# Lye Peeling of Apples Improved by Wax Solvents

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## SUMMARY

Apple peel wax interferes with the penetration of alkali during lye peeling. Wax solvents, such as ethanol or isopropanol, reduced the time and temperature required for lye peeling of apples. The wax solvents may be used prior to lye treatment or incorporated in the lye bath.

## INTRODUCTION

The usual peeling method used by apple processors is the mechanical knife. This involves much hand labor and the loss of 15% or more of the apple as peel. The apple lends itself rather uniquely to this method, and pressing the peels and cores recovers part of the peeling waste as by-products.

In contrast, it should be noted, caustic or lye peeling is widely used by food processors for a few fruits and most vegetables. Mazzola (1943) showed that caustic peeling was more economical than any other method in the saving of waste and labor for vegetable processing. Olsen (1941) reported that wetting agents improved lye peeling of peaches. Lankler and Morgan (1944) reported on the use of chemical wetting agents and demonstrated that alkyl aryl sulfonate considerably improved caustic peeling of apples by reducing the time for lye action and peel removal. Other aspects of the application of lye peeling were discussed by Woodroof *et al.* (1948).

The present study shows that alcohol (ethyl or isopropyl) used as a dewaxing agent greatly improves the lye peeling of apples.

## METHODS

Apples of the following varieties were obtained from roadside markets in New Jersey, Pennsylvania, and Virginia: Cortland, Golden Delicious, Rhode Island Greening, Jonathan, Rambo, Smokehouse, and Winesap. The fruit was firm ripe, 2½–3 inches in diameter, and relatively free of surface defects.

The peeling and dewaxing solutions were prepared from commercial grade sodium or potassium hydroxide, technical grade ethanol or isopropanol, and tap water. Alkali percentages are expressed as weight per volume, and the alcohol percentages as volume per volume of final solution. The temperature of the peeling solution was maintained within 5°F of the desired temperature with a large water bath.

Following the lye treatment, the apples were placed in cold running water (50–80°F) and the peel removed by one of three methods: a) by rubbing the skins off by hand; b) by brushing under water by a rotating brush; or c) spraying with jets of water. Brushing or spray washing are preferred, and can be objectively controlled and timed. The peeling time is the minimum time for removing 95–100% of the peel. The yield of peeled product was determined by weighing the fruit before and after peeling.

## RESULTS AND DISCUSSION

Apples were peeled by immersion in various combinations of NaOH and ethanol at 120°F (Fig. 1). This mild

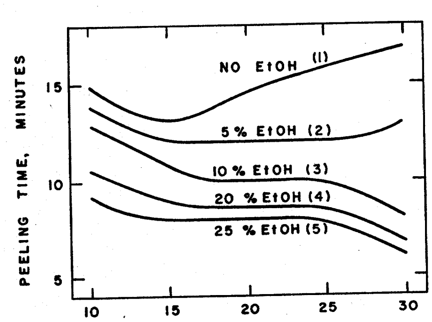


Fig. 1. Effect of lye and lye-ethanol concentrations on peeling time at 120°F.

temperature was selected to prevent heat softening of the fruit and to ensure that the skin digestion was due principally to caustic action. Curve

Table 1. Two-step peeling.[a] Dewaxing by alcohol prior to lye peeling.

| Dewaxing treatment | | Peeling treatment 20% NaOH | | Yield of peeled product [b] (%) |
|---|---|---|---|---|
| Time, min | Temp., °F | Time, min | Temp., °F | |
| 95% ethyl alcohol | | | | |
| 1.0 | 154 | 4.0 | 140 | 91 |
| 0.5 | 160 | 2.5 | 140 | 90 |
| 0.5 | 170 | 2.5 | 140 | 92 |
| 0.33 | Boiling | 3.0 | 140 | 92 |
| 98% isopropyl alcohol | | | | |
| 1.0 | 140 | 4.0 | 140 | 93 |
| 1.0 | 150 | 3.0 | 140 | 90 |
| 0.5 | 160 | 3.0 | 140 | 94 |
| 0.33 | Boiling | 2.5 | 140 | 95 |

[a] The apples were removed from the alcohol dewaxing step and placed directly in the lye peeling solution.
[b] Immediately after lye treatment the peels were removed by a jet spray rinse. The product was smooth and firm.

1, showing reaction time required for apple peeling with various lye concentrations, indicates that, for lye only, 15% is the most efficient concentration. Curves 2, 3, 4, and 5, for alcoholic-lye, show improved apple peeling effectiveness by reduction in peeling time. The amount of reduction was almost proportional to the added alcohol content when the lye concentration was below 15%. If the lye concentration was approximately 25–30%, the initial alcohol effect was much greater; however, it fell off rapidly as the alcohol content increased above 15%. In the range of 20% lye and 20% alcohol, small changes in either or both components did not greatly affect the peeling time, and these concentrations were used for much of this study.

Fig. 2 shows peeling improvement

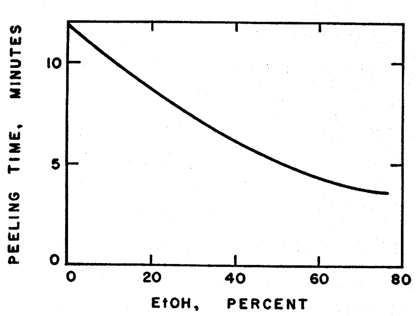


Fig. 2. Effect of varied ethanol content in 20% potassium hydroxide on peeling Cortland apples at 120°F.

when various amounts of ethyl alcohol were added to a 20% potassium hydroxide solution at 120°F. Seventy percent ethyl alcohol increased peeling efficiency threefold for Cortland apples.

In other trials, Rambo and Jonathan varieties were peeled in 1 min with a mixture of 30% KOH and 60% ethyl alcohol at 160°F, but Stayman Winesap required approximately 2 min.

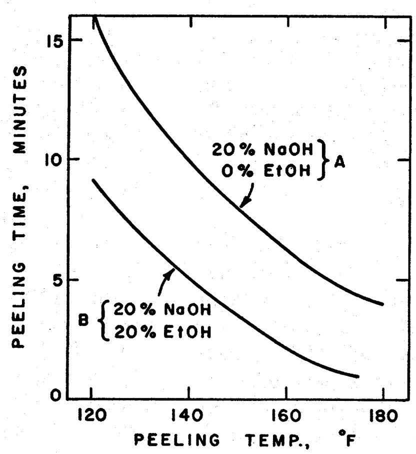


Fig. 3. Comparison of apple peeling efficiency at varied temperatures for lye and alcoholic-lye.

Fruit softening is a function of both time and temperature; it can be avoided by reducing peeling time.

Fig. 3 compares apple peeling efficiency of 20% lye with or without 20% ethyl alcohol over a range of temperature from 120 to 180°F. As the temperature increased, peeling time was reduced, and at 160°F, alcoholic-lye required only 2 min whereas lye required 6 min. The peeling of chilled fruit by alcoholic-lye may require extra time of ¼–½ min, but a smooth and firmer product usually results. Over the peeling temperature range studied, product yields for alcoholic-lye were 90% or greater.

Chemical apple peeling can be advantageously separated into a dewaxing step followed by lye treatment; then time, temperature, concentration, and methods of application for each process step can be varied and controlled separately. Table 1 shows the effects of varied dewaxing treatments using either ethyl- or isopropyl-alcohol at different temperatures but the peeling under similar conditions of temperature and lye concentration. The dewaxing time for both alcohols was reduced by increased temperature, and under the conditions used there was a minimum of fruit softening and peeling loss.

It should be noted that the dewaxing capacity of alcohols is reduced as they become diluted. If dilution occurs, isopropanol can easily be restored to an effective dewaxing concentration (above 70%) by adding alkali, either as a solid or concentrated liquid. Alkali extracts water from the isopropanol, which forms a separate phase. For example, isopropanol will form a separate upper phase over a lye solution containing 10% or more alkali. Such separations do not occur with ethyl alcohol until the alkali content is more than 30%. However, concentrated ethyl alcohol-lye combinations work well as a separate dewaxing-initial peeling step if followed by a separate alkali peel digestion step. For example, apples first dipped for 20–30 seconds in a mixture of 60% ethanol and 30% NaOH at 160°F, then immersed for 2 min in 15% NaOH at 160°F, gave an excellent peeled product of over 90% yield.

Apples were also dewaxed by condensing saturated vapors of ethanol or isopropanol on the fruit. This was accomplished by holding the fruit about 30 seconds in a refluxing chamber above the boiling alcohol. The dewaxed apples were then peeled by lye in a second step process.

Other dewaxing solutions such as ethyl acetate, methyl alcohol, or benzene are not recommended, because they are either toxic or produce off-flavors in the product.

Since little could be done to alter the softening effects of heat on unpeeled apples, this laboratory study was directed toward reducing the heat-time requirements for peeling such that a smooth and firm peeled product resulted. Alcohol and lye losses per unit of peeled product were not determined.

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