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Effect of Cucumber Holding Time and Temperature on the Quality of Pasteurized Fresh Whole Pickles[a, b]

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Development of the fresh cucumber pickle [described by Fabian and Switzer *(2)*], and the growing demand for this product has resulted in radical changes in many operating procedures of the pickle industry. As the quantity of glass-packed fresh cucumber pickles has increased, attention has been focused on the quality problem as related to appearance. Dirty, scuffed-appearing skin areas and an unnatural color have particularly troubled processors. Since the scuffed areas have the appearance of a scrape or other skin damage, processors have attributed this defect to rough handling; however, holding cucumbers too long after harvest and before processing also has been observed to cause quality deterioration. Before this quality problem can be eliminated, the causative factors must be determined and evaluated. The purpose of this experiment was to determine the relationship between the time and temperature at which fresh cucumbers were held and the quality of the resultant pickles.

EXPERIMENTAL METHODS

The experiment was designed as a split plot factorial with the major split for time of harvest and a second split for holding temperature. The latter was a precaution against possible variations of the holding conditions.

Ten bushels of cucumbers of the variety SR-6 measuring 1 1/16 to 1 1/4 inches in diameter were obtained on two harvest dates from a commercial field, brought into the laboratory and divided into 10 representative lots. Cucumbers in one lot were immediately packed while the remaining 9 lots were randomized and placed in temperature controlled rooms. Samples for all holding times were completely randomized in each room. Relative humidity in the rooms was not controlled and varied from 60 to 85%. Cucumbers were held before packing as indicated below:

Lot number	Holding time after grading hours	Holding temperature ° F.
1	0	Control
2	24	40
3	24	60
4	24	80
5	48	40
6	48	60
7	48	80
8	72	40
9	72	60
10	72	80

At the conclusion of the storage period, 12 jars of whole fresh dill cucumber pickles were packed from each lot.

Procedure used in packing the cucumbers was essentially that outlined by Esselen *et al. (1)*. The fresh cucumbers were soaked for 20 minutes in 120° F. water, drained, and placepacked in 32 oz. glass jars; one ml. of a mild kosher dill essential oil mixture[c] was added to each jar after which they were filled with a brine containing 12 grains (1.2%) acid and 5% salt. The jars of cucumbers were pasteurized in a 180° F. water bath for 40 minutes and cooled with a cold water spray. Jars were stored at room temperature in closed cases.

Four months after packing, 200 jars (10 jars from each treatment for each harvest) were rated for "in-the-jar" quality. Five jars of pickles which were subjectively judged *excellent, good, fair, poor* and *very poor* and numerically rated 9, 7, 5, 3 and 1, respectively, were used as standards. The experimental pickles were evaluated and numerically rated by comparing each jar with the standards. F tests were made with individual degrees of freedom to determine whether or not the relationships of quality to holding temperature and holding time were linear.

Eight months after packing, the pickles were evaluated for color, skin texture, flavor, and acceptability for commercial use. A panel, consisting of 5 persons experienced in judging pickle quality, rated 8 jars from each treatment. An individual analysis of variance was made for each quality factor. The F value for each of the differences discussed is significant at the 1% level.

A test was conducted to determine whether any difference due to treatment could be observed by consumers. A small consumer panel was given slices of the control sample and the sample held 72 hours at 80° F. in a triangular presentation.

RESULTS

Results of both the "in-the-jar" and internal quality ratings are summarized in Table 1. The observed effect of holding time and temperature on "in-the-jar" quality is illustrated in Figure 1. The quality of fresh whole pickles made from cucumbers held at varying times and temperatures was lower than the quality of the controls. The quality of pickles made from cucumbers held at 80° F. was lower than those held at 40° F. for corresponding time periods; however, the quality of cucumbers held at 40° F. was not reduced when the holding time was increased from 24 to 72 hours. The quality of cucumbers held for 72 hours at 60° F. was lower than the quality of cucumbers held at 60° F. for 24 hours; and the quality of cucumbers held at 80° F. for 48 hours was lower than the quality of cucumbers

TABLE 1
Pickle quality ratings
(Each rating is the mean of 20 observations)

Treatment	"In-the-Jar" quality ratings[1]	Panel quality ratings[2]			
		Acceptability for commercial use	Flavor	Color	Skin texture
No storage	7.6	3.0	2.8	2.9	3.3
1 day, 40°	5.8	2.7	2.2	2.8	3.2
1 day, 60°	5.2	2.6	2.9	2.8	3.2
1 day, 80°	4.3	2.0	2.4	2.2	2.8
2 days, 40°	5.6	2.7	2.8	2.8	3.0
2 days, 60°	4.2	2.2	2.4	2.4	2.6
2 days, 80°	2.4	1.4	2.2	1.8	2.3
3 days, 40°	5.0	2.6	2.8	2.9	2.9
3 days, 60°	3.5	1.7	2.2	2.2	2.4
3 days, 80°	1.3	1.0	1.9	1.2	1.7
L.S.D. .01	1.2	0.45	0.38	0.45	0.38

[1] Rating scale: 1 = very poor; 9 = excellent.
[2] Rating scale: 1 = very poor; 4 = excellent.

[a] Journal Paper No. 1927. Michigan Agricultural Experiment Station, East Lansing, Michigan.

[b] Presented before the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 12, 1956.

[c] Provided by the Wm. J. Stange Company.

held at 80° F. for 24 hours. Ratings for time-of-holding and temperature-of-holding treatments changed in a linear manner. The quality of the pickles decreased uniformly as the temperature increased and as the time of holding became longer.

Averages of ratings by the experienced panel (Table 1) indicate differences between treatments on the basis of color, skin texture, flavor and acceptability for commercial use. These results are comparable to the ratings for external quality, with

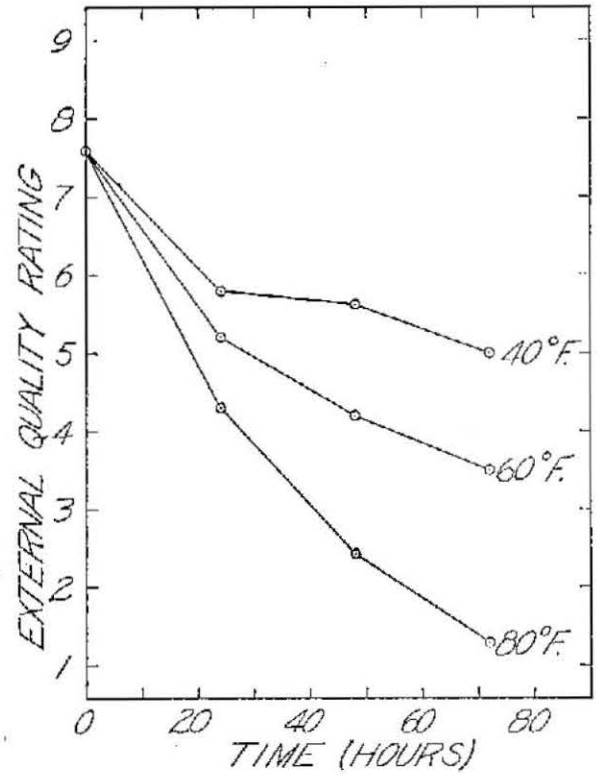

Figure 1. Observed effect of holding time and temperature on "in-the-jar" quality of fresh whole pickles.

the same differences present in both sets of data. It was found in this experiment that the two harvest dates yielded pickles of similar quality.

The consumer panel was not able to establish a difference on the basis of flavor between the control samples of pickles and pickles made from cucumbers held for 72 hours at 80° F.

DISCUSSION

Delay in precessing fresh cucumbers of the variety SR-6 into fresh whole dill pickles had a detrimental effect on quality. Quality factors that were seriously affected by holding cucumbers before packing were skin color and texture, discoloration of spine spots, shrinking at the stem end, and loss of desired flavor. Deterioration of skin color, scuffed and dirty skin areas, and discoloration of spine spots have, in the past, been blamed on rough handling of the fresh cucumbers. Results of this study indicate that this "rough handling" injury may be due to an unfavorable combination of holding time and temperature. Observations of the packing methods of commercial processors indicate that pickles made from cucumbers held for several days at high temperatures before packing are poor in appearance.

There appear to be several practical ways for the processor to avoid or substantially limit quality deterioration due to holding cucumbers too long at too high a temperature before packing. An awareness of the deleterious effect of holding cucumbers, coupled with the scheduling of sequential operations from field to bottling line, is undoubtedly the simplest measure. In a plant where cucumbers are both salted and fresh-packed, the versatility of the salting operation should permit effective scheduling of fresh cucumbers to the bottling line. A 40° F. refrigerated storage may be essential in plants that operate 2 shifts per day for 7 days per week during the cucumber season, if the plant is to operate at top capacity with minimum quality deterioration.

Results of this experiment indicate that it may be possible to predict the processed quality of a lot of cucumbers by knowing the length of time and average temperature at which they have been held. Any of several methods might be used to make this prediction. One of the alternatives to be considered is put forth here and is illustrated in Figure 2. The graph line, developed from data obtained in this experiment, represents an arbitrarily chosen quality rating. It divides the chart into two parts or areas. The area below and to the left of the line includes all holding conditions which will allow pickles of acceptable quality to be produced.

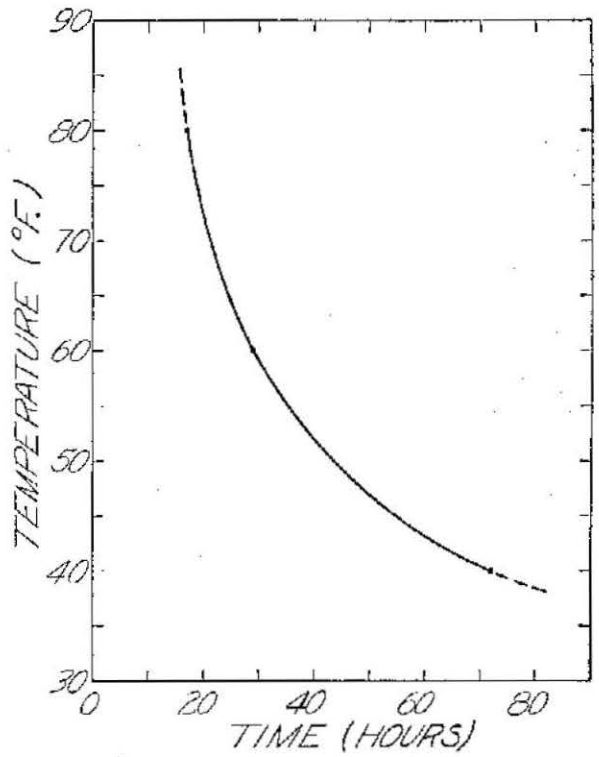

Figure 2. A graphic method of determining the permissible holding times and temperatures to produce pickles of a quality rating of 5.0 (fair).

The area above and to the right of the curve includes the conditions which will not allow pickles of desirable quality to be produced. Thus, the line is an artificial breaking point. To use this method, it would be necessary for the packer to choose a quality standard to be considered as the minimum acceptable level of quality in

the finished product. Then a chart similar to Figure 2 would be constructed to show the holding conditions required to allow production of the desired quality. This proposal is preliminary. There is not sufficient data available to show the effects of season, location, and variety on the response of cucumbers to storage.

SUMMARY

A study was made to determine the effect of holding SR-6 variety cucumbers on the quality of the whole fresh dill pickles. Cucumbers held for 24 hours at 40° F. before packing were rated lower on "in-the-jar" quality than the immediately packed controls. Increasing the holding time and temperatures of the cucumbers resulted in further uniform deterioration of quality. Color and general appearance were most affected, although undesirable changes of flavor were observed in pickles made from cucumbers held for 72 hours at 80° F. before packing. This flavor difference was not detected by a consumer panel.

Quality loss due to holding cucumbers at too high a temperature for too long a time can be minimized by proper scheduling of the packing operation. Packers who must hold cucumbers for several days may have to resort to refrigeration to maintain quality.

A method of predicting pickle quality based on cucumber holding time and temperature is presented. The method is preliminary since effects such as seasons, locations, and varieties have not been fully investigated.

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LITERATURE CITED

1. Esselen, W. B., Anderson, E. E., Ruder, L. F., and Pflug, I. J. Pasteurized fresh whole pickles. I. Pasteurization studies. *Food Technol.*, 5, 279 (1951).
2. Fabian, F. W., and Switzer, R. G. Classification of pickles. *Fruit Products J.*, 20, 136 (1941).