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Effect of different sanitizers on microbial and sensory quality of fresh-cut potato strips stored under modified atmosphere or vacuum packaging

David Beltrán, María V. Selma, Juan A. Tudela, María I. Gil *

Research Group on Quality, Safety and Bioactivity of Plant Foods, Food Science and Technology Department, CEBAS-CSIC, P.O. Box 164, E-30100 Espinardo, Spain

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Abstract

Chemicals containing SH-groups as sulfites and chlorine-based agents are commonly employed in the fresh-cut process of vegetables such as potatoes to prevent browning and to sanitize produce. However, there is a concern over the application of these compounds in fresh-cut commodities as they might affect human and environmental safety and this has created the need to investigate alternatives. In the present work, the effectiveness of different traditional and non-traditional sanitizers on the sensory and microbial quality of fresh-cut potatoes stored under passive modified atmosphere packaging (MAP) and vacuum packaging was investigated. Six different washing treatments consisting of water, sodium sulfite, sodium hypochlorite, Tsunami, ozone and the combination of ozone–Tsunami were evaluated. Browning and growth of aerobic mesophilic bacteria, psychrotrophic bacteria, coliforms, lactic acid bacteria (LAB), anaerobic bacteria, moulds and yeasts were studied. In general, vacuum packaging preserved the appearance better than MAP. Under MAP only sodium sulfite prevented browning although it conferred off-odors. After 14 days of storage, there was no evidence of browning in fresh-cut potatoes dipped in ozonated water or ozone–Tsunami and stored under vacuum and these treatments maintained initial texture and aroma. However, the use of ozonated water alone was not effective in reducing total microbial populations. Ozone–Tsunami resulted in the most effective treatment to control microbial growth achieving 3.3, 3.0 and 1.2 log-reductions for LAB, coliforms and anaerobic bacteria, respectively. Therefore, although microbial growth was not slowed down by ozone alone, the combination of ozone–Tsunami resulted an efficient and promising treatment for controlling microbial growth and maintaining sensory quality of potato strips under vacuum.

Keywords: Browning; Hypochlorite; Ozone; Packaging; Peroxyacetic acid; *Solanum tuberosum* L.

1. Introduction

Demand for fresh-cut fruit and vegetables has been increasing in recent years, mainly because consumers look for freshness and convenience when they purchase

* Corresponding author. Tel.: +34 968 396 315; fax: +34 968 396 213.
E-mail address: migil@cebas.csic.es (M.I. Gil).

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these commodities. However, fresh-cut processing includes unit operations such as peeling, trimming or cutting that alter the integrity of the commodity's tissues and can induce wounding stress (Saltveit, 2003). One of the most important consequences of this stress in fresh-cut potatoes is the development of enzymatic browning which can lead to changes in color and loss of nutritional value (Tudela et al., 2002a,b). Moreover, microbial development from natural flora is promoted due to the destruction of tissues and subsequent release of nutrients. Pathogens may form part of this microflora, leading to a potential safety problem (Beuchat, 1995; Francis et al., 1999).

Several studies have been done to determine the efficacy of washing, sanitizing and modified atmosphere packaging (MAP) conditions in order to inhibit browning and spoilage in fresh-cut fruit and vegetables (Sapers and Miller, 1998; Lanciotti et al., 1999; Bai et al., 2001; Emmambux and Minnaar, 2003). Chemicals containing SH-groups including sulfites are commonly employed to prevent browning in vegetables such as potatoes. However, the application of these compounds in fresh-cut commodities can cause bronchial asthma (Peroni and Boner, 1995) and undesirable flavors in addition to a significant reduction in the nutritional value in potatoes (Chalom et al., 1995). Agents that are chlorine-based have been often used to sanitize produce and surfaces, as well as reduce microbial populations in water applied during cleaning and packing operations (Delaquis et al., 2004). However, the production of chlorinated organic compounds, such as trihalomethanes, which are potential carcinogens (Fawell, 2000), has created the need to investigate the efficiency of non-traditional sanitizers and other alternative technologies. Therefore, preservation methods for fresh-cut fruit and vegetables are still under study. The concept of using multiple intervention methods where various preservation technologies, healthier for consumers, are employed is increasing their importance (Parish and Davidson, 1993; Soliva-Fortuny and Martín-Belloso, 2003).

Research on the efficacy of peroxyacetic acid to inactivate microorganisms has produced varying results. One group of researchers has demonstrated the effectiveness of peroxyacetic acid (Tsunami Ecolab, Mendota Heights, MN, USA) reducing *Escherichia coli* O157:H7 populations on the surface of cantaloupe melons but this treatment was not effective on asparagus spears (Park and Beuchat, 1999).

Ozone has been extensively applied for sanitation of drinking water with efficacy against bacteria, molds, viruses and protozoa (Korich et al., 1990; Restaino et al., 1995). Furthermore, ozonated water has reduced microbial populations and extended the shelf life of some fresh-cut fruit and vegetables (Beuchat, 1998; Kim et al., 1999). The decrease in pathogens including *Salmonella typhimurium*, *Yersinia enterocolitica*, *Staphylococcus aureus*, *Listeria monocytogenes* and *E. coli* O157:H7 has also been described (Restaino et al., 1995; Singh et al., 2002). Therefore, the use of ozonated water has been suggested as an interesting alternative to traditional sanitizers due to its efficacy at low concentrations and short contact times as well as the breakdown to non-toxic products (Graham, 1997; Rice, 1999).

The objective of this study was to provide information on how different traditional (sodium hypochlorite and sodium sulfite) and non-traditional (peroxyacetic acid and ozone) sanitizers alone or in combination, affect the microbial and sensory quality of fresh-cut potato strips stored under different packaging conditions (MAP and vacuum).

2. Materials and methods

2.1. Potato strip processing

Potatoes (*Solanum tuberosum* cv Monalisa) were purchased from a local supplier in Murcia, Spain, and transported by car to the laboratory (5 km) where those with defects (cuttings and bruisings) were discarded. Sound tubers were kept at 4 °C and 70% relative humidity (RH) in darkness prior to processing. Potatoes were hand-peeled and washed with sterile deionized water (electrical conductivity = 0.28 μS cm^{-1}) at 8 °C. After peeling, the tubers were sorted for absence of visual defects and uniform color. Potatoes were cut in 8 mm × 8 mm strips with a manual potato cutter (Sammic CF-4, Azpeitia, Spain). Immediately after cutting, the strips were again washed with sterile deionized water to remove excess starch and other cellular constituents and then strained on a draining board to reduce the water content on the potato strip surface. Uniform strips were selected and broken pieces were discarded.