Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.elsevier.com/locate/fpsl

Integrated effect of sodium hypochlorite and modified atmosphere packaging on quality and shelf life of fresh-cut cilantro

Roji B. Waghmare, Uday S. Annapure *

Food Engineering and Technology Department, Institute of Chemical Technology, India[1]

ARTICLE INFO

Article history:
Received 19 January 2014
Received in revised form
2 November 2014
Accepted 6 November 2014
Available online 18 November 2014

Keywords:
Fresh-cut cilantro
Sodium hypochlorite
Modified atmosphere packaging
Shelf-life

ABSTRACT

Fresh-cut cilantros were subjected to sodium hypochlorite dipping and modified atmosphere packaging (MAP) treatments. Fresh-cut cilantros were stored at 5 °C up to 25 days. Fresh-cut cilantro were dipped in a solution of 100 ppm sodium hypochlorite and packed in an atmosphere of 5% v/v O_2, 10% v/v CO_2, 85% v/v N_2. Headspace atmosphere, weight loss, firmness, color, microbial quality as well as sensory analysis were assessed. The combination of dipping and MAP had a significant effect on the maintenance of good sensory and microbiological qualities of fresh-cut cilantros. The combined treatment was more effective than alone treatment for maintaining storage quality. The results of this study demonstrate that a combination of sodium hypochlorite dipping and MAP treatment was the most effective and promising approach for maintaining the quality of fresh-cut cilantros during 25 days of storage.

1. Introduction

Coriander or cilantro (*Coriandrum sativum*) leaves are an important component of many cuisines (Eriksson et al., 2012). It has a unique aroma and flavor (Potter & Fagerson, 1990). Cilantros are finely chopped and used in food preparation, either added directly to the food for decoration or incorporated with food. Fresh-cut cilantros get rapidly spoiled as compared to whole cilantros due to tissue damage (Waghmare, Mahajan, & Annapure, 2013). The preparation of finely chopped cilantro produces large amount of waste and it is a time consuming task. Around 30% waste is produced due to cutting of stem and spoiled leaves. Cutting operations can transfer pathogenic micro-organisms from the surface of the intact produce to the internal tissues. Injured cells and released cell fluids supply nutrients for microbial growth. Low temperature throughout distribution is very important to maintain quality of fresh-cut produce. Low temperatures reduce enzymatic reactions and greatly slow down the multiplication of spoilage organisms (Food Safety). It also causes increase in respiration rate, induces synthesis of secondary metabolites and membrane disruption. Waghmare, Mahajan, & Annapure (2014) observed that the respiration rate increases for fresh-cut papaya. Hence, it is difficult to extend shelf-life of fresh-cut cilantros with an acceptable quality due to their high perishability (Waghmare & Annapure, 2013; Loaiza & Cantwell, 1997). Cilantros can be stored for around 10 days at 5 °C.

* *Corresponding author at*: Food Engineering and Technology Department, Institute of Chemical Technology (formerly UDCT), Nathalal Parikh Marg, Matunga (East), Mumbai 400019, India. Tel.: +91 22 33612507; fax: +91 22 33611020.
E-mail address: us.annapure@ictmumbai.edu.in (U.S. Annapure).

[1] University under Section 3 of UGC Act-1956, Elite Status & Center of Excellence – Govt. of Maharashtra TEQIP Phase II Funded.

http://dx.doi.org/10.1016/j.fpsl.2014.11.001
2214-2894/

Washing with sanitizer is the only step to achieve the reduction in spoilage due to microorganism in the fresh-cut produce production (Allende, McEvoy, Tao, & Luo, 2009). Chlorine has been widely used primarily to wash agricultural produce due to its low cost and proven efficacy against bacterial pathogens (Adams, Hartley, & Cox, 1989). The main active ingredient of acidified sodium chlorite solution is chlorous acid which is a very strong oxidizing agent, stronger than either chlorine dioxide or chlorine (Scientific Opinion of the Panel on Biological Hazards). The frequently used forms of free chlorine are liquid chlorine and hypochlorites (Parish et al., 2003). It is typically used in the range of 50–200 ppm free chlorine, usually having contact time of 5 min (Rico, Martin-Diana, Barat, & Barry-Ryan, 2007). Treatment of shredded lettuce and cabbage with 200 ppm chlorine reduced the microbial load of *L. monocytogenes* by 1.7 and 1.2 log CFU/g, respectively (Zhang & Farber, 1996). The effects of dipping treatment on the quality maintenance of fresh-cut cilantro have been reviewed by Allende et al. (2009) and Wang, Feng, & Luo (2004).

Modified atmosphere packaging (MAP) is a preservation technique which modifies the composition of the internal atmosphere of a package to improve the shelf life. This technique is already in use by the fresh-cut industry (Rico et al., 2007). Generally, low O_2 and elevated CO_2 concentrations are used to extend the post harvest life of various commodities (Kader, 1986). This atmosphere extends the shelf life of fresh-cut produce by slowing browning reactions at cut surfaces, reducing the transpiration and respiration rates, reducing ethylene biosynthesis (Gorny, Hess-Pierce, Cifuentes, & Kader, 2002). MAP has been shown to have more positive effect than storage in air on retaining the nutritional content of fruit and vegetables (A Review of the Fruit and Vegetable Food Chain). Thus, the objectives of this study were to determine the effects of MAP, sodium hypochlorite and combination of MAP with sodium hypochlorite on physicochemical (headspace gas, weight loss, firmness, color), microbiological (mesophilic aerobics and yeast and molds count) and sensory characteristics of fresh-cut cilantro stored at 5 °C.

2. Materials and methods

2.1. Plant material

Cilantro samples (*Coriandrumsativum* L.) were procured from Agriculture Produce Market Committee (APMC), Mumbai and were allowed to equilibrate at 5 °C. Damaged and yellow colored leaves were discarded from the cilantro. The cilantro samples were washed under running tap water, rinsed and then sliced to a length of around 5 cm.

2.2. Processing, packaging and storage

Fresh-cut cilantros were immersed in a 100 ppm solution of sodium hypochlorite for 2 min and then rinsed with tap water for 30 s. The temperature of water was around 25 °C. These fresh-cut cilantros were centrifuged with a commercial salad centrifugal dryer to remove excess water. This sodium hypochlorite treated fresh-cut cilantros were packed in air (T1) and in modified atmosphere packaging unit (consist of Reepack packaging machinery supplies and PBI Dansensor, MAP Mix 9001 ME, Ringsted, Denmark) containing 5% v/v O_2, 10% v/v CO_2 and 85% v/v N_2 (T2). Packages made from polypropylene (PP) film, supplied by Dhwani Poly Prints Private Limited, India, were used in the study. The PP bags had the dimensions of 20 cm length × 15 cm width and 25 μm thickness. The non-treated sample was packed in air (NT1) and MAP (NT2). 50 g of fresh-cut cilantro was packed in one PP bag. Hence the samples were tagged as NT1 (control) and NT2 (MAP), T1 (chemical treated) and T2 (chemical treated + MAP). Packaged fresh-cut cilantros were held at 5 °C and stored for 25 days. Samples were analyzed at the interval of 0, 5, 10, 15, 20 and 25 days. Three replicate packets were used for all treatments and analyzed on each storage day.

2.3. Physicochemical analyses

2.3.1. Headspace analysis

Just before being measured, packages were removed from storage. Gas composition (oxygen and carbon dioxide) of individual package was measured during storage through a septum with the help of a needle connected to the O_2/CO_2 gas analyzer (PBI Dansensor, Checkmate 9900, Ringsted, Denmark). After nearly 30 s, a screen displays the O_2 and CO_2 percentages, which were developed due to respiration of fresh produce. This instrument helps to measure changes in O_2 and CO_2 concentrations within a sealed jar directly. The apparatus uses a highly stable zirconium sensor for O_2 determination and an infrared detector to detect CO_2.

2.3.2. Weight loss

The net weight of each package was determined by weighing the whole individual package on the day of observation using a laboratory level weighing balance having 0.0001 g accuracy (Anamed electronic balance, India). Values are reported as weight loss per initial fruit weight (g/100 g).

2.3.3. Firmness

Texture was measured by a compression-shear test with a Kramer shear cell consisting of a five blade probe using TA-XT2i texture analyzer (Stable Micro System, Ltd. in Godalming, Surrey, UK) with a 50 kg load cell. The test speed was 0.5 mm/s, pretest speed 10 mm/s and probe reversing speed 10 mm/s. Texture was expressed in N force by determining the peak value of graph.

2.3.4. Color

The color of fresh-cut cilantro sample was determined using a Hunter Lab Colourimeter, (LabScan XE, Hunter Lab Calourimeter, DP-9000 D25A, Reston, USA). Instrument was calibrated with a black and white standard tiles. The results were expressed in terms of L^*, a^*, and b^* values, where L^* represents lightness, a^* represents chromaticity on a green (−) to red (+) axis and b^* represents chromaticity on a blue (−) to yellow (+) axis.

2.3.5. Sensory evaluation

Sensory evaluation of fresh-cut cilantros was evaluated by a panel of 15 trained members. Texture was scored on a 1–5