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Effect of cashew gum-carboxymethylcellulose edible coatings in extending the shelf-life of fresh and cut guavas

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ABSTRACT

Cashew gum (CG) and carboxymethylcellulose (CMC) based formulations have been evaluated as protective edible coatings on intact and cut red guavas. Samples were coated by dipping in aqueous mixtures of 1% CG and 1% plasticizer (glycerol) for CMC additions of 1 and 2% wt. The fruit was stored at ambient conditions (25–28 °C, 76.0 ± 12.4% RH), and loss of mass, color of pulp and peel, and texture were assessed. Magnetic Resonance Imaging (MRI) was used to visualize the internal structure decay of the intact fruits. Both coatings resulted in a reduction of mass loss, preserving firmness and delaying skin color changes. When comparing after 12 day storage, the mass loss in cut coated samples (CG plus 2% wt of CMC) was 38.5% inferior than that measure to uncoated references. At large, both coating formulations reduced water loss and changes in color of the cut surfaces. MRI analysis showed that tissue decay took place mainly near the peel or around the peduncle region between 8 and 12 days of storage at room temperature.

1. Introduction

Guava (*Psidium guajava* L.) is a tasty sweet fruit native from Central and South America. The guava tree is a very resistant culture (from the myrtle family—*Myrtaceae*), tolerating high temperatures and drought. It blooms continuously throughout the year, bearing at least two harvests annually (Morton, 1987). For many years guavas were exclusively associated with extractive exploitation. Recently however, in function of its proven nutritional properties (rich in vitamins A, C, iron, calcium and phosphorus), associated with ease of cultivation and a growing demand for manufactured products such as jams, jellies and juices, guavas are now cultivated in many tropical and subtropical countries.

One of the major drawbacks of fresh guava is that it perishes quickly. Guava is a climacteric fruit with elevated respiratory activity and high rate of ethylene production (Reys & Paull, 1995). This leads to a fast senescence process even under controlled refrigerated conditions (Srisvastava & Narasimhan, 1967). Various methods for postharvest conservation have been tried on fresh guavas, including the use of ionizing radiation to prevent microorganism proliferation (Silva, Correia, Moura, Maciel, & Villar, 2011); treatment by immersion in concentrated calcium chloride solution ($CaCl_2$) (Werner, Oliveira, Bona, Cavati, & Gomes, 2009) or calcium chloride associated with gibberellic acid ($C_{19}H_{22}O_6$) (Lima, Durigan, de Souza, & Donadon, 2003); polymeric packaging with controlled atmosphere (Singh & Pal, 2008a) and storage under 1-methylcyclopropene environment (Singh & Pal, 2008b). Additionally, edible coatings such as carnauba wax (Jacomino, Ojeda, Kluge, & Scarpare-Filho, 2003); cellulose emulsions (McGuirre & Hallman, 1995); starch and chitosan solutions (Soares et al., 2011), candelilla wax (Salinas-Hernández, Ulín-Montejo, & Saucedo-Veloz, 2010), milk-protein (Cerqueira, Jacomino, Sasaki, & Alleoni, 2011) and miscellaneous formulations based on gelatin, triacetin and lauric acid (Fakhouri, Batista, & Grosso, 2003) have been tested.

A potential biopolymeric material for edible coatings is cashew gum. Cashew gum (CG) is a non-toxic exudate polysaccharide obtained from the Anacardium occidentale tree. It is water soluble and can be transformed into transparent and resistant films by small additions of plasticizers and carboxymethylcellulose (CMC) (Britto, Rizzo, & Assis, 2012). The CG has a complex structure (Paula, Heatley, & Budd, 1998) and is reported to present antifungal and antibacterial properties against selected pathogenic and spoilage bacteria (Torquato et al., 2004). CG is typically used in popular medicines within Brazil such as cough syrup and as

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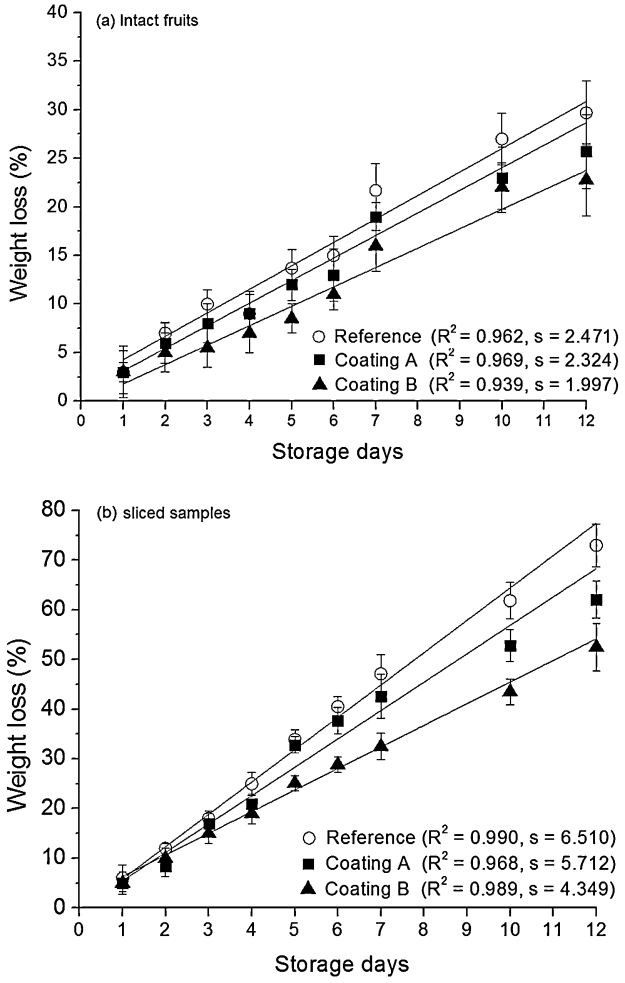

Fig. 1. Effect of CG-coatings of intact (a) and sliced guavas (b) on weight loss when storage at room temperature (25–30 °C and RH of 76.0 ± 12.4%). The error bars indicate the SD of thirty measurements.

thickening agent to stiffen the texture of broths and other liquid foods (Botelho, 1999). As an edible protective coating on fruits, CG with addition of plasticizers has been tested on apples by Carneiro-da-Cunha et al. (2009), with promising results in delaying general senescence.

This study aims to examine the effects of emulsions based on CG associated to CMC as edible coatings in prolonging the shelf life of intact and cut guavas stored at room temperature.

2. Materials and methods

2.1. Preparation of film-forming solutions

Crude natural exudate cashew gum was provided by Embrapa Agroindústria Tropical (CNPAT, Fortaleza, Brazil) and collected from cultivated *Anacardium occidentale* L. trees. Compositional analysis as reported by Paula, Heatley, and Budd (1998) revealed that the cashew gum structure is formed by complex chains of arabinogalactans rich in β-D-galactopyranose (72%) and α-D-glucopyranose (14%), with small fraction of arabinofuranose (4.6%), glucuronic acid (4.7%) and rhamnose (3.2%).

The CG was ground for composition homogenization and dissolved in distilled water under magnetic stirring at room temperature for 1 h. After another hour, in resting state, the precipitated gum was recovered (around 90% w/w) by suction filtration and the supernatant discarded. The recovered CG was dried in vacuum oven at 60 °C for 12 h and stored.

The coating formulations were then prepared by redissolution of the purified CG (1% w/w) in deionized water (pH 6.8). After complete solubilization, carboxymethylcellulose (CMC—Synth, Brazil) was separately added in two concentrations: 1 and 2% (w/v). Subsequently 1% (v/v) of glycerol (Gly—Synth, Brazil) was added to the solution as a plasticizer. The mixture was prepared in 500 ml beaker and moderately stirred with a magnetic bar at room temperature (~2 h) to assure homogenization.

Previous studies showed that pure cashew gum has no ability to form homogeneous films (Britto, Rizzo, & Assis, 2012), requiring the association with small amount of plasticizers and other polysaccharides such as CMC, which presents good filmogenic capacity, assuring the formation of a homogenous structures. For identification coating A refers to the composition made of 1% CG; 1% CMC; 1% Gly and coating B refers that of 1% CG; 2% CMC; 1% Gly.

2.2. Coating of guavas

Red guavas of *Kumagai* cultivar were acquired at the Terminal Market of Araraquara (SP, Brazil). The fruits were picked from the same lot and on the same day after delivery, reflecting at first, the same degree of maturity. The samples were sorted into similar size and mass (around 180–220 g) and without any physical damage or

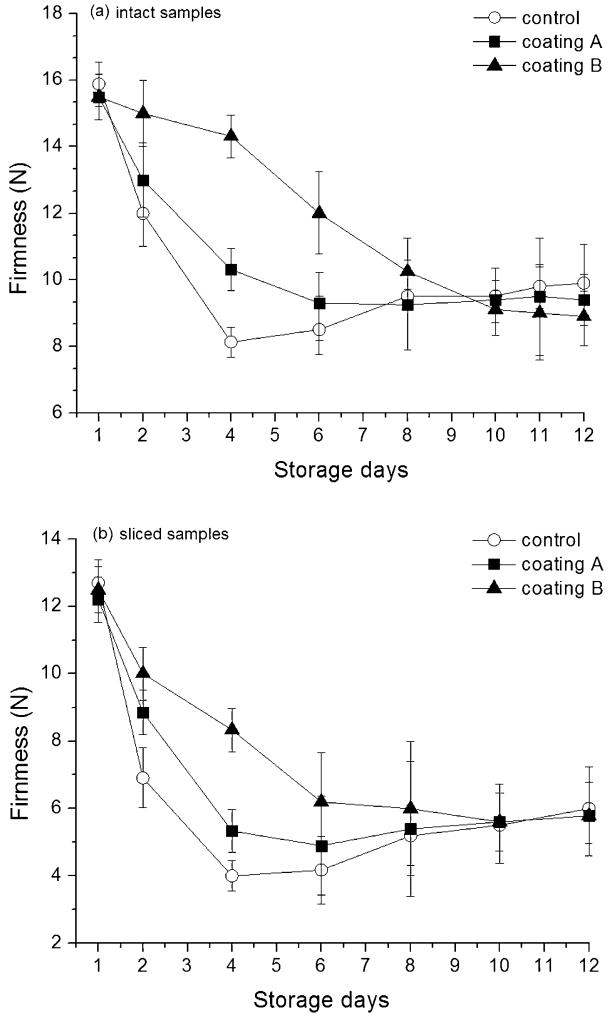

Fig. 2. Firmness of intact and cut guavas (uncoated and coated) during storage at room temperature and RH of 76.0 ± 12.4%. For sliced guavas the mesocarp region was probed. The error bars indicate the SD of nine measurements.