LOW SULFUR DIOXIDE STABILIZATION OF FRESH APPLE SLICES

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Sometimes a research project does not develop as expected, but progress and discoveries are made along an entirely different line. This was exemplified in a study undertaken at our laboratory recently. A newly discovered buffer treatment developed in the laboratory consisted of cutting fresh apples in the absence of air and soaking them in a buffer solution at pH 7.8-9.0 before storing them at 34°F. To determine the feasibility of retarding browning in dried apples by this procedure, we peeled, cored, and sliced some apples and soaked them in a 0.25% dibasic potassium phosphate buffer solution for five minutes, then dehydrated them at 150°F. to 25% moisture. As the apples dried they didn't remain light, as it was hoped they would, but instead they turned brown. After extensive investigation into other buffering treatments and times, it was concluded that this buffer treatment wasn't applicable in the processing of dehydrated apples.

Most treatments to prevent browning in apples make use of sulfur dioxide. Apples that are to be frozen are dipped in a sodium bisulfite solution (0.2-0.4%) or a solution containing SO_2, then they are usually treated in a salt brine under vacuum. For sliced apples that are not to be frozen, only a sulfur dioxide dip is used. This dip keeps the cut apple light in color for a limited period, depending on the concentration of sulfur dioxide and the storage temperature. The sulfur dioxide treatment, however, imparts an unpleasant taste and, especially in higher concentrations, decreases the crispness of the apples.

Bakers use a substantial quantity of fresh apples for processing into pies, tarts, turnovers, etc., so we decided to see if a buffer treatment would be advantageous for the apples used in these products. Bakers usually hold the unfrozen apples at 30-40°F. up to three or four days. The treatment with buffer solution mentioned above is not effective in retarding browning if the apples are peeled and sliced in air; the short exposure to air evidently initiates oxidative browning before the buffer can prevent it. But a procedure in which air is excluded is deemed commercially impractical. Therefore, we tested a method involving dipping the peeled apples in a bisulfite solution (0.25% $NaHSO_3$), followed by soaking for five minutes in 0.20% K_2PO_4 solution.

Materials and Methods

Pippin and Winesap apples were obtained from a commercial source. They were peeled and cored on a Bonanza* apple peeler equipped with stainless-steel knives, then cut into twelve

*Reference to a company or product name does not imply approval or recommendation of the product by the U.S. Department of Agriculture to the exclusion of others that may be suitable.

wedges each by a stainless-steel radial-knife slicer. The apples were then dropped into the following solutions:

A. 0.25% $NaHSO_3$ for 45 seconds

B. 0.25% $NaHSO_3$ for 45 seconds and then 0.2% K_2HPO_4 (pH 8.8) for 5 minutes

C. 1% $NaHSO_3$ for 45 seconds

After treatment, the apples were held at 34°F. in polyethylene bags until analyzed for color, flavor, and crispness.

Color and flavor changes were evaluated subjectively. The crispness of the wedges was measured on a laboratory-developed device (Figure 1) which indicates the degree of flexibility of the apple wedges. The wedges were placed on a grooved platform having a 32-mm. gap in the middle, and pressure was applied to the center of the wedge, perpendicular to its surface. The force required to produce a 1-mm. deflection was measured with Chatillon Gauge -R No. 516-100, which gives a maximum reading of 1000 gm.

The sulfur dioxide content was determined by the procedure of Ponting and Johnson.

Results and Discussion

Apples treated by the combination of bisulfite and buffer remained light-colored for four weeks in cold storage, but those that had been rinsed in water after the bisulfite treatment darkened rapidly (Figure 2).

The combination bisulfite-buffer treatment maintained excellent crispness in Pippin apples. A force of more than 1000 grams was required to bend these apple wedges 1 mm., even after three weeks storage at 34°F. Apple wedges that had been dipped only in a 0.25% $NaHSO_3$ solution, without subsequent buffer treatment, lost their crispness almost immediately (Figure 3). A 1.0% $NaHSO_3$ dip softened the wedges even more than did the 0.25% $NaHSO_3$ treatment. Winesap apples that underwent the bisulfite-buffer treatment also maintained a better texture than those dipped in bisulfite alone (Figure 4).

The bisulfite-buffer treatment does not mask the apple flavor. A panel of fifteen judges evaluated flavor one hour after the apples were treated; they indicated an 85% preference for the bisulfite-buffer-treated apples over those treated with only 0.25% $NaHSO_3$. After the apples had been in cold storage for 2 weeks, 100% of the panel preferred the bisulfite-buffer treated apples.

Sulfur dioxide analyses indicated that no SO_2 was present in the bisulfite-buffer-treated apples, in contrast with up to 76 ppm in the treated apples that had not been soaked in buffer. The rinsing action of the buffer must free the apples of SO_2.

Apples dipped in 0.25% and 1.0% $NaHSO_3$ developed a wet, slippery surface. In contrast, the apples which had been treated in bisulfite and then buffer maintained a natural rigid surface.

These studies suggest that a practical commercial process for the treatment of fresh apples to be held in cold storage should involve a combination bisulfite-buffer treatment. Apples so treated maintain excellent color and texture for at least three times as long as those produced by present commercial processes, and the flavor is substantially better. Thus research that began on dehydrated apples ended teaching us something about cold storage.

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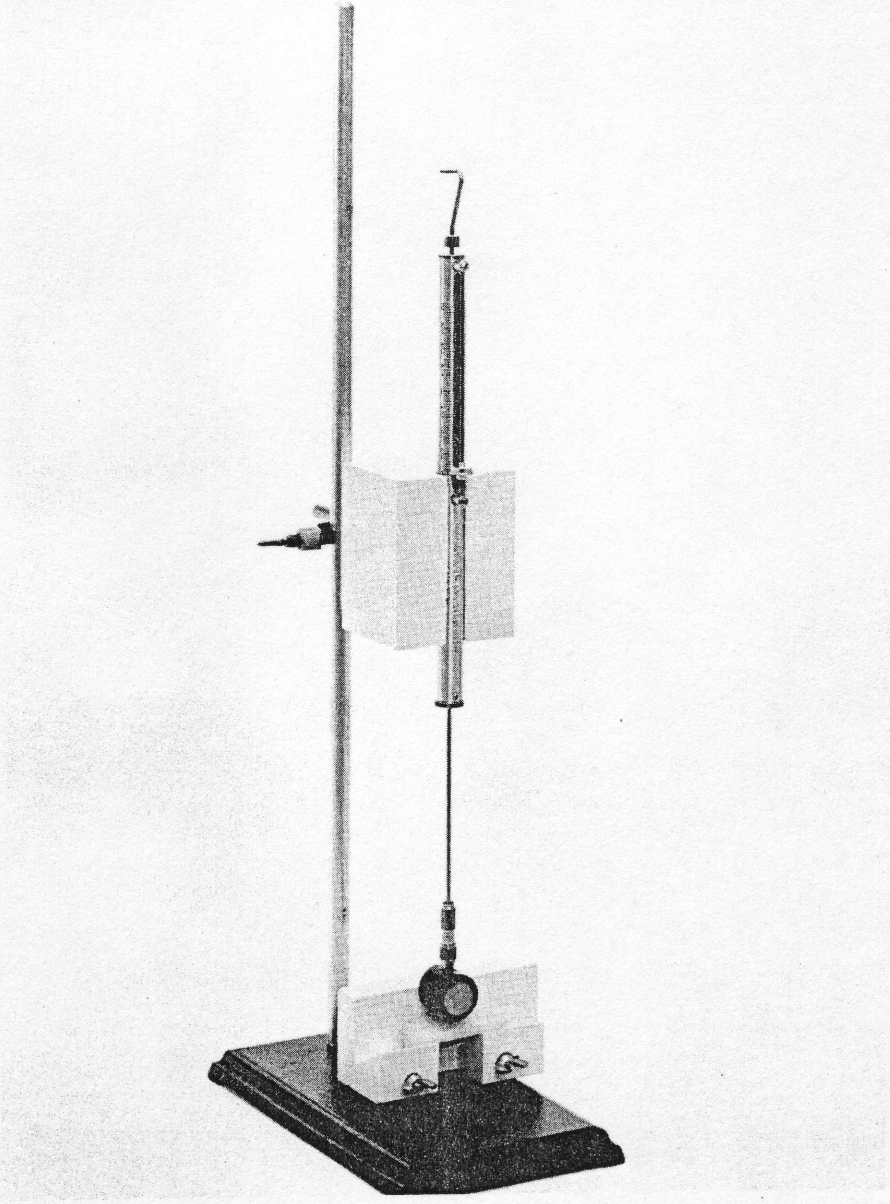

Figure 1. Instrument used to measure apple crispness.

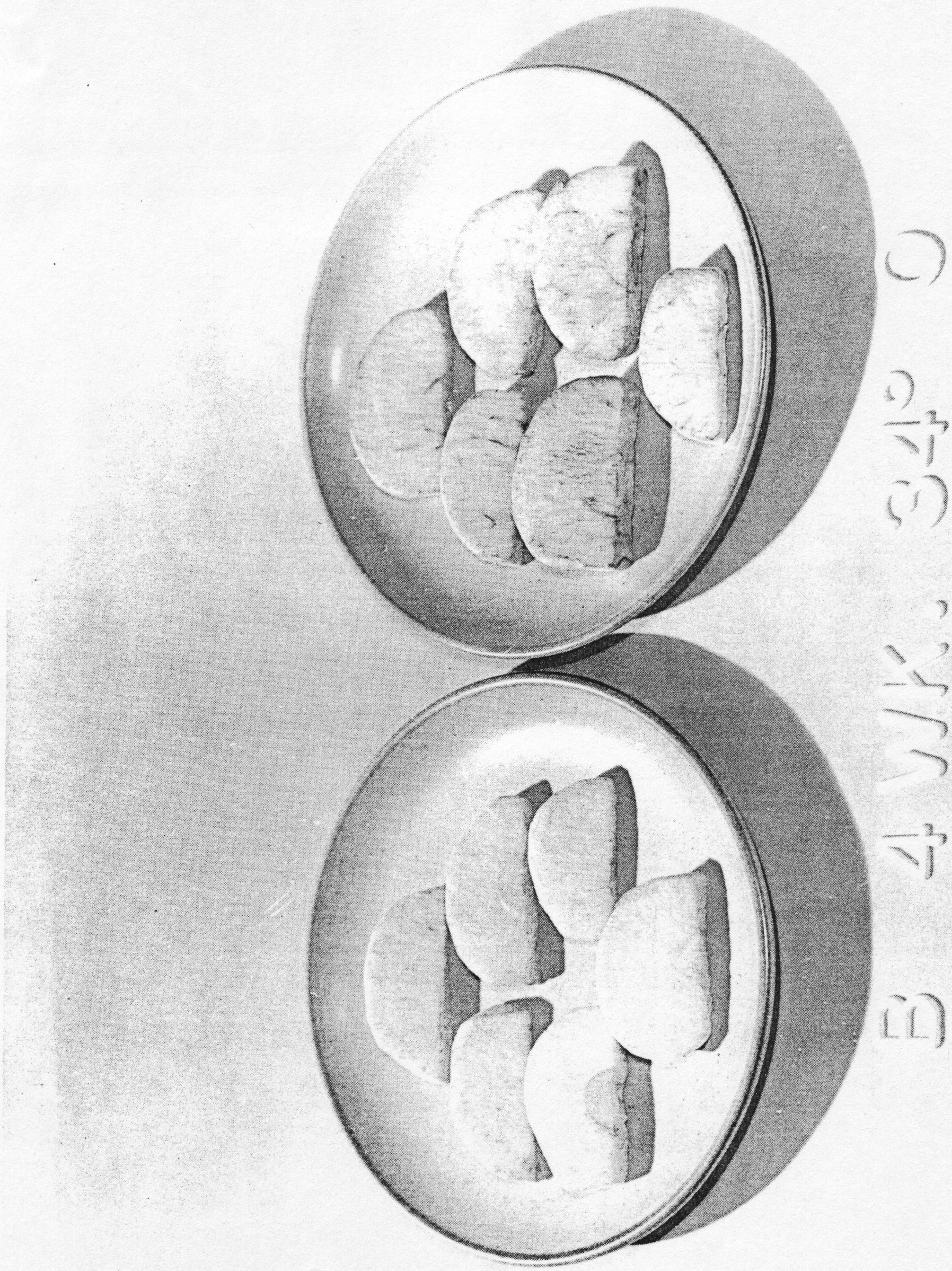

Figure 2. Treated apples: B - bisulfite then buffer; O - bisulfite then water.

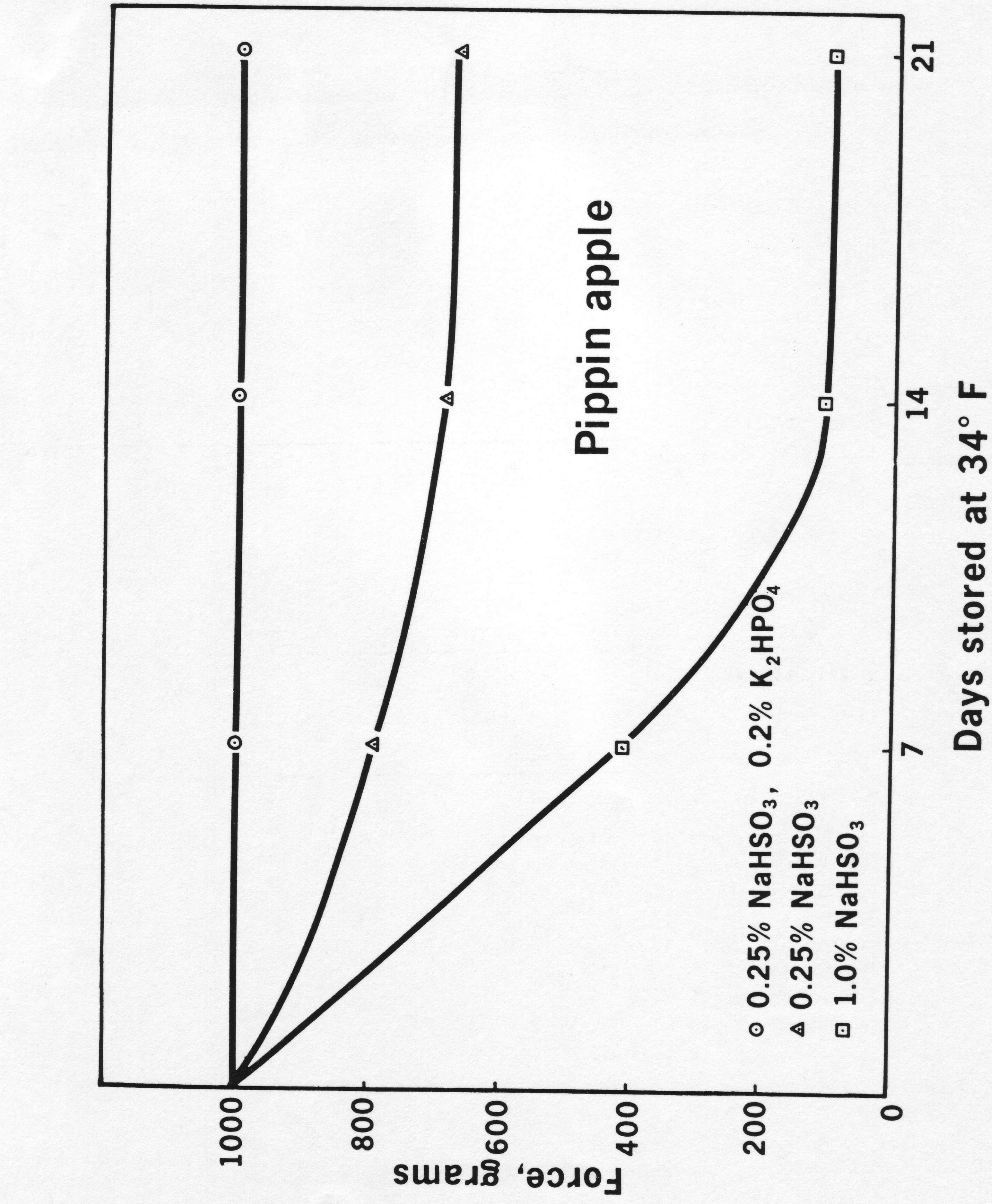

Figure 3. Crispness of treated Pippin apple wedges.

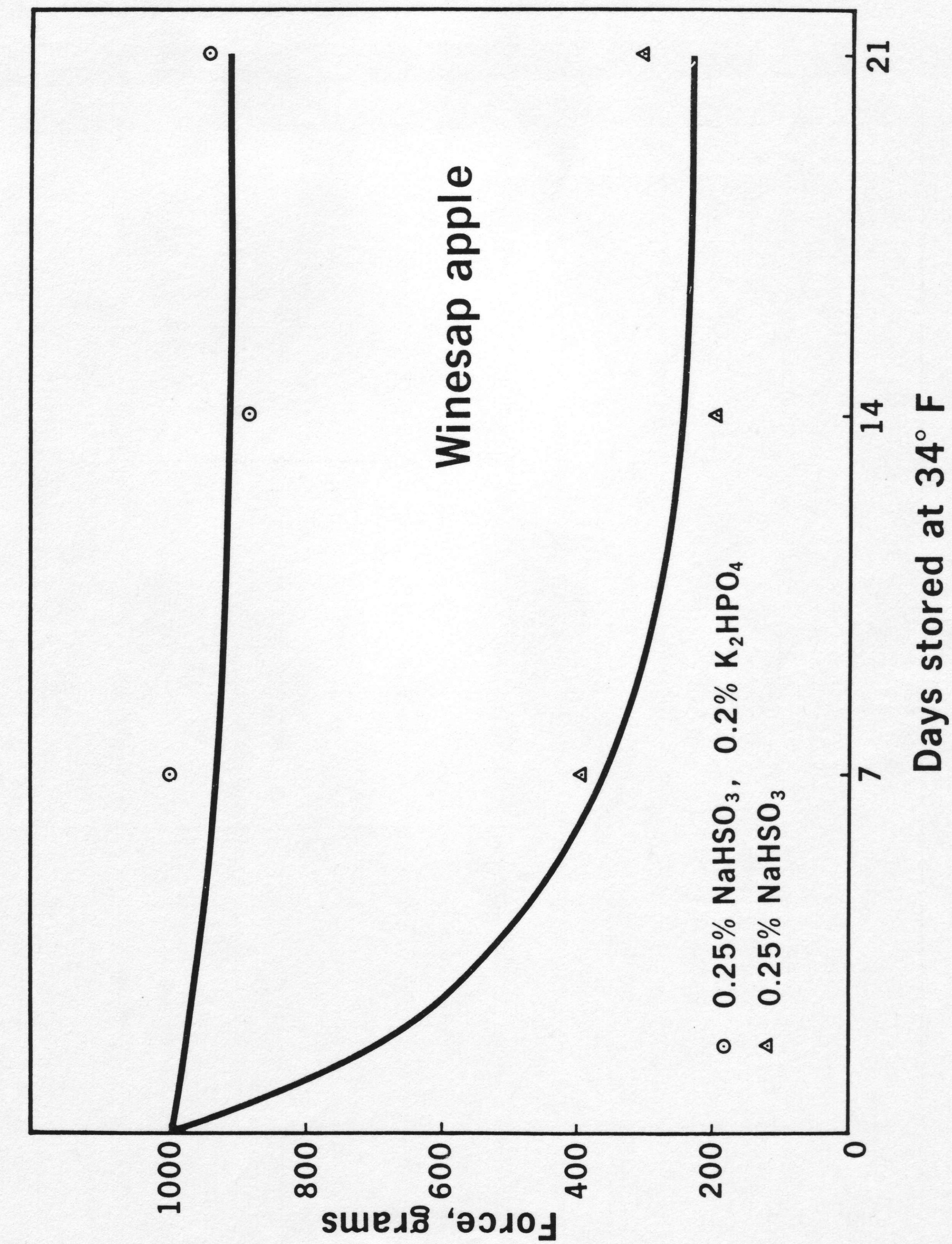

Figure 4. Crispness of treated Winesap apple wedges.