EFFECT OF BLANCHING TREATMENTS ON THE FIRMNESS OF CARROTS

C. Y. LEE, M. C. BOURNE and J. P. VAN BUREN

ABSTRACT

Carrots (26 varieties) were subjected to two blanching-in-water treatments prior to being canned in the conventional manner. (1) 4–5 min blanch at 212°F, (2) 20–30 min blanch at 165°F. All of the low temperature blanch carrots were firmer than the corresponding high temperature treatment. Blanching was carried out at 130°, 150°, 170°, 190°, 212°F. The firmness, free methanol and pH of these treatments all showed the same trend, increasing as blanch temperature was raised from 130° to 170°F and decreasing as blanch temperature was raised from 170° to 212°F. This evidence supports the conclusion that the increase in firmness is caused by the effects of pectin methyl esterase (PME) which is activated by the low temperature blanch and inactivated by the high temperature blanch.

INTRODUCTION

TEXTURE is one of the important quality attributes of canned vegetables. Generally the texture is expected to be tender, but solid, with no hardness, toughness, stringiness or excessive softness, mushiness or sloughing. Examination of commercially canned carrot slices in our laboratory has shown that a large proportion of the samples have a soft texture resulting in excessive sloughing and breaking of the slices during handling.

Earlier work has shown that excessive softness and sloughing in canned green beans could be overcome by low temperature blanching (Van Buren et al., 1960, 1962). This firming effect was attributed to activation of the pectin methyl esterase (PME) in the raw green beans at a temperature of 140°-167°F which made a large number of free carboxyl groups available on the pectin molecules which can then be cross-linked by means of salt bridges with calcium ions that are present in the tissue. Similar results in the form of firmer texture have been obtained with other canned vegetables including tomatoes (Hsu et al., 1965), cauliflower (Hoogzand et al., 1961), potatoes (Bartolome and Hoff, 1972), and frozen green beans (Steinbuch, 1976).

In view of the problem of softness in many samples of commercially canned carrots, we designed an experiment to determine whether carrots contain PME and whether low temperature blanching will give a firmer cutout texture.

MATERIALS & METHODS

CARROTS (Daucus carota, L.) grown at the Vegetable Crops Farm of the New York State Agricultural Experiment Station during 1973 and 1974 seasons were used for this study. Twenty-six cultivars of carrots grown under normal agricultural practices were harvested and processed at the pilot plant of the Department of Food Science & Technology. Washed and trimmed carrots were blanched at two blanching conditions: low temperature (165°F for 20–30 min) and high temperature (212°F for 4–5 min). Blanched carrots were peeled with an abrasive peeler, washed, sliced, and filled into No. 303 cans. The cans were retorted at 240°F for 35 min. After 6-months storage at room temperature, textural quality of canned carrots was measured by the Instron using an extrusion cell (Shannon and Bourne, 1971). In order to correlate the textural character with the chemical changes in carrots, methanol contents of processed carrots were measured. The method for the assay of pectin methyl esterase is based on the measurement of the released methanol and the increase in free carboxyl groups (Kertesz, 1951). The methanol content was assayed by a direct gas chromatographic method developed in our laboratory (Lee et al., 1975). In each test the whole content of a No. 303 can of carrots was homogenized in a blender at high speed for 3 min and centrifuged to separate liquid and solid phases. A portion of liquid was injected directly into the Column (Porapak QS) of Hewlett Packard GC 5830A with a HP 18850 A terminal, and methanol content was measured.

RESULTS & DISCUSSION

RESULTS for all varieties showed that canned carrots blanched at low temperature were firmer than those blanched at high temperature as shown in Table 1. The low temperature blanch produced a firmer product than the high temperature blanch for every variety of carrot, with a mean increase in firmness of 46.7%.

Methanol contents of conventionally blanched carrots (high temp.) were lower than those blanched at low temperature as shown in Table 2. These results indicate that high temperature inactivates PME in the carrot tissues while low temperature activated PME which release methoxyl groups.

Table 1—Effect of blanching conditions on firmness of canned carrots

<table>
<thead>
<tr>
<th>Variety</th>
<th>High temp</th>
<th>Low temp</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>Mean</td>
<td>Maximum</td>
<td>Minimum</td>
</tr>
<tr>
<td>1974</td>
<td>Mean</td>
<td>Maximum</td>
<td>Minimum</td>
</tr>
<tr>
<td>1974, 8 cultivars grown on mineral soil</td>
<td>409 562 38.3</td>
<td>530 718 66.4</td>
<td>528 497 11.8</td>
</tr>
<tr>
<td>1974, 11 cultivars grown on mineral soil</td>
<td>349 577 45.7</td>
<td>493 620 80.5</td>
<td>291 404 25.6</td>
</tr>
<tr>
<td>1973, 19 cultivars grown on organic soil</td>
<td>489 738 50.8</td>
<td>653 979 71.1</td>
<td>633 979 71.1</td>
</tr>
<tr>
<td>Minimum</td>
<td>389 577 29.4</td>
<td>493 620 80.5</td>
<td>291 404 25.6</td>
</tr>
<tr>
<td>Mean</td>
<td>384 551 45.7</td>
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increasing the methanol content. The free carboxyl groups may then cross-link by means of salt bridges with divalent metallic ions such as calcium which result in the formation of firmer texture. The corresponding results were observed in the extrusion forces.

Canned carrots showed the same trend in the firmness and methanol content for both treatments (Table 3). However, the differences were not as great as in the blanched carrots. It may be due to the high temperature process causing other chemical changes that partly mask the effects of PME and that produce additional MeOH.

Figure 1 show that 170°F was the optimum temperature for PME activation in carrots. The firmest texture, the highest MeOH content and the lowest pH were all obtained at 170°F. These three parameters all showed the same trend, increasing from 130 to 170°F and decreasing from 170 to 212°F.

When blanched carrots were held at 120°F for various times after blanching the canned carrots blanched at 170°F showed gradual increase in firmness as the holding time increased; however, the firmness of canned carrots blanched at 212°F did not show any change (Fig. 2).

Panel tests on two samples of canned carrots blanched at 170°F for 10 min and at 212°F for 4 min with 12 panelists revealed that there were 21 concurring judgments made in a total of 24 tests that the sample blanched at 170°F was firmer than the sample blanched at 212°F, thus establishing a 0.1% level of significance.

Therefore, we conclude that low temperature blanching gives a firmer texture in canned carrots and that the mechanism of firming is by the demethoxylation of the pectic materials in the carrot by PME probably followed by cross-linking at the free carboxyl groups with divalent cations that are naturally present in the tissue.

The longer time-lower temperature blanching of carrots is a process change that can be introduced fairly readily by the processing industry. It provides the processor an opportunity of improving the firmness of canned carrots at low cost.

REFERENCES


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