Evaluation of Edible Coatings in Fresh Cuts Mango Fruits

M. Freire Jr.[1]; M. Lebrun [2]; M.N. Ducamp [2]; M. Reynes [2]
[1]Embrapa Food Technology
e-mail: mfreire@ctaa.embrapa.br
[2]Cirad Flhor

Abstract

The potential benefits of edible films or coatings are to stabilize the product and thereby extend it shelf life. Edible films can delay ripening of climacteric fruit, delay colour changes in non-climacteric fruit, reduce water loss, reduce decay, and improve appearance. The aim of this work was to evaluate the use of edible coatings to preserve the quality of fresh cut mango fruits storage under refrigeration. Mangoes (*Mangifera indica* L.) cv. Kent cultivated in Ivory Coast were used as raw material. Four treatments were evaluated: 1% Sodium Carboxy Methyl Cellulose, 0,75% Chitosan, 1% Dextrin potato starch. and distilled water as a control treatment. The mango cubes were dipped in the coating solutions and placed polypropylene plastic trays sealed with polypropylene film. The trays were stored at 4°C for up to 9 days. At 3-days intervals, the fruits were taken for evaluation. The fresh-cut mango treated with Chitosan showed lowest respiratory quotient and the best appearance, a clear yellow colour without browning.

Keywords: fresh-cut; mangoes; edible films; coatings; chitosan

INTRODUCTION

A continuously increasing demand for fresh-cut mango mostly used as fresh-cut products or ready-to-use products is expected to attend restaurants, supermarkets, hotels, industrial kitchens, fast foods chains, caterings, hospitals, schools and others.

Minimally processed products (MPP) deteriorate because of physiological ageing and biochemical changes that may result in degradation of colour, texture and flavour of the produce. The potential benefits of edible films or coating for MPP are to stabilize the product and thereby extend its shelf life. Edible films can create a modified atmosphere, in the product, which is a function of coating permeability and fruit respiration. Edible films or coatings have the potential to reduce or control moisture transfer between food and the surrounding environment to restrict oxygen transfer thus reducing oxygen partial pressure within the package, thereby in a decreasing of the metabolism rate, and controlling respiration, and to carry additives that retard discoloration (KESTER & FENNEMA, 1986; LABUZA & BREENE, 1989; BALDWIN *et al*., 1995). Stearic acid and ascorbic acid or citric acid would be add to the coating formulation as a additives and/or antioxidants, to control the barrier properties for water and oxygen transfer and to reduce the losses (% vitamin C)(AYRANCI & TUNC, 2004).

Investigations on the use of edible films on fresh-cut mangoes are lacking, so, the aim of this work was to evaluate their use to preserve the quality of this product, evaluating some physical and chemical characteristics during their storage, during refrigeration.

MATERIALS AND METHODS

Raw material

Mangoes (*Mangifera indica* L.) cv. Kent, cultivated in Ivory Coast, obtained from a wholesale market near Montpellier, FR, were used for this study. Fruits were sorted to eliminate those either damaged or defective, cleaned and washed in 200 ppm chlorine solution. After disinfecting, fruit were manually sliced with a sharp knife and cut in pieces (2 x 2 cm) and immersed in 40 ppm cold chlorine water (5 °C).

Edible coatings

Four treatments were evaluated (i) solution containing 1% Sodium Carboxy methyl cellulose (CMC, from Fluka Chemika) + 0,5% citric acid (Fluka Chemika) + 0,05% estearic acid (Fluka Chemika) + 0,5% ascorbic acid (Aldrich 99% pure*)*; (ii) solution containing 0,75% Chitosan + 3% citric acid; (iii) solution containing 1% Dextrin potato starch (Fluka Chemika) + 1% calcium lactate (Fluka Chemika) + 0,5% ascorbic acid. Distilled water was used as a control treatment. The mango pieces were dipped for 2 min in coated solutions, drained and placed in a 0,5 L polypropylene plastic tray (130 to 140 g/tray). Trays were sealed with polypropylene film (thickness 40µ) using a thermal sealer (model La barket Befor). After sealing, 10 trays per treatment were stored at 4°C for up to 9 days.

Analytical procedures

At each 3-days intervals, two trays per treatment were taken for evaluation of quality changes. O_2 and CO_2 concentrations were measured by withdrawing air samples through a gas analyser (Checkmate 9900 PBI Dansensor Danemark). The results were expressed as a percentage (%). To determine the respiratory rate,O_2 and CO_2 concentrations were measured at one-hour intervals for four consecutive hours, by withdrawing air samples through the same gas analyser. To calculate the intensity respiratory software developed by Varoquaux *et al.*, 2002. was used

The covering film was then removed and the mango pieces from each treatment were evaluated for firmness and colour (L^* and b^* values). Colour (L^* and b^* values, representing lightness brightness and yellow colour) was measured at the centre of each using a Minolta CR-300 Chromameter (Minolta, Japan), calibrated to a white plate using the CIE L*, a* and b* system. Twenty pieces per replicate were evaluated from each treatment. A decrease of L^* values indicated a loss of brightness, and a more positive b^* values indicated yellowing.

Firmness was determined transversally on the pieces with the aid of a Texture Analyser TA-TX2 (Texture Technologies Corp., Scarsdale, NY, USA) using a system of 2 mm diameter probe inserted to a distance of 2mm.

After firmness and colour measurements, the pieces of each treatment were blended and evaluated for total titrable acidity, pH and total soluble solids. Total soluble solids measurements were carried out using hand refractometers with scale ranges of 0–32 °Brix (Codiam Scientific 700001). The pH was measured by using a pHmeter CG 842 (Schott, USA; electrode Blue Line 14 pH). Total titrable acidity was determined by titration with NaOH 0,1N until pH 8.1.

Statistical analysis were carried out by variance analysis using 5% LSD with Excel 2000 Software.

RESULTS AND DISCUSSION

Raw Material

Table 1 shows the characteristics of the raw material characterisation. The fruits showed a wide variation related to colour and firmness. These properties had a high coefficient variation between the samples, which influenced the interpretation of some of the results.

Table 1: Raw material characterisation

Analysis	Mean	Coefficient of Variation (%)
Total soluble solids (°Brix)	13 ± 0.0	0
pH	3.92 ± 0.0	0
Total titrable acidity (meq/100g)	7.4 ± 0.0	0
Firmness (Newton)		
Peel	17.7 ± 5.3	30.2
Pulp	3.1 ± 1.3	42.7
Colour		
Peel		
*L**	51 ± 4.9	9.7
*b**	31 ± 6.3	20.2
Pulp		
*L**	78.3 ± 3.0	3.9
*b**	59.4 ± 5.0	8.4

Fresh-cut Treated Mangoes

The analysis of total soluble solids showed no significative difference between the treatments. The total soluble solids of the fruits ranged from 12°Brix to 13°Brix.

Table 2 summarises the physical-chemical characterisation of the fresh cut mangoes submitted to the different coating solution and storage at 4°C for nine days.

Comparing all the treatments, the chitosan treatment had the lowest pH value, without resulting in an undesirable sour taste. The use of preservatives (Chitosan) or acidulants (citric acid) and low pH levels are effective methods that may be synergistic for controlling the presence of surface microorganisms on cut products. The effect of low pH in a coating alone may not be adequately effective against bacterial populations (BALDWIN *et al.*, 1996).

The chitosan treatment showed greater values of acidity in relation to the other treatments throughout the storage period. Reduction in total titrable acidity content over time is another indicator of ripening, as organic acids are also used during respiration (LIZADA, 1993).

Similar patterns in the reduction of oxygen and the increase of carbon dioxide levels were observed in control and treated samples. Oxygen levels decreased continuously in control and CMC treated samples to a concentration while chitosane and dextrin treatments showed a continuous decay up to 4% and 7%, respectively. Figures 1 and 2 show the in-package (O_2 and CO_2) changes of fresh-cut mango under different treatments.

The CO_2 levels increased more rapidly in control and CMC treated fruits than in chitosan and dextrin ones. CO_2 content accumulated progressively, reaching slightly higher levels than those of dextrin at the end of storage period. The behaviour observed in the dextrin treatment was different. The modified atmospheres created inside the packages of mango slices did not induce any noticeable presence of ethanol and acetaldehyde for the consumer. Previously, it had been observed that mango fruit is very tolerant to very low O_2 concentration(< 0.5%) (YAHIA & VASQUEZ, 1993). Generally, the tolerance of fresh-cut slices is higher than that of intact fruit (WILEY, 1994). RATTANAPANONE & WATADA (2000) found that low oxygen atmospheres had minimal effect, if any, on the physical-chemical change of mango cubes during storage in low oxygen atmospheres. The firmness results showed no differences between the treatments. During the storage period, the firmness coefficient of variation of the samples ranged from 40% to 50%. This result suggest that it is essential and very important to review the initial fruit maturity and your uniformity before processing (Figure 3).

Table 2: Total soluble solids, total titrable acidity and pH of fresh-cut treated mango stored at 4°C.

	Total soluble solids (°Brix)		
	3 day	6 day	9 day
Water	12,6 aA	12,2 aA	12,2 aA
CMC	12,2 aA	12,6 aA	12,6 aA
Chitosan	12,2 aA	12,4 aA	12,0 aA
Dextrin	12,2 aA	12,0 aA	12,0 aA

	Total titrable acidity (meq/100g)		
	3 day	6 day	9 day
Control	8,25 aA	7,75 aA	8,78 bA
CMC	8,45 aA	7,65 bA	7,30 bB
Chitosan	10,40 aB	10,45 aB	9,23 bC
Dextrin	6,85 aC	5,98 bC	6,88 cD

	pH		
	3 day	6 day	9 day
Control	3.74 aA	3.82 bA	3.82 bA
CMC	3.78 aB	3.88 bB	3.84 bA
Chitosan	3.62 aC	3.64 aC	3.59 aB
Dextrin	3.96 aD	4.00 aD	3.83 bA

Same lower case letters in the same horizontal line indicate non-signifient differences during storage time
Same capital letters in vertical line indicate no-significant differences between treatments.

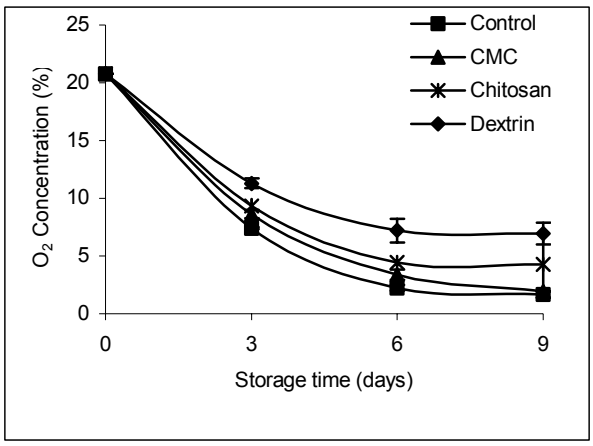

Figure 1: O_2 concentration in the packages of fresh-cut mango storage at 4°C.

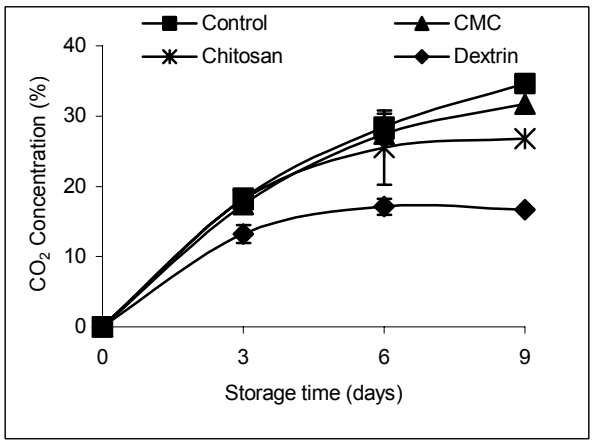

Figure 2: CO_2 concentration in the packages of fresh-cut mango storage at 4°C.

During the first 3 days of storage, browning and decay symptoms do not appear and after the 6 days, decay symptoms were observed only in untreated pieces (control) and in dextrin treatment (data not shown). After this period, deterioration became more noticeable.

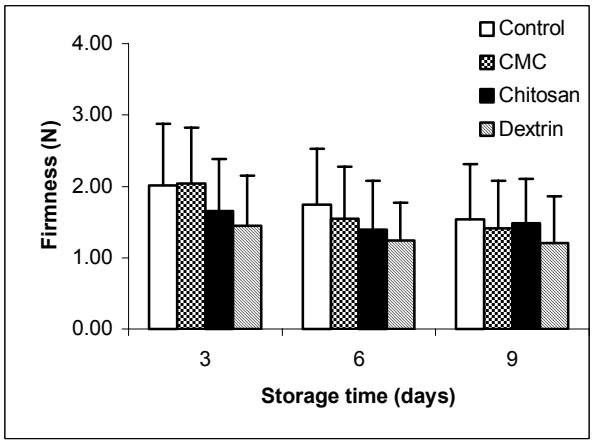

Figure 3: Firmness of fresh-cut mango stored at 4°C.

After nine days of storage at 4 °C, fresh-cut mango treated with chitosan had better visual quality, and yellow colour (value *L** and *b** more positive) and fewer symptoms of browning and decay, followed by CMC treatment. The great diversity of colour in the initial raw material, which had coefficient variation of 78%and the use of average values can explain these results. Control fruits and the dextrin treatment showed many dark cubes. As already mentioned some raw material properties such as the colour has high variation coefficients of variation (42%), which associated with the use of average values led to inexact interpretations of the effect of the treatments on these properties (Figures 4 and 5).

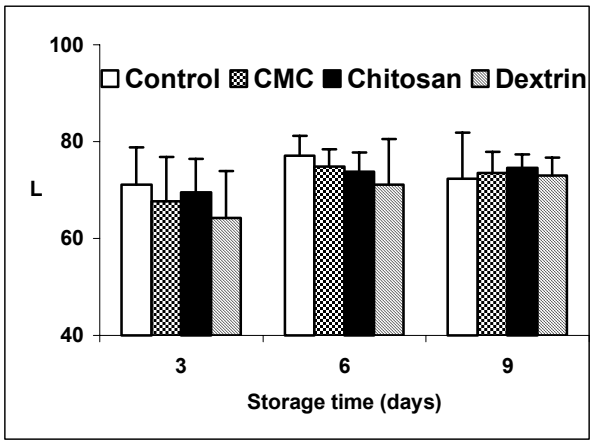

Figure 4 : Colour (Brightness *L value) of fresh-cut mangoes stored at 4°C.**

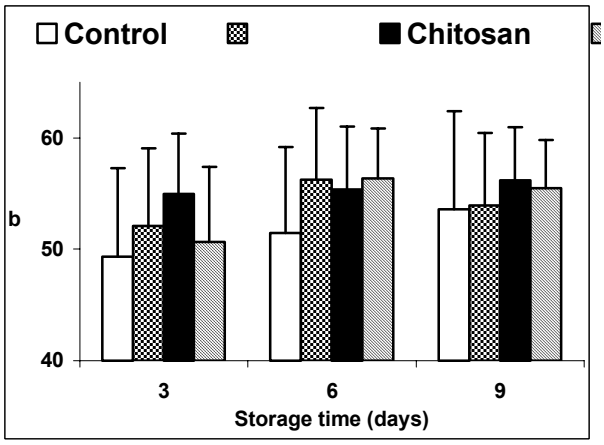

Figure 5: Colour (*b value) of fresh-cut mangoes stored at 4°C.**

Respiratory Intensity

Edible coating applied to the minimally processed mango have successfully slowed the respiration rate and decrease the rate of quality changes (PURWADARIA & WURYANI, 2000). Inconsistent respiration data for various fresh-cut mangoes appear in the literature and it is difficult to determine if respiration patterns in fresh-cut mangoes are due to variety, post harvest treatments or modified atmosphere packaging (BEAULIEU & LEA, 2003).

Table 3 shows the results of the tests carried out to determine the respiration rate. The trials were carried out with green and mature fresh cut mangoes and in fresh cut mangoes treated with chitosan and CMC. The dextrin treatment was excluded due to the bad colour presentation development during the first experiment.

One subjective evaluation of the fresh-cut mangoes showed that the CMC coating resulted in apparent browning, no taste alteration and firmer pieces and the chitosan coated fruits showed no browning, clearer (yellow) colour and also no taste alteration. The control samples (distilled water) presented sufficiently browning and softer pieces.

Table 3: Changes in respiration rate (RR O_2 and RR CO_2) and respiratory coefficient (RQ) for fresh cut mangoes treated with coatings and stored at 23°C.

Products	T (°C)	IR O_2	IR CO_2	RQ
Mature mangoes	23	1.50	3.92	**2.61**
Control	23	1.34	2.29	**1.71**
Carboxy methyl cellulose	23	1.19	2.02	**1.70**
Chitosan	23	1.24	1.71	**1.38**

In this study (data not show), after 2-days at 23°C, fresh-cut mangoes (control) showed bad appearance, sufficiently browning and pieces softer. Fresh-cut mangoes with CMC treatment showed apparent browning, no taste alteration and firmer. pieces Due to its ability to form semi permeable films, chitosan coating can be expected to modify the internal atmosphere as well as decrease the transpiration loss (EL GHAOUTH *et al.*, 1991b) and delay the ripening of fruits (EL GHAOUTH *et al.*, 1992). These results may be attributed to decreased respiration rates, inhibition of fungal development and the delay of ripening due to the reduction of ethylene and carbon dioxide evolution (DU *et al.*, 1997; EL GHAOUTH *et al.*, 1991a). The results are in agreement with those of MILLER & KROCHTA (1997) who pointed out that chitosan coatings are effective in extending the shelf-life of fresh fruits by modifying the oxygen and carbon dioxide transfers and are also in agreement with KITTUR *et al.* (1998) who reported that chitosan films have moderate water permeability values and could be used to increase the storage life of fresh produce and foodstuffs with higher water activity values.

It is important to evaluate the changes in fresh-cut mango quality with regard to initial fruit maturity and uniformity of the pulp colour and source. This is especially true because significant flavour and aroma differences have been reported for mature-green versus ripe mangoes and for different mango varieties (BEAULIEU & LEA, 2003).

CONCLUSIONS

Absolute uniformisation of the initial raw material used for processing is essential to deliver optimum appearance, sweetness and quality of fresh-cut mango.

The fresh-cut mango treated with chitosan showed the lowest respiratory quotient and the best appearance, clear yellow colour, without browning and no taste alteration.

According to the results obtained in this study, the chitosan treatment shows the best results in relation to the others treatment after 9 days of storage at 4°C and could be used to maintain the quality of fresh-cut mangoes without detrimentally affecting physical-chemical characteristics.

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