *Salmonella enterica* ser. Enteritidis PT30 on oil-roasted almonds. Based upon this research, a minimum process of 2.0 minutes of exposure to hot oil at 260°F or above is required to provide a 5-log reduction of *S. enterica* ser. Enteritidis PT30 on the surface of whole almonds. Since the studies to establish the oil-roasting pasteurization criteria for oil-roasted almonds were completed using uncoated whole-kernel almonds, ABC is interested in evaluating the heat resistance *S. enterica* ser. Enteritidis PT30 on oil-roasted almonds with various commercial coatings to verify the suitability of the oil-roasting process (260°F for 2.0 min) for coated almonds.

**Objectives**

- Determine an enumeration procedure using various mixing techniques to recover *S. enterica* ser. Enteritidis PT30 from coated almonds.
- Determine if various oil-roasting treatments are sufficient to achieve the required 5-log reduction of *S. enterica* ser. Enteritidis PT30 when applied to uncoated, honey-coated, xanthan-coated and starch-coated almonds.

**Materials & Methods**

**Almond Products**

- Uncoated almonds
- Honey-coated almonds
- Xanthan-coated almonds
- Starch-coated almonds

**Target Organism**

- *S. enterica* ser. Enteritidis PT30

**Sample Process Techniques Evaluated**

- Blending
- Smashing
- Shaking

**Oil Roasting Treatment**

- 260°F for 1.0, 1.5 and 2.0 minutes
- 3 replicate samples
- 3 trials

**Enumeration**

- Dilute with cold tryptic soy broth
- Plate in duplicate onto tryptic soy agar
- Incubate at 35°C for 2 days

**Results**

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**Conclusions**

- The recovery of *S. enterica* ser. Enteritidis PT30 from uncoated and xanthan-coated almonds was similar between blending, smashing and shaking sample process techniques both before and after oil roasting.
- The log reduction of *S. enterica* ser. Enteritidis PT30 on honey-coated, xanthan-coated and starch-coated almonds achieved by oil-roasting processes of less than 2.0 minutes at 260°F was inconsistent.
- A greater than 5-log reduction in *S. enterica* ser. Enteritidis PT30 was achieved on uncoated, honey-coated, xanthan-coated and starch-coated almonds after oil roasting for 2.0 min at 260°F.
- The commercial oil-roasting process, which achieves temperatures greater than 260°F for longer than 2.0 min, should be sufficient to reach a greater than 5-log reduction of *S. enterica* ser. Enteritidis PT30 on uncoated, honey-coated, xanthan-coated and starch-coated almonds.

**Next Steps**

- Conduct additional studies to investigate the reason for the inconsistent recovery of *S. enterica* ser. Enteritidis PT30 on coated almonds.
- Conduct additional studies to evaluate the impact of coating material drying time on the effectiveness of the oil-roasting process to reduce *S. enterica* ser. Enteritidis PT30 on coated almonds.

**Reference**


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**Table 1. Average Water Activity and Moisture Content of Coated and Uncoated Almonds Prior to Oil Roasting (n=6)**

<table>
<thead>
<tr>
<th>Almond Type</th>
<th>Water Activity Mean ± SD</th>
<th>% Moisture Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncoated Almonds</td>
<td>0.5578 ± 0.0135</td>
<td>4.91 ± 0.17</td>
</tr>
<tr>
<td>Honey-Coated Almonds</td>
<td>0.5633 ± 0.0147</td>
<td>5.69 ± 0.28</td>
</tr>
<tr>
<td>Xanthan-Coated Almonds</td>
<td>0.6484 ± 0.0151</td>
<td>5.97 ± 0.24</td>
</tr>
<tr>
<td>Starch-Coated Almonds</td>
<td>0.7443 ± 0.0389</td>
<td>7.72 ± 1.24</td>
</tr>
</tbody>
</table>

**Figure 1. Average recovery of *S. enterica* ser. Enteritidis PT30 from uncoated almonds via blending, smashing, and shaking methods. Vertical bars indicate standard deviation (n=9).**

**Figure 2. Average recovery of *S. enterica* ser. Enteritidis PT30 from almonds oil roasted at 260°F for 1 min using blending, smashing, and shaking methods. Vertical bars indicate standard deviation (n=9).**

**Figure 3. Average survival of *S. enterica* ser. Enteritidis PT30 on coated and uncoated almonds after oil roasting at 260°F for various treatment times. Vertical bars indicate standard deviation (p < 0.05).**