Commercialization of Vitamin D Enhanced Mushrooms by UV Light Treatment

Mushrooms Canada
Guelph Food Technology Centre
Vitamin D2 Conversion

UV light

Ergosterol \rightarrow \text{Vitamin D2} \text{ (pro-vitamin D2) \rightarrow (ergocalciferol)}

Vitamin D2 conversion is a function of UV light energy
## Daily Reference Intake

<table>
<thead>
<tr>
<th></th>
<th>FDA</th>
<th>Health Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infants, children, men, and women aged 19-50</td>
<td>200 IU</td>
<td>5µg (200IU)</td>
</tr>
<tr>
<td>Men and women aged 51-70</td>
<td>400 IU</td>
<td>10µg (400IU)</td>
</tr>
<tr>
<td>Men and women over 70</td>
<td>600 IU</td>
<td>15µg (600IU)</td>
</tr>
</tbody>
</table>
Target

Vitamin D 400 IU/one serving fresh mushroom

or

Vitamin D 10μg/100g fresh mushroom
Variables

- Variety of mushrooms (agaricus, shiitake, oyster, enoki)
- UV energy / unit area (dosage)
  - Intensity (wattage of bulbs, number of bulbs, distance)
  - Exposure time

Dosage (J/cm²) = Intensity (mW/cm²) × Time (s)
UVB Treatment Facility at GFTC
UVB Intensity Decay

- Solutions
  - Commercial equipment which delivers consistent UV light intensity
  - Automatic UV intensity compensation

![Graph showing UVB intensity decreases with time]
- Day 3 might represent the product at the retail level
White Button Mushroom

Vitamin D vs Storage time

Day

Vitamin D (IU)

1min6bulb20cm
5min6bulb20cm
Brown Crimini Mushroom

Vitamin D vs Storage time

Days

Vitamin D (IU)

- 1min6bulb20cm
- 5min6bulb20cm
Shelf life studies – white mushroom
Day 1
Shelf life studies – white mushroom
Day 3
Shelf life studies – white mushroom

Day 7

No significant difference in appearance between the control and the treated
Shelf life studies – brown mushroom
Day 1
Shelf life studies – brown mushroom

Day 3
Shelf life studies – brown mushroom
Day 7

No significant difference in appearance between the control and the treated
Sensory Study

- Triangle sensory evaluation on Day 2
- Control vs UVB treated
- Twelve panellists participated the triangle test. Eight out of twelve couldn’t tell the difference between the control and the treated. Four out of twelve picked the right sample. Statistically, there is 1/3 chance that the panellist will get the right answer even they can’t taste the difference.
- Sensory panel indicates there is no significant difference between the control and the treated.
## Microbial test - white mushroom

<table>
<thead>
<tr>
<th></th>
<th>White control</th>
<th>White treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>APC</td>
<td>4.30E+04</td>
<td>8.60E+04</td>
</tr>
<tr>
<td>E. Coli</td>
<td>&lt;1.0E+01</td>
<td>&lt;1.0E+01</td>
</tr>
<tr>
<td>mold</td>
<td>1.60E+03</td>
<td>1.95E+03</td>
</tr>
<tr>
<td>yeast</td>
<td>5.00E+01</td>
<td>&lt;5.0E+01</td>
</tr>
<tr>
<td>S. aureus</td>
<td>&lt;2.5E+01</td>
<td>&lt;2.5E+01</td>
</tr>
<tr>
<td>Listeria sp.</td>
<td>neg</td>
<td>neg</td>
</tr>
<tr>
<td>Salm. Sp.</td>
<td>neg</td>
<td>neg</td>
</tr>
</tbody>
</table>

*Same order of magnitude between the control and the treated*
## Microbial test - brown mushroom

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>Brown control</th>
<th>Brown treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>APC</td>
<td>&gt; 2.5E+05</td>
<td>&gt; 2.5E+05</td>
</tr>
<tr>
<td>E. Coli</td>
<td>&lt;1.0E+01</td>
<td>&lt;1.0E+01</td>
</tr>
<tr>
<td>mold</td>
<td>9.0E+02</td>
<td>3.0E+02</td>
</tr>
<tr>
<td>yeast</td>
<td>5.00E+01</td>
<td>&lt;5.0E+01</td>
</tr>
<tr>
<td>S. aureus</td>
<td>&lt;2.5E+01</td>
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</table>

Same order of magnitude between the control and the treated
The frozen mushroom samples were used. Fractions of the internal standard, D2 and D3 are collected using a semi-preparative normal phase HPLC column. The fractions are then concentrated, and the total amount of Vitamin is determined using reverse-phase HPLC with UV detection.
Conclusions

- The target level of vitamin D (400IU/serving) can be achieved by relatively low dosage of UVB exposure for both white and brown mushrooms (approx. 0.2 - 0.3 J/cm^2).
- This UVB dosage can be applied at relatively low intensity (0.8 – 1.2 mW/cm^2) and in reasonable length of time (2-3 min).
- Vitamin D decreases during storage but stabilizes at 60-80% of original level after a week.
- No significant quality difference between the control and the treated.
- No detectable sensory difference.
- UVB intensity decays with time.