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EFFECT OF TOMATO GRADE ON INCIDENCE OF DECAY DURING SIMULATED SHIPPING

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Abstract. **Extra-large, green tomatoes (cv. Sunny) of grades U.S. #1 Combination, U.S. #2 and U.S. #3 were retrieved after commercial packing at two Florida packinghouses (Packinghouse 1 and 2) 'Heritage' tomatoes from Packinghouse 3 were used for two other tests. For the first test with 'Heritage' the tomatoes had been harvested after a significant dry period while, for the second, the samples had been harvested after a rainy period. Samples of 'Heritage' were taken prior to and after immersion in the packinghouse dump tank. Dump tank water contained 50 or 100 ppm free chlorine at pH 7 and 40°C. Five cartons (11.3 kg each) of each grade were stored at 20°C and evaluated for incidence of decay in the subsequent 14 days. For Packinghouse 1 and 2, five cartons of 'Sunny' tomatoes of each grade were inoculated with *Erwinia carotovora* subsp. *carotovora* (Jones) Bergey et al. in a simulated dump tank before storage at 20°C. The incidence of decay was higher for grades #2 and #3 than for #1 fruits from all packinghouses. After 14 days storage, inoculated tomatoes from Packinghouse 2 had 0.7%, 10.5% and 13% decay for #1, #2 and #3 grades, respectively, while tomatoes from Packinghouse 1 had 0.4%, 0.7% and 1.5% for the same grades. The primary site of infection was mechanical injury (88.2%), of which 82.4% was due to fungi (mostly *Alternaria alternata* (Fr.:Fr.) Keissl.) and 17.6% was due to bacteria (*E. carotovora* subsp. *carotovora*). The second most common site of infection was stem and blossom-end scars (11.8%). Overall, fungi accounted for higher incidence of decay than bacteria. Inoculation with *E. carotovora* subsp. *carotovora* increased the incidence of decay to a greater extent in #2 and #3 grade fruit than in #1 fruit.**

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The U.S. Department of Agriculture (Standards for Grades of Fresh Market Tomatoes) defines the requirements for each of the grades packed by Florida shippers (U.S. Dept. Agric., 1991). Increased pressure is being brought on the federal government to reduce the grade standards relating to "cosmetic" blemishes, such as color and scars, in order to further reduce the use of pesticides during production. A comprehensive review of U.S.D.A. market inspection records in New York revealed that disease was the major cause of rejected tomato shipments (Ceponis et al., 1986). We report on preliminary investigations concerning the incidence of decay and the susceptibility of the three tomato grades to bacterial soft rot (*E. carotovora* subsp. *carotovora*), with the assumption that the lower the grade, the more likely the fruit will have surface blemishes that promote postharvest decay.

Materials and Methods

Four tests were conducted between April and July, 1992. In the first two tests, ten cartons of packed tomatoes (cv. 'Sunny', Extra Large size) for each grade were retrieved from two packinghouses in the Palmetto/Ruskin area. Five cartons were placed directly at 20°C (68°F) for ripening with no ethylene treatment, fruits from the other five cartons were immersed for one minute in 35°C (95°F) water previously contaminated with 1×10^6 cfu/ml of *E. carotovora* subsp. *carotovora* (Florida strain SR 38) prepared according to Bartz (1988). Treated fruits were dried, re-

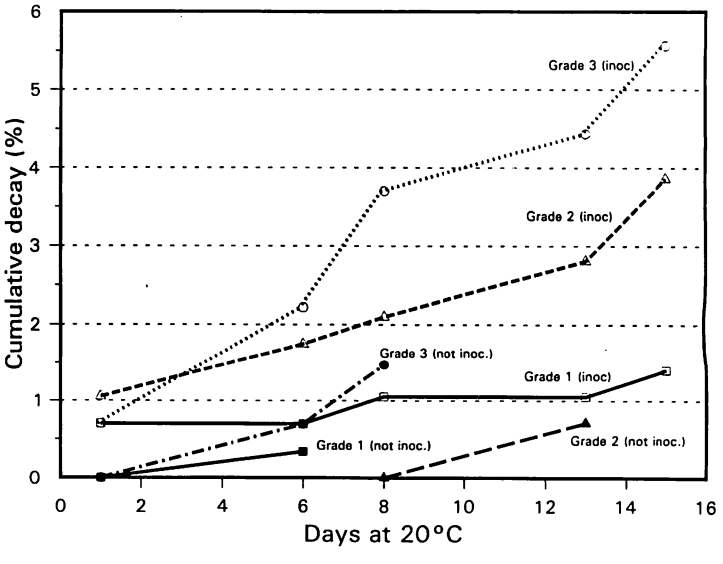

Fig. 1. Cumulative decay for inoculated and noninoculated tomatoes during storage at 20°C (68°F). Packinghouse 1.

packed, placed at 20°C (68°F) and high relative humidity, and evaluated for incidence and source of decay during two weeks storage. Two other tests were made at one packinghouse in which noninoculated tomatoes were sampled at two locations: prior to immersion in the dump tank, and after being emptied into the dump tank. Dump tank water contained 50 to 100 ppm free chlorine at pH 7 and 40°C (104°F). The first sample consisted of tomatoes which were harvested after a significant dry period and the second sample was taken after a rainy period. At each sampling, four cartons of each grade were retrieved and returned to the laboratory for storage at 20°C (68°F) and determination of incidence and source of decay. At this time, tomatoes were treated with ethylene simulating commercial ripening. The concentration determined at the end of the 48 hour treatment period was 204 ppm. Soluble solids content of the juice from the tomatoes was measured using a refractometer, and acidity (expressed as percent citric acid) was measured by titration to pH 8.1 endpoint with 0.1 N NaOH.

Results and Discussion

In all tests, Grade #3 tomatoes had the highest incidence of decay, followed by #2 and #1 Noninoculated fruits had significantly less decay than inoculated. There were also differences in decay between packinghouses. For Packinghouse 1, noninoculated tomatoes had 0.3%, 0.7% and 1.5% decay for grades #1, #2 and 3, respectively (Fig. 1), while the same grades from Packinghouse 2 had 0.7%, 10.5% and 13% decay (Fig. 2). Inoculated fruits had more than three times the incidence of bacterial soft rot of the respective, noninoculated fruits. Noninoculated and inoculated tomatoes sampled from Packinghouse 2 had significantly higher incidences of soft rot than those from Packinghouse 1. Noninoculated Grade #3 tomatoes had about 13% decay and inoculated about 17% decay. There can be significant differences in dump tank sanitation between packinghouses and also between lots in a given packinghouse. *E. carotovora* subsp. *carotovora* was primarily responsible for the decay on inoculated fruits, 94.7% and 82.8% for Packinghouse 1 and Packinghouse 2, respectively.

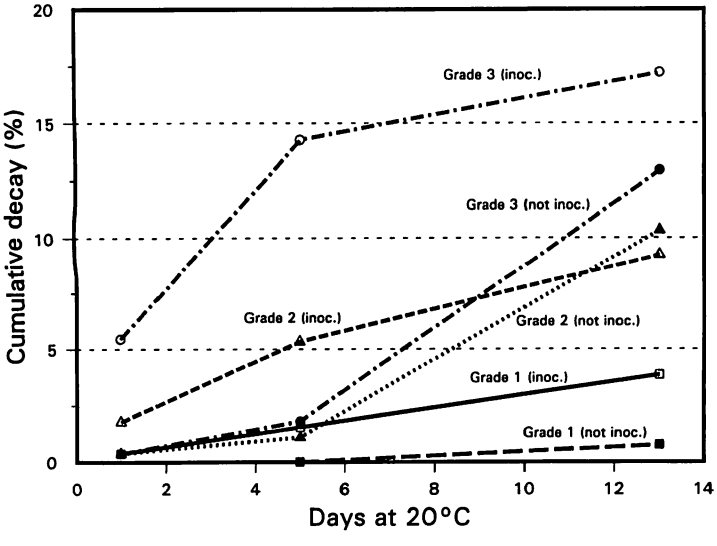

Fig. 2. Cumulative decay for inoculated and noninoculated tomatoes during storage at 20°C (68°F). Packinghouse 2.

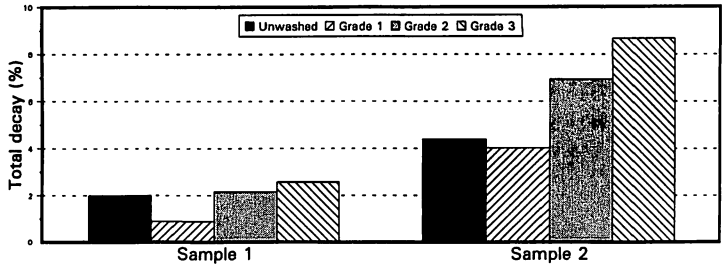

Fig. 3. Total decay for unwashed or packed tomatoes after storage at 20°C (68°F). Packinghouse 3.

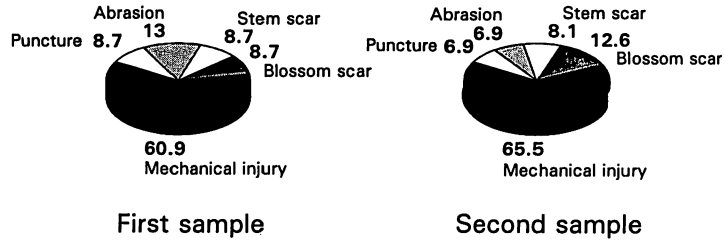

Fig. 4. Sources of bacterial and fungal decay for packed tomatoes after storage at 20°C (68°F). Packinghouse 1 and 2.

Fungi were the primary cause of decay on noninoculated fruits, 80.6% and 84.6% for Packinghouses 1 and 2, respectively.

For Sample 1 of Packinghouse 3, unwashed, ungraded tomatoes (harvested after prolonged dry conditions) retrieved from the field bins had 2% decay after storage. Packed Grades #1, #2 and #3 had about 0.9%, 2.1% and 2.6% decay, respectively (Fig. 3). Tomatoes from corresponding locations for Sample 2 (harvested after prolonged rain) had higher decay incidence. Unwashed tomatoes had 4.4% decay while Grades #1, #2 and #3 had about 4%, 7% and 8.7%, respectively. For Sample 1, fungi accounted for only slightly more decay than bacteria; however, for Sample 2, fungi caused 77% of all decay (Table 1). Bacteria are more sensitive to chlorine than fungi (Dychdala, 1991) and, as such, were more effectively controlled by the dump tank water treatment. *Alternaria alternata* was the leading source of fungal decay in all tests. Other identified pathogens were *Fusarium* sp., *Rhizopus stolonifer, Stemphylium botryosom, Colletotrichum* sp. and *Geotrichum candidum.*

The primary pathogens associated with postharvest decay in tomatoes normally do not cause infection without a point of entry (Bartz, 1980), such as a break in the skin. A significant amount of decay occurred through stem-end and blossom-end scars. Data from inoculated tomatoes for

Table 1: Source of decay of 'Heritage' tomatoes retrieved from Packinghouse 3.

Pathogen		Low free chlorine[z]	High free chlorine	Unwashed
First sample				
Erwinia carotovora	(43.5%)	80.0%	20.0%	0.0%
Fungi	(56.5%)	38.5%	38.5%	23.0%
Second sample				
Erwinia carotovora	(23.0%)	40.0%	55.0%	5.0%
Fungi	(77.0%)	38.8%	50.7%	10.5%

[z]Chlorine levels were 50 ppm in the low chlorine test and 85 ppm (for the first sample) and 100 ppm (for the second sample) in the high chlorine test.

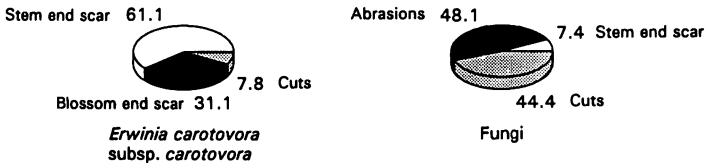

Fig. 5. Sources of total decay for packed tomatoes after storage at 20°C (68°F). Packinghouse 3, Samples 1 and 2.

Packinghouses 1 and 2 showed that, of the infections attributed to *Erwinia carotovora* subsp. *carotovora*, 60% originated at the stem-end scar and 31% at the blossom-end scar (Fig. 4). Decay caused by fungi occurred primarily at abrasions and cuts. Causes of infection were determined for Samples 1 and 2 from Packinghouse 3, and mechanical injury was the predominant source of decay (Fig. 5).

Previous studies have reported that tomato cultivars with large amounts of locular tissue had better flavor quality than those with less locular tissue (Brecht et al., 1976; Stevens et al., 1977). Representative normally shaped and misshapen tomatoes selected from the three grades of each sample were analyzed for flavor components and there were no significant differences in total soluble solids and titratable acidity (Table 2). Therefore, differences in fruit shape between the three grades (as permitted by the U.S. Grade Standards) had no discernible influence on flavor quality.

Increased amounts of fungal decay (up to 17%) were associated with Grade #2 and #3 tomatoes. There were higher incidence of mechanical injury and larger stem-end and blossom-end scars in these grades than in U.S. #1 Combination, which accounted for the inability of dump tank sanitation to control the decay. These results clearly illustrate the importance of avoiding mechanical injury during harvest and handling operations and the need for constant vigilance in removing injured fruits during grading operations.

Table 2: Total soluble solids and titratable acidity of tomatoes, cv. Agriset, stored at 20°C during 2 weeks.

	Sample 1		Sample 2	
	Normal ripening[z]	Late ripening	Normal ripening	Late ripening
Total soluble solids (°Brix)				
Normal shaped	4.40	4.40	4.40	4.50
Misshapen	4.40	4.40	4.50	4.30
Acidity (% citric acid)				
Normal shaped	0.46	0.42	0.42	0.45
Misshapen	0.48	0.43	0.46	0.44

[z]Normal ripening fruit were selected from those ripening within 7 days of the average for the lot; late ripening fruit were selected from the slowest ripening ca. 20% of the lot.

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