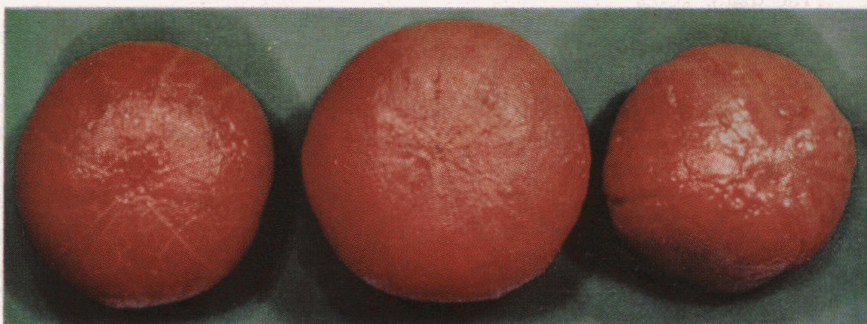


Fruits of Chico variety scalded in 25 percent NaOH (230° F.) for 20 seconds, 45 percent CaCl₂ (250° F.) for 30 seconds and water (212° F.) for 90 seconds, respectively. The fruits were photographed immediately after scalding.

Chemical Peeling of Tomatoes



Fruits of Homestead variety scalded in 25 percent NaOH (230° F.) for 20 seconds, 45 percent CaCl₂ (250° F.) for 30 seconds and water (212° F.) for 90 seconds, respectively. The fruits were photographed immediately after the cans were opened.

Summary

Tomato fruits of the Chico and Homestead varieties were scalded in solutions of water, NaOH and CaCl₂ at various concentrations, times and temperatures. Fruits were weighed before and after peeling to determine percent weight loss and were visually rated for percent peel removed. After canning and subsequent storage the fruits were subjectively evaluated for firmness and color.

Graphic presentation of the data provided a basis for selecting desired scalding treatments according to variety and chemical in terms of percent peel removed and percent weight lost.

Both NaOH and CaCl₂ solutions were more effective for peeling tomatoes than the standard water treatment. More complete peel removal was obtained with equal or less weight loss and the fruits generally were firmer and possessed a more attractive red color. The CaCl₂-treated fruits were particularly firm and attractive after thermal processing and storage. (See Photos)

Chemical Peeling of Tomatoes / Gerald C. Heddins and E. E. Burns*

The tomato, *Lycopersicon esculentum* Mill, is widely grown for both fresh market and processing. Tomatoes are processed into many forms; one of the most highly prized is canned whole tomatoes. However, before the fruits are placed into the cans the peels must be removed. This phase of the processing procedure greatly affects the quality of the finished product. It is also time consuming and laborious.

REVIEW OF LITERATURE

Early canners removed the peel entirely by hand with the aid of sharp knives (2). This method was later replaced by a technique that has been the standard process for many years. The fruits are passed through boiling water or live steam, cooled in water, and the peels are removed by hand (9, 11).

Through the years there have been several new methods proposed for peeling tomatoes, but most have not been adopted by canners. Cagnoni (6, 7) developed a process which involves immersing fruit in a freezing solution. The skin is superficially frozen, and upon thawing the peel separates from the fruit and is removed, leaving the remainder of the pericarp intact.

Brown and Murnane (3) proposed a process whereby tomatoes are quickly heated to 240°-260° F. under 10-15 pounds steam pressure. Cold water then is injected into the pressure tank, causing a partial vacuum to be produced. This induces rupturing of the peel, making it easily removable.

In recent years some processors, especially those in California (1, 9), have added NaOH to the scalding water. The literature does not indicate clearly the concentrations, temperatures or time intervals utilized. Considerable information is available regarding the lye peeling of peaches, apricots, sweet potatoes and carrots, but specific information regarding the lye peeling process for tomatoes is very limited. However, when the lye is used in peeling peaches and sweet potatoes the terms for describing the peel removal indicates a dissolution or cauterization of the cells (5, 9).

Childs et al. (8) states that high concentrations of CaCl₂ may be used at high temperatures to cause a separation of the peel from the remainder of the pericarp and to firm the exposed tissues.

According to Campbell et al. (5), proper scalding is very important because of the resultant effects on quality, yield and rapidity with which the fruits may be peeled.

Crues (9) stressed this factor by stating that 20-50 percent of the fruit is lost when peeling is done by the water scalding method. The amount of hand trimming necessary is partially related to the effectiveness of the scalding process (5).

Wholeness of the fruit is an important factor in determining grades and prices for canned tomatoes. Wholeness of canned tomatoes can be reduced by excessive heat penetration and related softening of fruit during scalding (5). Excessive handling of the fruit on the peeling lines is another factor. Proper scalding, careful handling and the addition of fruit firming chemicals are adjuncts to maintaining wholeness of fruit (4).

Kertesz et al. (10) investigated practical methods of using CaCl₂ for firming canned whole tomatoes. The addition of CaCl₂ just prior to sealing the cans and processing is now an accepted practice and is of considerable importance for the tomato canning industry.

The purpose of this research was to establish desirable times, temperatures and concentrations of CaCl₂ and NaOH for peeling tomatoes.

MATERIALS AND METHODS

Fresh fruits of Chico and Homestead tomato varieties were collected in the same general production area near

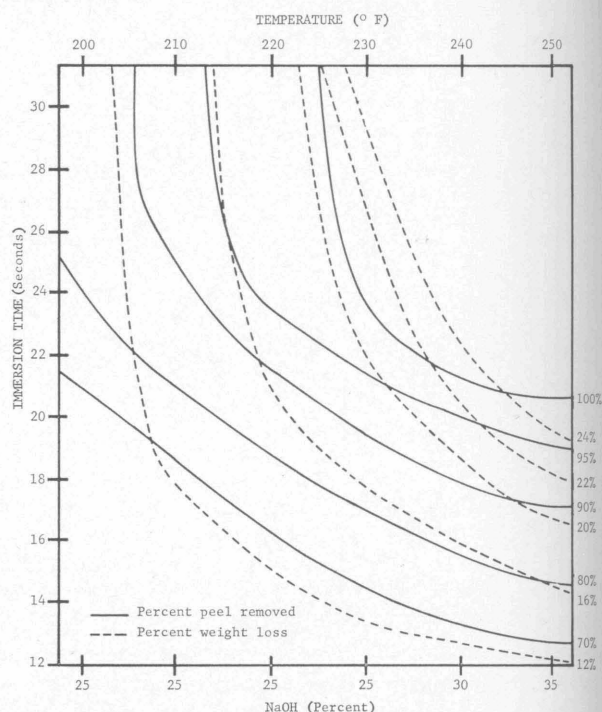


Figure 1. Percent peel removed and weight loss for Chico variety (U. S. No. 1) at varying times, temperatures and concentrations of NaOH.

*Respectively, superintendent of industries, Texas Department of Corrections, Sugar Land; and associate professor, Department of Soil and Crop Sciences, Texas A&M University.

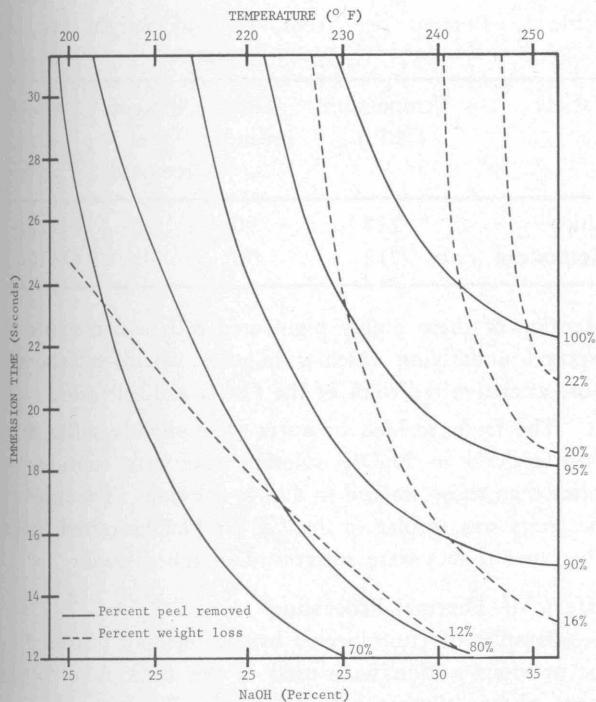


Figure 2. Percent of peel removed and weight loss for Homestead variety (U. S. No. 1) at varying times, temperatures and concentrations of NaOH.

Weslaco. The samples were harvested and subjectively graded into one maturity class. The class was U. S. No. 1 as determined by comparison with the United States Department of Agriculture Tomato Red Color Standards.

The fruits were also selected for uniformity of size. The Chico variety ranged in size from $1\frac{3}{4}$ to 2 inches in diameter. The size of the Homestead variety was from 2 to $2\frac{1}{4}$ inches in diameter. The fruits underwent preliminary grading at harvest, but final selection was made just prior to treatment. The fruits were stored overnight at 70° F. and used as quickly as possible the following day.

Each fruit was weighed to the nearest hundredth gram and individually scalded according to one of the following schedules:

1. 25 percent NaOH (212° F.), 25 percent NaOH (230° F.), 35 percent NaOH (250° F.) for 10, 20 and 30 seconds, respectively.
2. 25 percent CaCl₂ (212° F.), 25 percent CaCl₂ (230° F.), 45 percent CaCl₂ (250° F.) for 10, 20 and 30 seconds, respectively.
3. Water (212° F.) for 90 seconds.

The various treatments were replicated six times. After scalding, the fruits were dipped in running water and passed individually through a revolving drum washer. As each fruit emerged from the washer it was given a visual rating from 0 to 10, based on the amount of peel removed from the fruit. Zero was given to those with the peel completely intact, 10 to those with the peel com-

pletely removed and gradation in between relative to the estimated percent of peel removed.

After the scalded fruits were rated for peel removal, the adhering peels were removed and the fruits were placed on a 0.5-inch mesh screen for 2 minutes to drain off excess water. Each fruit then was weighed to the nearest hundredth gram.

The fruits were canned separately in No. 303 cans according to commercial methods (9). The fill juice for all cans was from one lot of Chico tomatoes and had approximately the same pH and percent soluble solids. The canned fruits were stored at room temperatures for about 3 months. The cans were opened and the fruits were subjectively examined for color and firmness.

RESULTS AND DISCUSSION

Peeling Test

The large number of variables involved in the peeling test and the presence of two response surfaces (peel rating and weight loss) rendered the drawing of statistical inference impractical. However, desired NaOH and CaCl₂ peeling treatments can be selected from Figures 1, 2, 3, and 4. The procedure for using the tables is to follow an iso-peel curve corresponding to the specified percent peel removal desired until a temperature and concentration is reached which corresponds to the smallest percent weight loss. This point often appears in the upper right-hand margin of the figures involving CaCl₂ treatments. The CaCl₂ treatments are dependent on a high solution temperature of about 250° F.

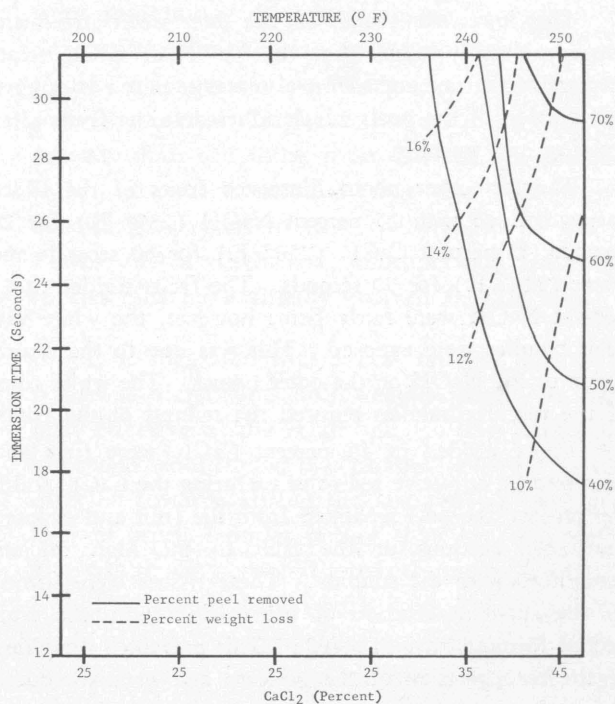


Figure 3. Percent of peel removed and weight loss for Chico variety (U. S. No. 1) at varying times, temperatures and concentrations of CaCl₂.

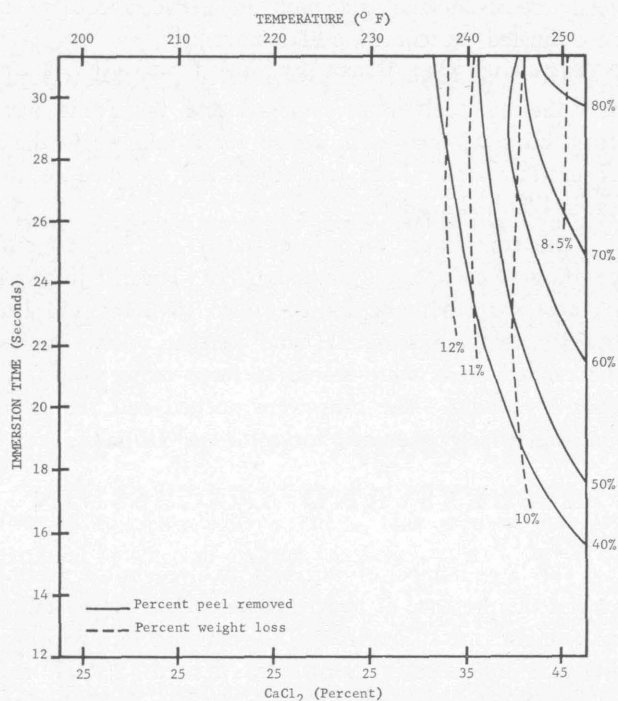


Figure 4. Percent of peel removed and weight loss for Homestead variety (U. S. No. 1) at varying times, temperatures and concentrations of CaCl_2 .

Since the standard hot-water treatment involves only one time (90 seconds) and one temperature (212°F .); figures comparable to 1, 2, 3, and 4 could not be formulated. Table 1 represents results obtained when U.S. No. 1 fruits were scalded by the standard hot water method. These results are averages of six replicates.

The immersion time of the hot water treatment was considerably longer than the NaOH or CaCl_2 treatments. More time and effort also was required to remove that portion of the peels which adhered to the fruits after scalding and washing.

The top cover photo illustrates fruits of the Chico variety scalded with 25 percent NaOH (230°F .) for 20 seconds, 45 percent CaCl_2 (250°F .) for 30 seconds and water (212°F .) for 90 seconds. The fruits scalded in 25 percent NaOH were fairly firm; however, the white vascular bundles were exposed. This was due to the caustic action of the NaOH on the outer tissues. The white color of the vascular bundles reduced the redness of the fruits.

Fruits scalded in 45 percent CaCl_2 were firm and possessed an attractive red color. During the CaCl_2 scalding process, the peel separated from the fruit and exposed the outer portions of the fruit to the high calcium concentration in the solution. These tissues were firmed by the apparent reaction of the calcium with the fruit pectins forming calcium pectate. This prevented sloughing of the outer portion of the pericarp and greatly reduced weight loss and exposure of the vascular bundles.

According to McCollum (12), the total carotenoids are highest in the outer portion of the pericarp wall. The

Table 1. Percent peel removed and weight loss by standard hot water treatment

| Variety | Temperature ($^\circ \text{F}$.) | Time seconds | Percent peel removed | Weight Loss, percent |
|-----------|------------------------------------|--------------|----------------------|----------------------|
| Chico | 212 | 90 | 25 | 17.0 |
| Homestead | 212 | 90 | 48 | 10.5 |

retention of these highly pigmented cells and the lack of exposed underlying vascular bundles would explain the more attractive red color of the CaCl_2 -scalded fruits.

The fruits scalded in water were slightly softer than those scalded in NaOH solution and were considerably softer than those scalded in CaCl_2 solution. The color of the fruits was similar to that of the NaOH-treated fruits. The outer tissues were softer and sloughed readily.

Effects of Thermal Processing

Samples of fruits peeled by the methods discussed in the previous section were used in this test. The bottom cover photo illustrates fruits of the Homestead variety peeled by three methods, canned and stored for 3 months. The fruits subjected to the NaOH and water treatments appeared similar, but the water-treated fruits were softer and lost moisture rapidly. This can be noted by the moisture circles that appear around the fruits in the bottom photo.

The CaCl_2 -treated fruits were very firm and held their shape similar to that of fresh fruits. The color was attractive and there was little evidence of thermal softening. The cover photos illustrate the small quantity of moisture lost by the CaCl_2 -treated fruit.

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