Handling operations that contributed most to objectionable internal bruising injury were: harvesting and pouring into field box, dumping of field box at sorting station, and the filling of cartons during packing. The filling of cartons during packing accounted for the greatest increase of slight internal bruising (fig. 1).

The extent of objectionable and slight internal bruising, according to the handling procedures employed by each packinghouse, is shown in table 1. The relationship of external bruising to internal bruising is also shown. Differences were found among packinghouses in the amount of objectionable internally-bruised tomatoes after packing in cartons, ranging from 0.6 per cent in packinghouse No. 4 to 2.9 per cent in packinghouse No. 2.

No fruit had an objectionable internal bruising rating higher than 8. In fact, there were only five fruits with ratings higher than 6, four of which were in the samples obtained after the dumping of field boxes at the packinghouse; two of these had a rating of 7 and the others a rating of 8.

External bruising was generally high, especially at packinghouse No. 1, after harvesting and pouring into field boxes, transporting field boxes to packinghouses, and dumping of field boxes at sorting station. Graders detected most externally bruised fruit and eliminated it. Where externally bruised fruit was not eliminated by graders, the percentage of internally bruised fruit was higher, as noted in packinghouse No. 2.

Previous studies have shown that the extent of objectionable internal bruising upon arrival at terminal markets can range from 3 per cent for tomatoes arriving in a green stage to 60 per cent for those arriving in a firm-ripe or a pink stage.[1]

The present study indicates that only a slight percentage of internal bruising damage found in tomatoes at terminal markets was attributable to handling in the field and by the packers, prior to shipment.

Slight internal bruising is not commercially objectionable, but its presence at the packinghouse may, with further handling, result in objectionable bruising at the terminal and retail level. Since bruising injury is cumulative, attention should be given to careful handling during all operations, not only in transit and at terminal markets, but also during field and packinghouse operations.

[1]McCULLOCH, LACY P. 1962. Bruising Injury of Tomatoes. U.S.D.A. Marketing Research Report No. 513.

EFFECT OF STORAGE TEMPERATURES AFTER RIPENING ON THE COLOR, FIRMNESS AND PLACENTAL BREAKDOWN OF SOME TOMATO VARIETIES[1]

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Little emphasis has been placed on temperature effects on ripe fruits since ripe tomatoes are generally not stored. Parsons (3), Wright, *et al.* (4) and Hall (1) have studied the effects of storage at temperatures of below 50°F and have found that tomatoes store well for up to three weeks at 35°-40°F. However, fruits held at these low temperatures for long periods deteriorated rapidly when placed at room temperature.

The objectives of this study were to determine the effect on ripe tomatoes of storage at 50°, 59° or 68°F on certain quality factors and to determine whether there was a varietal response.

METHODS

Mature-green fruits of three varieties, Marion, Manapal and Homestead 24, and an advanced breeding line, Step 430, were ripened for 5 days at 68°F and then held at 50°, 59° and 68°F for 1, 2 and 3 weeks. The color, firmness and placental breakdown were determined at the end of each storage period including the 5-day ripening period at 68°F. Observations were made of general appearance. The fruits, obtained from Dr. J. M. Walter at the Gulf Coast Experiment Station, were harvested, transported to Gainesville and placed at 68°F on May 21, 1963. Three replications were used for each treatment.

[1]Florida Agricultural Experiment Stations Journal Series No. 1739. Appreciation is expressed to Dr. James M. Walter of the Gulf Coast Station for supplying the tomatoes.

Color, firmness and placental breakdown were determined as previously described (1), (2).

The relative humidity of the storages was 80% for 50°F, 80-85% for 59°F, and 85% for 68°F.

Results and Discussion

Effect on color: Statistical analysis showed the main effects of variety, temperature and storage period to be highly significant (Table 1). The variety-storage period and the temperature-storage period interactions were highly significant. The variety-temperature interaction and the variety-temperature-storage period interactions were not significant.

A considerable increase in color values occurred with all varieties during the first week followed by a small increase the second week and a small decrease the third week (Fig. 1). Marion had the highest color values throughout but lost color at a more rapid rate during the last week. Homestead 24 had lower color values than Manapal to begin with, but had higher values after 2 and 3 weeks storage. Step 430 had the lowest color values.

As would be expected, the most color developed at 68°F and the least at 50°F (Fig. 1). The difference in rate of color development was

TABLE 1. The F values for the treatments and the treatment interactions for firmness, color and placental breakdown.

	Color	Firmness	Breakdown
Variety (V)	283.1**	76.6**	279.4**
Temperature (T)	250.5**	69.3**	63.1**
Storage Period (S)	530.8**	497.0**	342.2**
V X T	1.5	0.8	1.2
V X S	4.4**	0.9	5.9**
T X S	36.9**	10.1**	9.4**
V X T X S	0.5	1.2	1.0

**Significant at 1.0% level.

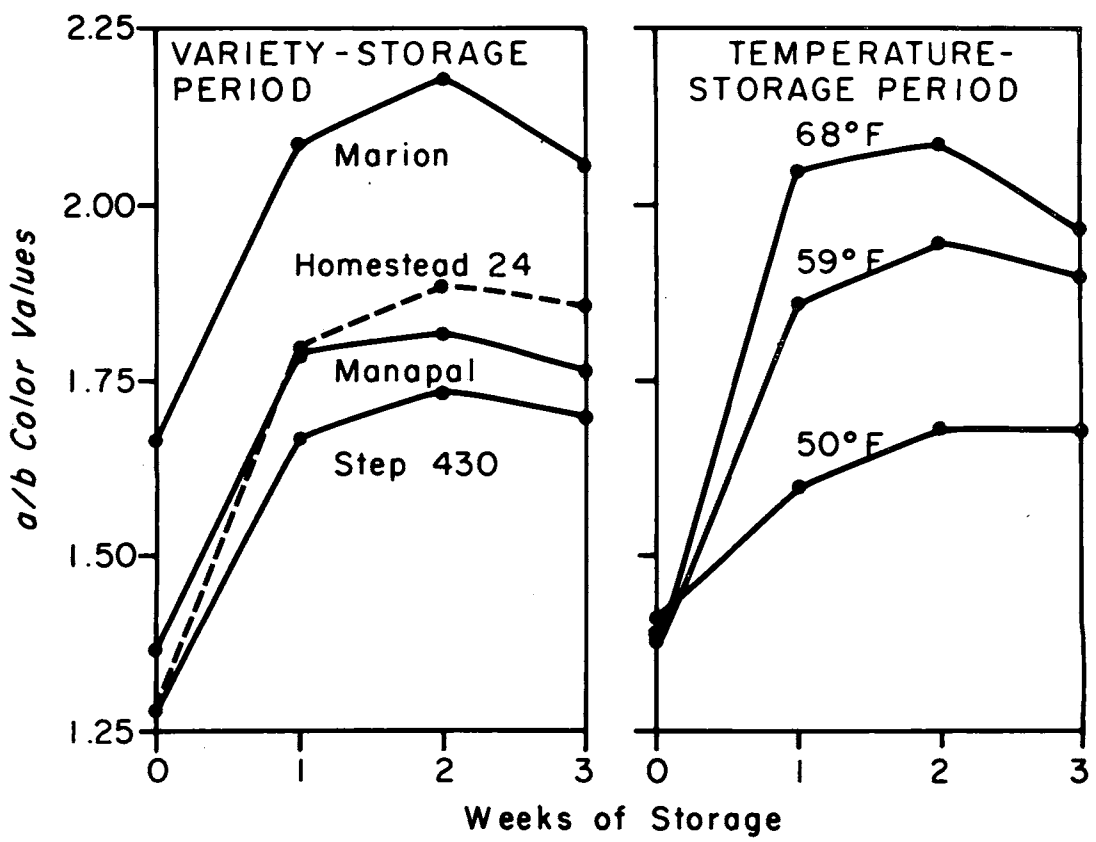

Figure 1.—The variety-storage period and the temperature-storage period interaction effects on the a/b color values of ripened tomato fruits. The higher the value the better the color.

greatest during the first week. The rate of color development fell off sharply at all temperatures during the second week of storage. At the end of the third week, the 50°F fruits had maintained their color, while fruits at 59° and 68°F had lower color values than at the end of the second week. The decrease in color value was much larger at 68° than at 59°F. That the 50° and 59° fruits did not continue developing color the third week (had not attained the color capability shown by the 68°F fruits) indicated the synthesis of color pigments within the fruit became slowed down or inoperative at the same chronological age irrespective of storage temperature.

Effect on firmness: Statistical analysis showed the main effects of variety, temperature and storage period and the temperature-storage period interaction to be highly significant (Table 1).

The variety means were 5.61, 5.25, 4.84, and 5.70 for Marion, Manapal, Homestead 24 and Step 430 respectively. Homestead 24 was significantly firmer than the other varieties. Manapal was firmer than Marion and Step 430, which were similar in firmness.

Considerable softening occurred during the first week of storage with the rate proportionately less at the lower storage temperatures (Fig. 2). An abrupt reduction in rate of softening occurred during the second and third weeks of storage.

Effect on placental breakdown: Highly significant effects were found for variety, temperature, storage period and the variety-storage period and temperature-storage period interactions (Table 1).

Marion had the most placental breakdown at all storage periods (Fig. 3). Manapal and Step 430 were similar to Homestead 24 at the beginning of storage but had more breakdown after 1, 2 and 3 weeks. The rate of change in breakdown was similar for Marion, Manapal and Step 430. Homestead 24 had a lower rate of change than the others.

The breakdown increased proportionately with temperature during the first week of storage. The rates were about the same during the second week. During the third week of storage, the rate was higher at 50°F and lower at 68°F than at 59°F.

Effect on appearances: At the end of the first week of storage all samples had good internal appearance with those at the lower temperatures possibly better than those at 68°F.

At the two-week sampling, the 68°F fruits were poorer in appearance than the 50°F and 59°F fruits. Marion had the poorest appearance and Homestead 24 had the best with Manapal and Step 430 being intermediate. There was a tendency for the skin to slough on Step 430 fruits held at 68°F when the fruits were sliced.

At the three-week sampling, all the 68°F fruits except Homestead 24 had a poor internal appearance. Manapal and Step 430 tended toward graininess of the flesh. The skin of Step 430 fruits sloughed badly.

The 59°F fruits of Manapal, Marion and Step 430 were better appearing than the 68°, but were still poor appearing. Homestead 24 had the best internal appearance with the locules retaining a better structure and appearance and the inner tissue being firmer. The skin of Step 430 fruits sloughed at this temperature also.

The 50° fruits had a better internal appearance than the 59° and 68°F fruits. Homestead 24 had the best appearance. Marion was slightly better than Manapal with Step 430 being better than either.

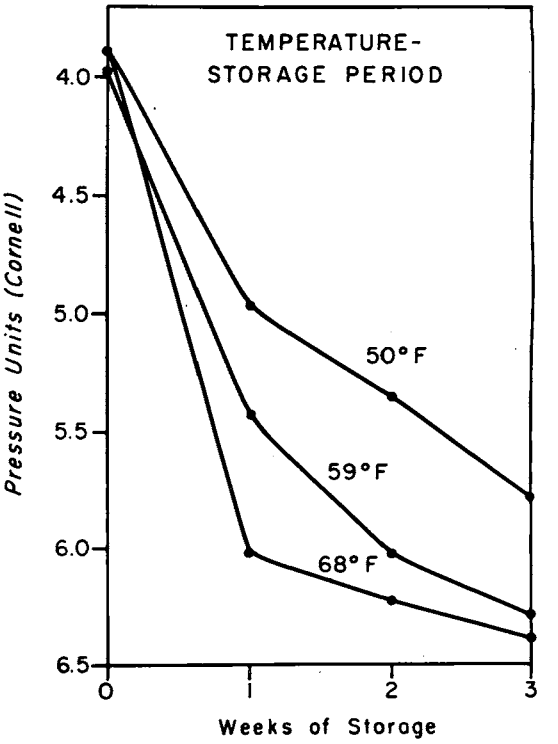

Figure 2.—The effect of temperature and storage period on the firmness of ripened tomato fruits. The lower the value the firmer the fruit.

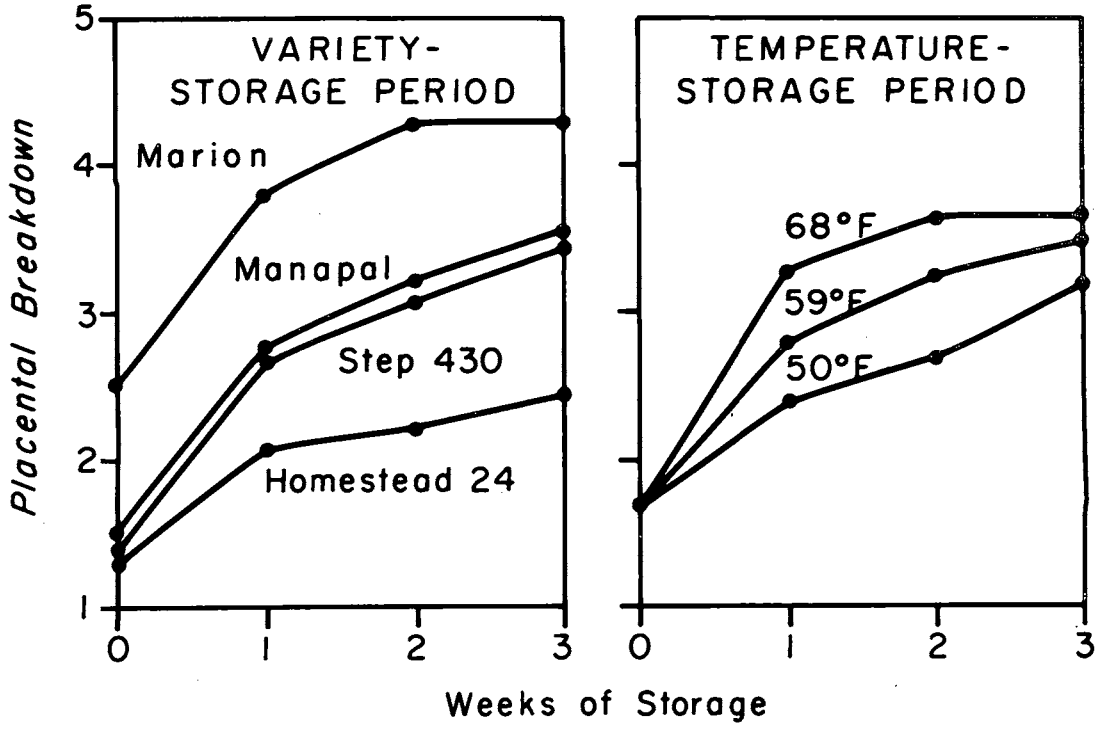

Figure 3.—The variety-storage period and the temperature-storage period interaction effects on the placental breakdown of ripened tomato fruits. Ratings are on a basis of 1 to 5 with 1 indicating no breakdown and 5 severe.

There was much shriveling of Manapal, Marion and Homestead 24 at 68°F with less at 59° and little at 50°. Step 430 was less subject to shriveling.

SUMMARY

Ripened fruits (turned 5 days) of Manapal, Marion, Homestead 24 and Step 430 were stored at 50°, 59°, or 68°F for 1, 2 or 3 weeks. Color, firmness and placental breakdown were determined at the end of each storage period.

The main effects of variety, temperature and storage period and the temperature-storage period interaction were significant for color, firmness and placental breakdown. The variety-storage period interaction was significant for color and placental breakdown.

The greatest changes in color, firmness and placental breakdown occurred during the first week of storage. The rate of change was much reduced during the second and third weeks. All varieties had lower color values after the third week of storage than after the second.

Storage temperature had an effect on the rate of change in color, firmness and placental breakdown with the greatest effect during the first week of storage.

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