Evaluation of Impact Damage during Handling of Fresh Market Tomatoes

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Tomato is one of the most consumed vegetables in the world, and Brazil occupies a prominent place among the major producers. Harvest and postharvest handling are among the main points of occurrence of mechanical injuries for fresh market tomatoes, which can be caused by impact of fruit dropping, inappropriate handling, and also from brush pressure. Damage due to brushing during the cleaning and polishing steps is difficult to measure and quantify. The main goal of this work was to evaluate damage incidence due to the brushing step using a cleaning, sorting, and packing prototype that simulates a packing line. Previous studies indicated that gentian violet could be used as a marker for skin superficial damage on tomatoes. In this study, fresh market tomatoes were washed and sorted in a prototype that consists in cleaning and polishing step using synthetic and non-synthetic brushes in a rotational movement at 120 rpm. After cleaning and sorting, fruit were immersed in a solution of gentian violet, then cleaned and rinsed with water. After drying, fruit color analyses of skin damage were done based on scores for intensity and severity. Fruit subjected to the prototype showed higher incidence of total injuries, mostly of low and medium severity, as compared to control. Those injuries increased weight loss but did not affect CO2 production. The results indicate that the use of the skin color method can be an important tool for evaluating physical skin damage on tomato processing.

Material and Methods

Tomato fruit ‘Pizzadoro’ were obtained from a farm in São Carlos, São Paulo State, Brazil, and transported immediately after harvest in plastic boxes coated with a bubble plastic film, to avoid possible injuries during transportation. Fruit were selected for size, absence of external injuries, and maturity stage, at the breaker and turning stages, based on the United States Department of Agriculture (USDA) scale.

Fruit were separated in two groups: one group was subjected to sorting in a prototype that simulates a packing line having the steps of washing, drying, polishing and sorting by size using divergent longitudinal rollers. Washing and polishing were done by the use of brushes (120 rpm), and washing was done by spray sprinklers. The second group was not submitted to any type of treatment, being used as control.

Then, fruit were stored at 21 ± 2 ºC for 14 d. Weight loss and CO2 production were measured every 2 d for 2 weeks. The destructive analysis for mechanical injury evaluation was performed on the first day. These laboratory analyzes are detailed below.

Weight loss

Twelve fruit were used for each treatment, individually weighted (precision 0.01g) and weight loss (%) was recorded during storage.
The production of CO$_2$ was measured from 12 fruit placed in hermetically sealed 9-L chambers. Three replicates per treatment were used, totaling 6 chambers. Each chamber was equipped with inlet and outlet gas ports to allow continuous flow of atmospheric airflow, provided by a board (~ 5000 mL/h). Samples (1 ml) were collected from the outlet tube with a 1-mL Hamilton® syringe.

The samples were then analyzed on a gas chromatograph Varian CP-3800, equipped with a thermal conductivity detector and packed column. The temperatures used in the injector and oven were 150 and 50 °C, respectively. The thermal conductivity detector temperature was set to 150 °C, with the filament temperature of 280 °C. Argon was used as carrier gas.

Incidence of physical damage
Tomato fruit were dipped in a solution of gentian violet to enhance color of injuries. The solution concentration used was 2%, diluted with distilled water, as previously determined. The procedure is described below:
1. Tomatoes were dipped in the gentian violet solution, so that the whole fruit was in direct contact with the solution.
2. After immersion in the gentian violet solution, tomatoes were placed in a beaker containing water for about 2 min, and then washed with a continuous flow of water to remove the excess of dye that was over the fruit skin.
3. Fruit were dried at ambient temperature, and following that, color analysis of the damage was done based on a score scale.

Scores were related to damage intensity (number of colored spots) and severity (low, medium, high, very high) of the detected lesions. The attribute intensity is referred to the number of identified and severity to the degree of significance of those.

Weight loss analyses and CO$_2$ production were conducted in a completely randomized factorial design consisting of two factors: two treatments (processing prototype and the control group), and eight dates of analysis (0, 2, 4, 6, 8, 10, 12, and 14 d). Data were subjected to analysis of variance, and means were compared over days of storage, using the Tukey test at 5% significance.

Results and Discussion

Weight loss
There were significant differences between treatments. Throughout the storage, the average weight loss of the fruit processed in the prototype was 4.86%, while the control group was 4.28% (Fig. 1). Magalhães and Ferreira (2006) also observed weight loss in tomatoes subjected to impact during processing. Atarassi (2008) observed higher weight loss in tomato fruit subjected to processing. Likewise, Ferreira et al. (2004) reported significant weight loss in tomato fruits subjected to postharvest handling.

Postharvest handling, and specifically tomato processing, are factors that potentially can cause greater fruit weight loss. Processing can cause abrasions and disruption of the external cuticle in tomato. As the cuticle is impermeable to gases and water, its disruption can result in significantly greater weight loss, as observed in this study (Calbo, 2001).

CO$_2$ production
There were no significant differences between treatments (data not shown). However, other authors reported an increase in CO$_2$ production in tomatoes subjected to processing. Magalhães et al. (2009) reported a significant increase of CO$_2$ production after 4 h of storage from tomatoes subjected to cleaning by brushing before storage. Atarassi (2008) also noted types of processing that caused an increase in respiratory activity of tomatoes. Results from our study suggest that the degree of impact at which the tomato fruits were subjected during processing did not cause sufficient injury to result in an increase of CO$_2$ production as observed in other studies.

Incidence of injury
Tomato fruit subjected to processing showed greater intensity and severity of injuries (Fig. 2). In total, the control group had 34 injuries, all being of low severity. In contrast, the fruits subjected to processing with the prototype showed 81 injuries, distributed in low and medium intensity (86% and 14%, respectively). The injuries detected in the control fruit originated from the field, before any processing. Indeed, they had the shape of small dried points. Therefore, it is believed that these were present in the fruit prior to harvest, since the injuries caused after harvest showed a different standard feature (such as “scratches” or “bruises”) (Fig. 3).
Conclusions

High intensity and greater severity of injuries found on the processed fruit suggests a relationship with the largest weight loss observed in this treatment.

The analysis of injury incidence applying a dye method, developed in this work, showed a rapid and efficient method to detect and evaluate low intensity physical damage in tomato fruit.

Literature Cited


