Implication and chemical testing of two rhizopus fungi in softening of canned apricots

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Evidence from these tests showed that a single fruit decayed by Rhizopus arrhizus, and placed into a no. 10 can of healthy fruit before canning resulted in total disintegration of healthy fruit during six months' storage at room temperature. Addition of a single Rhizopus stolonifer decayed fruit also resulted in significant softening within a six-month period in fruit from one out of three orchards. There was little change in rating of fruit after nine months' storage, but in one treatment 40% of the good Tilton fruit showed initiation of softening, with flesh starting to disintegrate, and soft to the touch.

The addition of Botran (2,6-dichloro-4-nitroaniline) when the fruit was canned did not reduce softening although in one test there was a significant increase in good fruit. There was no correlation between pH and Rhizopus-associated softening. Similar results from addition of R. stolonifer to canned apricots have been reported from Australia. R. arrhizus is also present in Australia but tests with this fungus were not reported. The 1973 California studies showed that pre- and postharvest Botran applications did not control R. arrhizus on apricots. Previous studies also have shown that R. arrhizus is present in orchards throughout California and that Botran failed to control it.

Chemicals

Chemicals tested were 75% Botran (2, 6-dichloro-4-nitroaniline) and 70% Topsin M (1,2-bis(3-methoxy-carbonyl-2-thioureido)-benzene-thiophanate-methyl). Botran was applied at the rate of 1/3 lb per 100 gallons of water as a field spray and as a postharvest dip. Definite amounts of Botran in acetone were added to empty cans and acetone-evaporated before filling with fruit. Only 4.08 mg of proprietary 75% Botran was added to each can, giving one ppm of active ingredient on a weight-for-weight basis. Topsin M was applied only as a field spray at the rate of 0.5 lb per 100 gallons of water. Field sprays were applied with a hand gun sprayer on June 13 and July 2, 1973, at the rate of about 6 gal per tree.

Effect of heat

The PG activities in the liquid media of the mold cultures were quite high. To study the differences between them, the culture filtrate was diluted five times with water. Two ml of the diluted enzyme were added to the 36° Brix syrup of each can during canning.

The cans were processed at 100°C (212°F) and 110°C (230°F) respectively for 10 minutes, with PG from R. stolonifer added to the cans. Thirty days after canning the fruit showed some softening, with flesh starting to disintegrate, and soft to the touch.

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Heat resistance of pectic enzymes was checked. Even at a temperature reaching 215°F (101.7°C) for five minutes, residual PG activity of enzyme from R. stolonifer was detected. The PG enzymes produced by R. arrhizus and R. oryzae were less heat-resistant than that of R. stolonifer. The concentration of enzyme other than PG may also be different between the organisms.

Discussion

An important factor in the enzymatic softening problem seems to be intrinsic and/or parasitai-originated pectic enzymes. To solve the problem, the food processing industry should work toward control of molds in apricot orchards, and for methods of handling and processing that result in minimum mechanical damage. Prompt handling and canning of the fruit after harvest may also help.

Much remains to be investigated concerning pectin biosynthesis, activation of pectic enzyme systems, the effect of pectic and cellulase enzymes from microorganisms on fruit texture.

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EFFECT OF RHIZOPUS FUNGI ON SOFTENING OF BLENHEIM AND TILTON APRICOTS IN CANS AND HELD FOR 6 AND 9 MONTHS

<table>
<thead>
<tr>
<th>Orchard</th>
<th>Softening Category</th>
<th>6 month storage</th>
<th>9 month storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check</td>
<td></td>
<td>91.2a</td>
<td>82.2a</td>
</tr>
<tr>
<td>R. stolonifer decayed fruit</td>
<td></td>
<td>90.0a</td>
<td>75.7a</td>
</tr>
<tr>
<td>R. arrhizus decayed fruit</td>
<td>Orchard D (pH not taken)</td>
<td>28.4b</td>
<td>0.0b</td>
</tr>
<tr>
<td>Check</td>
<td></td>
<td>99.6a</td>
<td>97.6a</td>
</tr>
<tr>
<td>R. stolonifer decayed fruit</td>
<td></td>
<td>90.1b</td>
<td>91.9ab</td>
</tr>
<tr>
<td>R. arrhizus decayed fruit</td>
<td></td>
<td>0.0c</td>
<td>0.0c</td>
</tr>
<tr>
<td>R. stolonifer decayed fruit plus Botran</td>
<td></td>
<td>98.9a</td>
<td>97.6a</td>
</tr>
<tr>
<td>R. arrhizus decayed fruit plus Botran</td>
<td></td>
<td>90.1b</td>
<td>90.0a</td>
</tr>
<tr>
<td>Botran added</td>
<td></td>
<td>99.9a</td>
<td>99.6a</td>
</tr>
</tbody>
</table>

3.8-4.2, and Orchard B 4.0-4.2.

Canned fruits were stored for six months at room temperature in Sunnyvale, then transported to the University of California, Davis by car and three cans of each treatment were inspected on January 7, 1974. The remaining cans were opened on April 15, 1974, and two additional treatments were evaluated on June 11, 1974.

Variations from normal maturity were as follows: Fruits from orchard A were slightly greener than those from orchard B; those from orchard C had more over-ripe; and fruits from orchard D were greenish-white with a few of the fruit showing brown rot (Monilinia laxa). Canned fruits were prepared by inoculation of Blenheim apricots with known isolates of Rhizopus stolonifer (RS 140) or Rhizopus arrhizus (RX 149). Before inoculation the fruits were surface-sterilized for three minutes with 400 ppm chlorine prepared from commercial Purex. The cooking time of the cans was 23 minutes with a maximum temperature of about 209°F. This was sufficient to kill fungal pathogens added to the cans.

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