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A novel approach for quality maintenance and shelf life extension of fresh-cut Kajari melon: Effect of treatments with honey and soy protein isolate

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ABSTRACT

Effect of treatments with different concentrations of honey (0 mL/L of water, 50 mL/L of water, 100 mL/L of water, 150 mL/L of water) followed by coating with soy protein isolate (50 g/L of water) on fresh-cut Kajari melons was investigated. Effect of honey separately without soy protein isolate coating was also investigated. The treatments were given prior to packing the samples in polypropylene trays and stored at 4 °C for sensory and overall shelf life studies. A total of eight combinations of samples with three replicates each were analyzed for various quality attributes throughout the storage life. Highest weight loss occurred in untreated melon samples. Sample treated with 150 mL honey/L of water +50 g SPI/L of water maintained highest total soluble solids throughout the storage. Sensory scores below 5 were given to control sample after day 8 of storage. Samples treated with honey (150 mL/L of water) showed better results in terms of most of the sensory characteristics. Ripening index decreased remarkably over the storage period with control sample reaching lowest values in comparison to treated samples. Total plate count of 9.63 log colony forming units per gram (CFU/g) for control sample and counts of less than 5 log CFU/g for treated samples were observed at the end of the storage.

1. Introduction

Melon (*Cucumis melo*) is a popular fruit grown and consumed all over the world. Kajari is one among the different varieties of melon which is believed to be originated from India. It has a smooth orange colored rind with white and green stripes, green color flesh and a large seed cavity. It is widely available in Indian markets however, for a short seasonal period. Novel strategies including fresh-cut processing may be effective to reduce quantity loss during storage of such highly perishable whole fruits. Fresh-cut fruit and vegetable market is expanding at a rapid pace largely due to the convenience to consumers. Melon is considered as one of the most important fruits in fresh-cut fruit market sector (Fundo et al., 2015). Nevertheless, fresh-cut fruits are highly perishable and have a very short shelf-life. In fact fresh-cut processing leads to increased biochemical changes and renders the commodity more susceptible to microbial deterioration (Qadri, Yousuf, & Srivastava, 2016). Thus to avoid such problems and to enhance the storage stability of fresh-cut fruits, various approaches have been investigated by the researchers. One of the promising approaches is applying edible coating and other chemical treatments to fresh-cut fruit surfaces to improve quality and shelf life of such products. Edible coatings may act as semipermeable barrier to gases and water vapor, slow down rate of respiration, water loss and enzymatic browning of the fruit tissue (Perez-Gago, Serra, Alonso, Mateos, & Rio, 2005). Depending up on the material used in the formulation, the coatings may be polysaccharide, protein or lipid based (Qadri et al., 2016).

Proteins from various sources exhibit excellent coating or film forming properties. Among protein based coatings, soy protein isolate (SPI) is potential candidate and a commonly used material for production of biodegradable biopolymer films which provide an effective barrier to oxygen but exhibit poor water vapor barrier properties. Nonetheless, they have been extensively used as edible films and coating in food industry for being environmentally friendly and having a promising scope to develop novel food packaging (Kim, Weller, Hanna, & Gennadios, 2002). Additionally, they are abundant and cost effective and have been used in different composite coating formulations for fresh and fresh-cut products (Ghidelli, Mateos, Rojas-Argudo, & Perez-Gago, 2014;

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Ghidelli, Mateos, Rojas-Argudo, & Pérez-Gago, 2015). Eswaranandam, Hettiarachchy, and Meullenet (2006) suggested that soy protein films can be used to coat the whole apples and the fresh-cut cantaloupes without affecting the sensory properties. Likewise, there are numerous studies regarding soy protein isolate as a coating or film forming material (Cho, Park, Batt, & Thomas, 2007; Hopkins, Chang, Lam, & Nickerson, 2015; Kokoszka, Debeaufort, Hambleton, Lenart, & Voilley, 2010; Rhim, Lee, & Ng, 2007; Sivarooban, Hettiarachchy, & Johnson, 2008; Su, Huang, Yuan, Wang, & Li, 2010; Wang, Hu, Ma, & Wang, 2016) and its application on different foods (Kang, Kim,You, Lacroix & Han, 2013). Recently, Koshy, Mary, Thomas, and Pothan (2015) have presented a detailed review regarding soy protein isolate based materials and discussed their applications in the field of food preservation and packaging technology. Earlier, Singh, Kumar, Sabapathy, & Bawa, (2008) have compiled a comprehensive review on functional and edible uses of soy protein products. From industrial point of view, use of soy protein based coatings and films are feasible due to its availability, inexpensive and edible or completely biodegradable nature.

Natural preservatives are always appreciated by consumers. Honey in combination with vacuum impregnation has been used to prevent enzymatic browning of fresh-cut apples (Jeon & Zhao, 2005). Nyawali et al. (2015) also used honey for enzymatic browning reduction in white cabbage. Aloe vera gel and honey based edible coating for fresh-cut papaya has been observed to have a preventive role towards quality maintenance by retention of total phenols and ascorbic acid, reduced microbial load and relatively low Polyphenol oxidase and Peroxidase activity (Kuwar, Sharma, & Tadapaneni, 2015). Honey solution dip treatments have yielded promising results in maintaining the overall quality of minimally processed grapes (Sabir, Sabir, & Kara, 2011). In addition to antibrowning nature, honey has a proven antimicrobial activity (Mandal & Mandal, 2011), though the mechanism of inhibition is not still clear and is believed to be the combined effect of different causes. Researchers have demonstrated that honey possess effective antimicrobial properties against various species of human pathogens such as *Escherichia*, *Enterobacter*, *Salmonella* and *Staphyllococus*. Honey also possess antioxidant activity and has potential applications in foods as a natural ingredient including in minimal processing industry (Garcia & Barrett, 2002).

To our knowledge, till date honey and soy protein isolate treatments have not been investigated on fresh-cut melons. Therefore, in context with the above discussion, this work was aimed to investigate the effect of honey and soy protein isolate on the quality attributes and storage stability of fresh-cut Kajari melon at 4 °C for 12 days.

2. Material and methods

2.1. Melon

Fresh Kajari melon of uniform shape, size and maturity were purchased from local market of Aligarh, India. Melons free of any bruises were washed and equilibrated at 5 °C. Outer rind of the melons was removed by using sharp edged knives and the fruits were cut into two equal halves. Seeds were scraped off from the seed cavity. Further processing of the fruit was carried out by preparing uniform trapezoid shaped pieces with the help of sharp stainless steel knives. Food grade polyethylene gloves were used during whole process of preparation of melon pieces.

2.2. Other materials

The material used in packaging of melon pieces included Polypropylene (PP) trays (Saran™ with oxygen and water vapor transmission properties 800 mL/m^2/24 h and 13 g/m^2/24 h respectively) and polyvinyl chloride (PVC) stretch wrapping films (Silver Wrap™ with oxygen and water vapor transmission properties 320 mL/m^2/24 h and 8 g/m^2/24 h respectively). Honey (Dabur™, Dabur India Ltd., Ghaziabad, India) was slightly brown in color with mustard as floral source and composition as: carbohydrates (80 g/100 g), protein (0 g/100 g), fat (0 g/100 g), sodium (17 mg/100 g), potassium (138 mg/100 g), calcium (13 mg/100 g), iron (1.5 mg/100 g), phosphorus (5 mg/100 g). Soy protein isolate (JEECON™) containing 90% protein, flavorless and dull white in color was purchased from Jeecon Foods, New Delhi, India.

2.3. Preparation of coating solutions and experimental design

Coatings were prepared by carefully dissolving the ingredients in double distilled water. Effect of honey with and without SPI coating treatment was investigated. Preliminary experiments were performed to choose the appropriate concentrations of the honey and SPI so as to obtain better results for storage of fresh-cut melon. Different combinations of treatments were applied by using honey and soy protein isolate as described ahead. A total of 480 fresh-cut pieces of melon were prepared (described in sub-section 2.1) and grouped in four lots for day 1, 4, 8, 12 of analysis. Each lot consisted of eight samples and each sample consisted of 15 melon pieces weighing 150 g. Briefly, for each lot, first four samples were treated only with honey at concentration of 0 mL/L of water, 50 mL/L of water, 100 mL/L of water and 150 mL/L of water. Another four samples were treated with honey at same concentration as 0 mL/L of water, 50 mL/L of water, 100 mL/L of water and 150 mL/L of water followed by coating with SPI (50 g/L of water) in all the four samples. The samples treated with SPI in addition to honey treatments were first dipped in the honey solutions for 2 min and then the excess solution was allowed to drip off by putting the melon pieces on a blotting paper for 3 min. The samples were then dipped in SPI coating solution for 2 min. After removing from the coating solution, the excess coating solution was allowed to drip off. The first sample which was given none of the treatments (i.e. 0 mL honey/L of water and 0 g SPI/L of water) was labeled as control sample. All the samples except control sample were also pretreated with 10 g calcium chloride/L of water to maintain firmness. After coating, the samples were packaged in polypropylene trays and wrapped with PVC stretch wrapping films. The trays were then stored at 4 °C for further analysis and shelf life studies at day 1, 4, 8 and 12 of storage period. For replicates the whole study was repeated two more times.

2.4. Weight loss

Weight of whole package on each day of analysis was measured by using laboratory scale digital weighing balance (BL-220H, Shumadzu Corporation, Kyoto, Japan) with accuracy of 0.001 g. Weight loss was determined by comparing the weights of samples during 12 days of storage with initial weights and the values were expressed as percentage weight loss.

2.5. Total soluble solids (TSS), pH and titratable acidity

To measure total soluble solids (TSS) content, samples were crushed to extract juice. The TSS of the juice was estimated by using a bench refractometer (Metzer Optical Instruments, Mathura, India) and the values were expressed as degree brix (°B).

The pH was determined by digital pH meter (Cyberscan pH-1500, Ectech Instruments, Ayer Rajah, Singapore) using the AOAC method 981.12 (AOAC., 1990a) as reported by Mantilla, Castell-