FOOD AND BIOPRODUCTS PROCESSING 90 (2012) 118–122

Contents lists available at ScienceDirect

Food and Bioproducts Processing

journal homepage: www.elsevier.com/locate/fbp

Short communication

Effects of ozonized water and heat treatment on the papaya fruit epidermis

Carolina Pereira Kechinski[a,*], Cândida Raquel Scherrer Montero[c], Pâmela Virgínia Ramos Guimarães[b], Caciano Pelajo Zapata Noreña[b], Lígia Damasceno Ferreira Marczak[a], Isabel Cristina Tessaro[a], Renar João Bender[c]

[a] Chemical Engineering Department, Federal University of Rio Grande do Sul (UFRGS), Porto Alegre, RS, Brazil
[b] Food Technology Department, UFRGS, Porto Alegre, RS, Brazil
[c] Horticulture and Forestry Department, UFRGS, Porto Alegre, RS, Brazil

ABSTRACT

This study examined the effects of O_3 and hot water treatments on the epidermis of Golden papaya fruit. Heat treatments were applied in a hot water brushing (HWB) system. Papayas were brushed under a pressurized hot water rinse stage at 45, 55 and 65 °C for 60 s. In the HWB treatment, 4 ppm ozone was applied to the papayas for 1 or 2 min. The results show that ozone applications did not affect the fruit's cuticular surface, while heat treatments allowed natural fissures on the fruit epidermis to recover. Several crystalloid forms were identified on the epidermis of the papayas after the heat treatments. The predominant crystalloid forms on papayas are tubular and there is a positive response to temperature; the higher the temperature, the larger and more frequent the tubular crystalloids.

Keywords: *Carica papaya*; Thermotherapy; Ozonized water

1. Introduction

Papaya (*Carica papaya* L.) is one of the most important fruit crops in Brazil and is valued for its high nutrient content. Papayas fruits are widely consumed in Brazil. More than 2.5% of the annual national papaya produce is exported (Brapex, 2007). Papayas are highly perishable, and, therefore, postharvest studies focusing on agricultural practices, improvements in storage capabilities and adequate fruit transport are essential to reducing market losses.

The need for suitable replacement to fungicides to control postharvest decay has prompted research aimed at identifying mold control strategies using combinations of different alternatives that are as effective as synthetic chemicals. A good strategy would eradicate all pathogens present with the treatment employed and would prevent further infection (Conway et al., 2004). In the near future, alternative treatments are likely to include a combination of different and less aggressive methods (Teixidó et al., 2001). In the present work, hot water, ozone and a combination of both treatments were used as an alternative to synthetic chemicals.

Ozone (O_3) is widely used as an anti-microbial agent to inactivate bacteria, fungi, viruses and protozoa, allowing water in the food industry to be disinfected and wastewater to be reused, as well as controlling the alkalinity and pH of shrimp pond water (Kim et al., 1999). Ozone has been recently approved for use on food by the FDA (Federal Register, 2001) and is thought to reduce decay in some fruits and vegetables, though results have been inconsistent (Forney, 2003). The effectiveness of ozone for the decontamination of *Escherichia coli* and *Bacillus cereus* in kernels, shelled and ground pistachios was investigated by Akbas and Ozdemir (2006). They reported that ozone concentrations of less than 1.0 ppm were effective in reducing the number of both bacteria in ground pistachios

---

[*] Corresponding author at: Departamento de Engenharia Química, UFRGS, Campus Central, Rua Luis Englert, s/n. 90040-000 Porto Alegre, RS, Brazil. Fax: +55 5133083638.

E-mail address: carolinapk@gmail.com (C.P. Kechinski).

Received 11 June 2009; Received in revised form 7 January 2011; Accepted 15 January 2011

doi:10.1016/j.fbp.2011.01.005

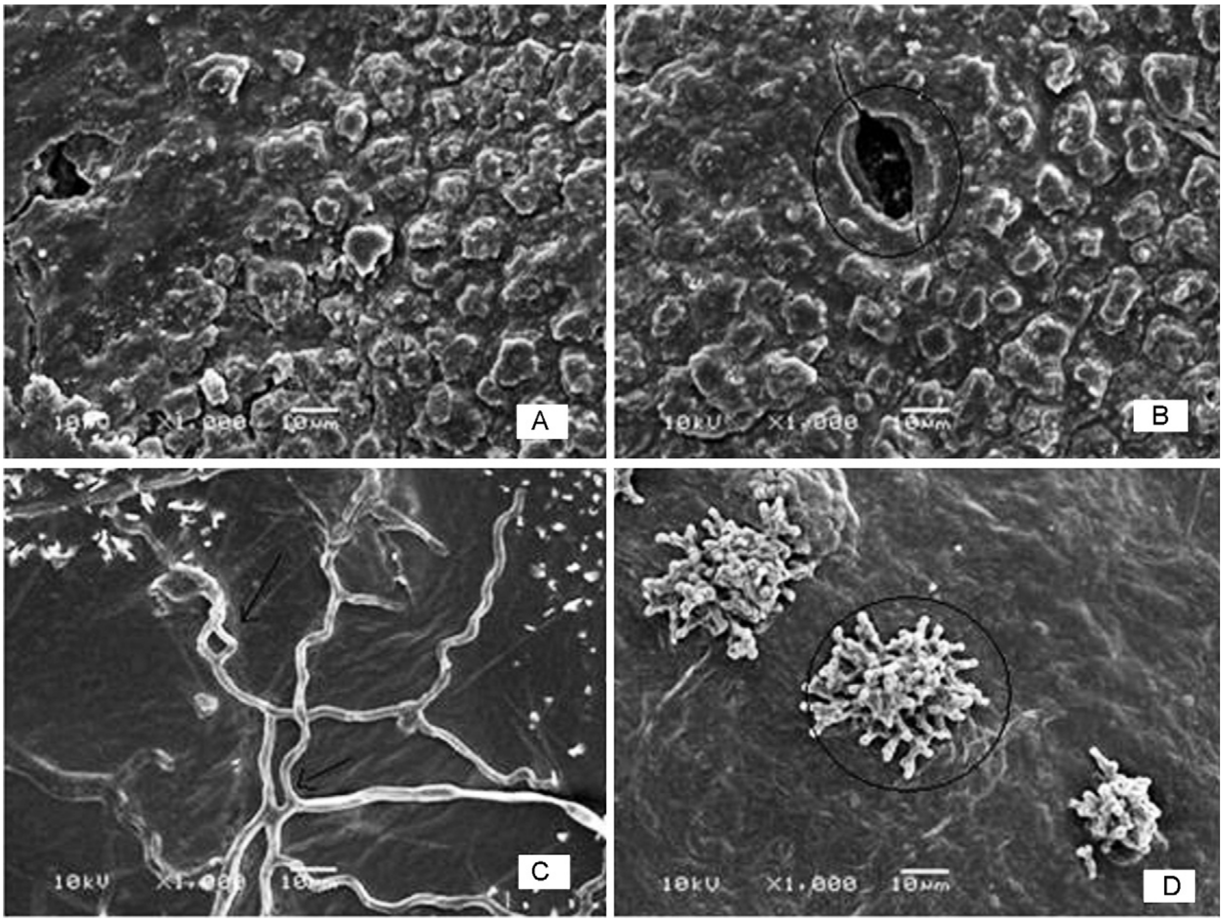

Fig. 1 – Cuticular surface of the control samples at room temperature 15 days after harvest. The typical covering (A and B) is characterized by cracked layers, while the stomata (B) are indicated in the circle, the hyphae of molds are indicated by the arrow (C) and spores (D) are indicated in the circle.

without demonstrating a change in their physical–chemical properties.

The objectives of heat treatments, developed primarily for fruits, are to stop insect infestations, to control diseases, to modify tissue responses to other types of stress and to maintain product quality during storage (Paul and Jung Chen, 2000). This treatment has a number of advantages, which include being relatively straightforward to use, having a short treatment time, allowing reliable monitoring of fruit and water temperatures, and killing surface-borne decay-causing agents (Lurie, 1998). To put this treatment into practice, several time–temperature combinations must be tested in advance, taking into account that the botanical origin of edible parts (fruits, stems, petioles, leaves, buds, inflorescences, among others) is considerably broader in vegetables. Moreover, the optimum time and temperature combination chosen to extend fresh product quality during storage depends on the cultivars, maturity stage, size and growing conditions (Fallik, 2004). In addition, selection of treatment types (heating in dry air, steam or water) may depend on the product characteristics (Viña and Chaves, 2008).

Changes in the fruit surface gloss suggested probable modifications to the light reflectance characteristics which could be caused by either a loss of cuticular wax and/or ultra-structural changes in the crystalline structure of the surface wax. Any modification in the fruit surface could also contribute to a reduction in the adhesion of the pathogen, thereby reducing colonization (Charles et al., 2008).

Heat is known to affect fruit surfaces, causing cuticular waxes to melt and natural openings to close, thus obstructing possible entrance sites for pathogens and acting as a physical barrier against infection (Eckert and Eaks, 1988).

The objective of the present study was to evaluate the effects of using hot water treatments in combination with ozonized water on the papaya fruit epidermis.

2. Materials and methods

Papaya fruits (cultivar *Golden*) were harvested from June to September 2007 (June 11 and 14, August 7 and September 10 and 20) at a private orchard in the State of Bahia in northeastern Brazil. The papayas, wrapped individually in paper and stored in wooden boxes, were transported more than 2500 km to the State of Rio Grande do Sul, the southernmost state in Brazil. Papayas were transported in an unrefrigerated truck (medium ambient temperature of 28 °C), and the trip took 5 days. At the Postharvest Laboratory of the Horticultural Sciences Department at UFRGS, the papayas were immediately treated with either ozonized water and/or hot water sprays. After treatment, the papayas were stored at room temperature (25 ± 2 °C) for 10 days before epidermis samples were retrieved and prepared for visualization on a scanning electron microscope (SEM) JEOL JSM-6060 at 10 kV.

Ozonized water was supplied by a prototype which uses pure oxygen and water to produce ozone. Ozone and dissolved ozone concentrations are measured by a Thornton 770Max