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Preliminary evaluation of physiological changes in tomatoes with mechanical damage related to development of postharvest technologies.

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ABSTRACT

Tomato is classified as a functional food due to its high content of vitamins, lycopene, phenolics, flavonoids and fibers. Nonetheless, tomatoes are very sensitive soft-textured fruit, for which improper handling may reduce final product quality. The flavors of fresh, commercially produced fruits and vegetables, such as tomato, are generally considered poor by the consumer. Consequently, it is important to maintain horticultural product quality to offer more pleasant flavors and, beyond that, prevent food losses. Some mechanical forces, such as compression, can bruise tomatoes. However, such forces may not cause externally perceptible injuries. Despite this, internal bruises and cell damage still can change fruit physiology, increasing respiration and accelerating ethylene production. Therefore, it may be necessary to adopt different technologies depending on the postharvest management that the fruit received. A study of ethylene and carbon dioxide produced by tomatoes simulating different such management practices, resulting in occurrence of mechanical damages, can provide great value to development of technologies such as new packages, coatings, machinery and implements. The aim of this paper was to subject tomatoes to mechanical damage caused by compression that resulted in no perceptible injury, and measure the resulting changes in the respiration rate and ethylene production patterns. Tomatoes were subjected to compression using different loads: 0, 1, 5 and 10 kg. Ethylene and carbon dioxide production were evaluated after 1 hour and during 7 days of storage. An increase in ethylene production was observed for all treatments, while carbon dioxide production increased on only the first day of storage. Mechanical damages were responsible for increasing tomato ethylene production during the entire postharvest life and the respiration immediately after the application of treatments.

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Keywords: *Lycopersicumesculentum, ethylene, respiration, quality.*

RESUMO

Avaliação preliminar de alterações fisiológicas em tomates com danos mecânicos para o desenvolvimento de tecnologias de pós-colheita.

Tomates são classificados como um alimento funcional, devido ao seu alto teor de vitaminas, licopeno, fenólicos, flavonóides e fibras. No entanto, são frutos sensíveis e de textura macia, onde o manuseio indevido pode reduzir a qualidade do produto final. Frutas e hortaliças comercializados frescos, como o tomate, são geralmente considerados pobres de sabor pelo consumidor. Por isto, é importante manter os produtos hortícolas com qualidade para oferecer sabores mais agradáveis e, além disso, evitar as perdas de alimentos. Algumas forças mecânicas, como a compressão, pode danificar os tomates sem causar lesões perceptíveis. Apesar disso, danos internos e celulares ainda podem alterar a fisiologia do fruto, aumentando a respiração e acelerando a produção de etileno. Diante disso, pode ser necessário a adoção de diferentes tecnologias dependentes do manuseio pós-colheita que os frutos receberam. O estudo da produção de etileno e dióxido de carbono por tomates simulando diferentes manejos, como a ocorrência de danos mecânicos, pode ter grande valor para tecnologias em desenvolvimento, tais como novas embalagens, coberturas, máquinas e implementos. O objetivo deste trabalho foi submeter tomates a danos mecânicos não perceptíveis causados por compressão, e verificar as mudanças nos padrões de produção e taxa de respiração de etileno. Tomates foram submetidos a compressão utilizando diferentes cargas: 0, 1, 5 e 10 kg. A produção de etileno e dióxido de carbono foi avaliada após uma hora e ao longo de sete dias de armazenamento. Observou-se uma mudança no padrão de produção de etileno em todos os tratamentos, enquanto a produção de dióxido de carbono foi mais afetada no primeiro dia. Danos mecânicos foram responsáveis pelo aumento da produção de etileno tomates ao longo de toda a vida pós-colheita, e da respiração imediatamente após a aplicação dos tratamentos.

Palavras-chave: *Lycopersicum esculentum, etileno, respiração, qualidade.*

INTRODUCTION

Tomato (*Lycopersicum esculentum* Mill) world production was estimated at 145.8 million tons in 2010, distributed throughout the world (FAOSTAT, 2012). Brazil is currently the 9th largest producer of tomatoes and produced 3.7 million tons in 2010, 24% more than 10 years ago (FAOSTAT, 2012). Soft fruits, such as tomatoes, are very sensitive to improper handling, storage and transport conditions. Therefore, proper pre and postharvest handling are critical for obtaining their highest quality, a requirement for successful fruit marketing (Yahia et al., 2005). Mechanical damage in tomatoes is the most common and severe defect in this crop; it has great economic consequences, mainly due to negative changes in sensory attributes and internal breakdown reactions (Martinez et al., 2004). Bruising injuries, which leave the skin intact and may not be visible externally may cause increases in respiration and ethylene production (FAO, 2011). Physiological disorders caused by mechanical damages can modify flavor and aroma of tomatoes, reducing the potential acceptance of this product (Moretti & Sargent, 2000). Moretti et al. (1997) conducted a sensory analysis test to study consumer acceptability of tomato fruit with internal bruising. The results suggested that tomato flavor compounds alterations could be associated with mechanical injuries such as internal bruising. This provides evidence of the need to avoid mechanical damage, and to develop and adopt appropriate technologies depending on changes in physiology caused by postharvest handling. This work aimed to subject tomatoes to mechanical damage caused by compression that resulted in no perceptible injury and verify changes in ethylene production and respiration rate patterns.

MATERIAL AND METHODS

The experiment was carried out in the Horticultural Sciences Department - University of Florida. Plant material was cultivar Tasti-Lee® tomatoes produced in the state of Florida- USA. Tomatoes were selected at stage 2 of maturation (breakers) with no pests, diseases or any severe or mild defects. Tomatoes were exposed to compression loads of 0 (control), 1, 5, 10 or 20 kg for 10 seconds with a TA.HD.Plus texturometer (Atta-Aly El & Awady, 1995). The fruit were stored in a cold room with controlled temperature (± 22°C) and relative humidity (60%). For evaluations, tomatoes were placed in 500 mL glass jars and, after 1 hour, a gas sample of 1 ml was withdrawn for ethylene and CO_2

analysis using a gas chromatograph - Varian CP3800. Analyses were carried out in 0 (1 h after treatments applications), 1, 4 and 7 days after harvest.

RESULTS AND DISCUSSION

It was verified that an increase in ethylene production occurred for all treatments 1 h after tomatoes were subjected to compression forces (Fig 1). Tomatoes subjected to the 1-kg load treatment was able to recover and produce ethylene in the same pattern as the control, and remained so throughout storage, not demonstrating significant differences from the control. This result is evidence that when the compression force received by the fruit was relatively low, the tomatoes could recovery a normal ethylene production compared to the control. Therefore, they may have their postharvest longevity less impaired by the occurrence of mechanical damages by compression. The effect of ethylene in postharvest ripening is widely known and the increase of its biosynthesis until concentrations that stimulate this process are reached characterizes the transition between development and senescence stages for vegetables (Chitarra & Chitarra, 2005). The other treatments exhibited increased ethylene production following compression that did not returned to levels displayed by the control. The ethylene production by the 5-kg and 10-kg load treatments increased and the production returned to control levels only by 7 days of storage. However, such recovery after 7 days does not represent an advantage, since during those days the ethylene production increased in some cases by more than 67% as could be noticed on day 0 for the 10-kg load treatment, which was accompanied by acceleration of fruit ripening (Fig 1). The ethylene production by the 20-kg treatment was never at any time equivalent to the control patterns, generating 56, 29, 18 and 16% more ethylene after 0, 1, 4 and 7 days . These results indicate that despite increased ethylene production on the first day, the load of 1 kg of compression would be the maximum tolerable in terms of ethylene production in this test. Above that, the production increased significantly and did not return to the control levels. Ethylene production increases tomato ripening processes logarithmically and reducing postharvest life of this product. Studies on a wide variety of fruits and vegetables have shown that any ethylene level is considered deleterious and can reduce postharvest life (Wills & Warton, 2004).

Carbon dioxide production (Fig 2) was increased by mechanical damage only on day 0 of the experiment. Control, 1-kg and 5-kg loads behaved similarly, while larger loads increased respiration significantly in relation to the control. However, it was observed that respiration rates were not consistently affected by compression beyond the first day. Accordingly, it was observed that mechanical damage caused by compression of more than 1 kg applied for 10 seconds was responsible for increasing the tomatoes ethylene production along all of its postharvest life and responsible for increasing the respiration only immediately after the application of treatments. Thus, it is recommended to take into consideration the potential for postharvest quality losses in relation to management of these fruit, especially when developing processes and technology to be applied after harvesting. In this perspective, some simple solutions can be adopted to prevent excessive damages of tomatoes until their arrival to consumers, since ripening and softening are key attributes that contribute to the vegetables perishability (Kader & Rolle, 2004). The adoption of methods to avoid excessive ethylene production and respiration can positively influence tomato conservation. The use of suitable packages and coatings to protect fruits during transportation and marketing can be a way to conserve fruit quality.

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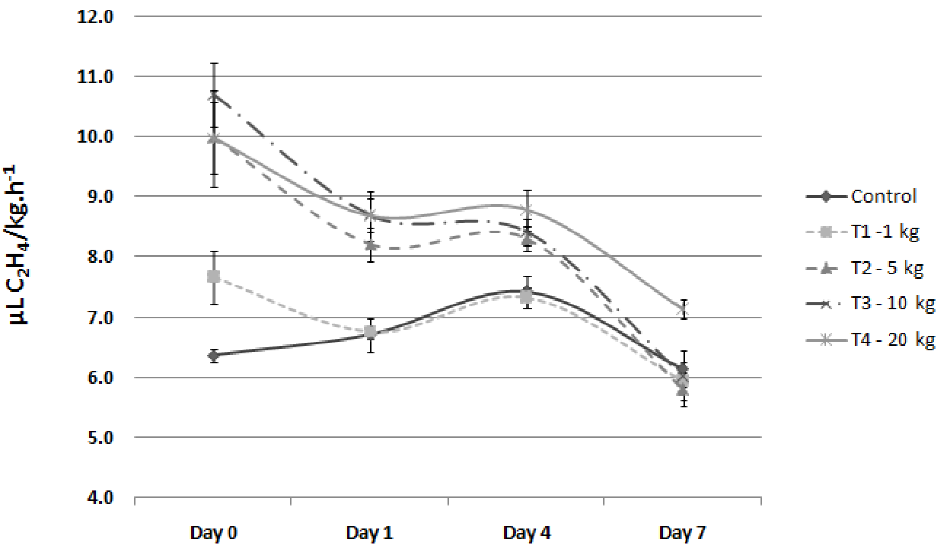

Figure 1. Ethylene production (µL /kg.h^{-1}) by tomatoes subjected to different loads to simulate compression mechanical damages during postharvest life. [Produção de etileno (µL / kg.h^{-1}) em tomates submetidos a diferentes cargas para similar danos mecânicos por compressão durante a vida pós-colheita.]

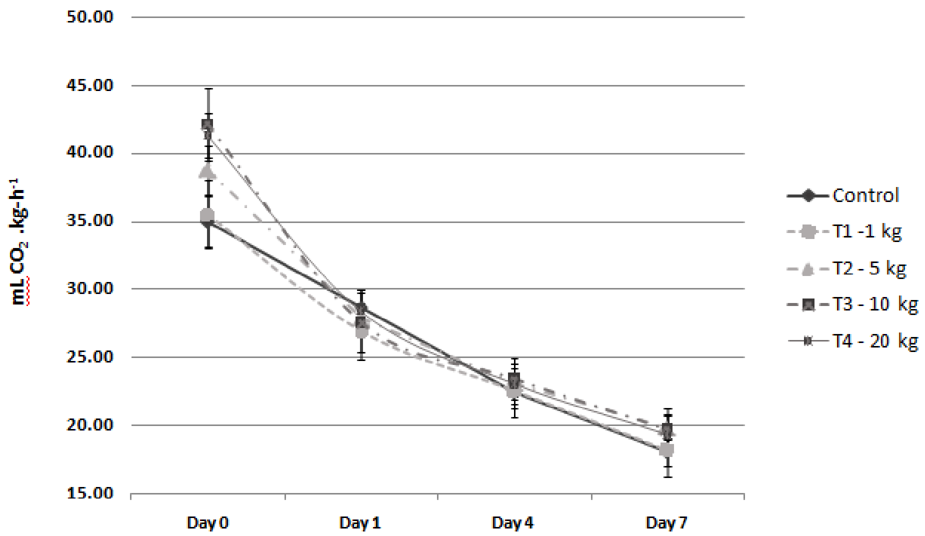

Figure 2. Carbon dioxide production CO_2 (mL /kg.h^{-1}) by tomatoes subjected to different loads to simulate compression mechanical damages during postharvest life. [Produção de dióxido de carbono CO_2 (µL / kg.h^{-1}) em tomates submetidos a diferentes cargas para similar danos mecânicos por compressão durante a vida pós-colheita.]