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Muhammad Farooq
Institute of Food Science & Technology, Sindh Agriculture University Tandojam, Hyderabad, Sindh, Pakistan

Amir Gull
Department of Food Engineering and Technology, SLIET Longowal, Sangrur Punjab, India

Gulzar Ahmad Nayik
Department of Food Engineering and Technology, SLIET Longowal, Sangrur Punjab, India

Correspondence
Muhammad Farooq
Institute of Food Science & Technology, Sindh Agriculture University Tandojam, Hyderabad, Sindh, Pakistan

Application of biopolymer in postharvest shelf life enhancement of strawberry fruit

Muhammad Farooq, Amir Gull and Gulzar Ahmad Nayik

Abstract
The objective of this study was to examine how biopolymer coatings at concentrations (1, 2% w/v) incorporated with anti-browning agents (0.75% w/v) influenced the characteristics of strawberry fruit during refrigeration storage. The addition of biopolymer coatings increased the firmness, reduced browning index compared to the control. Emulsion coated samples also showed significant ($p \leq 0.05$) increase in DPPH radical scavenging activity compared to the control sample. The present study confirmed that biopolymer coatings could be used to extend the postharvest shelf life of fruits especially strawberry.

Keywords: strawberry, coatings, shelf life, biopolymer, DPPH

Introduction
Strawberries (*Fragaria x ananassa* Duchesne) being most popular non-climacteric fruit; characterized by its desirable flavor and taste is usually consumed either fresh or in processed form. Being potent sources of bioactive compounds such as vitamin C, vitamin E, carotene and anthocyanin's these are known to have protective role against reactive oxygen groups, therefore showed beneficial effect on the consumer health by reducing variegated cancer forms (Van De Velde *et al.*, 2013) [12]. Strawberry fruits are having short shelf life due to its susceptibility to mechanical injury, physiological disorders and activity of enzymes such as polyphenol oxidase and peroxidase, as this cause browning reaction and reduce polyphenol content (Vu *et al.*, 2011) [13]. Several techniques such as low temperature, controlled and modified atmosphere packaging have been developed for fruit preservation, but these always have certain limitations (Sallato *et al.*, 2007) [11]. Usually consumers demand food products with improved quality without addition of chemical preservatives. Hence, there is need to explore effective measures for maintaining nutritional quality and improving shelf life of fruits. This could be made possible by using environment friendly technology such as edible coatings as these have potential to prolong storage life by creating semi permeable barrier around the fruit, therefore does not allow the transfer of gases and moisture (Martinez-Romero *et al.*, 2006; Baldwin, 2001) [7, 1]. To extend shelf life of fruits several polysaccharide types can be used as edible coating by controlling biochemical processes (Oms-Oliu *et al.*, 2008; Rojas-Grau *et al.*, 2007) [9, 10].
Carboxy methyl cellulose received significant attention as it is extensively been used to delay fruit ripening, reduce quality loss in several fresh fruits such as pears and cherries (Zhou *et al.*, 2008; Yaman and Bayoindirli, 2001) [16, 14]. Alginate is derived from marine brown algae (*Phaeophyceae)* also is finding significant use in the food industry as texturizing agent (Mancini & McHugh, 2000) [6]. By incorporating active carriers such as antioxidant and antimicrobial agents in biopolymer coatings provide novel way to improve the shelf-life of fruits (Cagri *et al.* 2004) [2]. Keeping in view the benefits of biopolymer the present work was conducted to study the effect of emulsion coatings loaded with active carrier anti browning agents on quality parameters of strawberry fruit during refrigerated storage.

Material and Methods
Ripe strawberries were supplied by a local distributor and kept in refrigeration condition (4°C) prior to processing. Food grade sodium alginate and carboxy methyl cellulose (Sigma-Aldrich and HiMedia) were the carbohydrate biopolymers used to prepare the coating

formulations. Calcium chloride was used to induce a crosslinking reaction and acetyl cysteine were the added anti browning agent. All other reagents used were of analytical grade.

Emulsion preparation

Emulsions were prepared by dissolving biopolymers, sodium alginate and car boxy methyl cellulose at concentrations (1% and 2% w/v) in distilled water heated at 70°C, while stirring until complete dissolution. For biopolymers cross linking calcium chloride solution (2% w/v) containing *N*-acetyl cysteine at 1% (w/v) was prepared. The mixture was blended using homogenizer for 20 min.

Strawberry fruits were selected based on uniformity of colour, size and deprivation of fungal infection. Fruits were washed with sodium hypochlorite solution, rinsed with tap water and drained. Emulsions were further used as film-forming solutions to form coating onto fruit surface. Fruit were then dipped in emulsions for few minutes at room temperature. Fruits dipped in distilled water are designed as control. Uncoated or coated fruits were placed in polypropylene trays. The fruits were analyzed up to 8 days of storage except the control fruit which was analyzed for up to 6 days only as thereafter they began to decompose.

Physicochemical Properties

Decay percentage was calculated by using the method of (El-Anany *et al.*2009) [3]. Browning index was measured by using the method of (Olivas *et al.*, 2007).Firmness was measured by using texture analyzer (TA-XT2., Stable Micro systems, UK). The maximum force (N) required for the fixed penetration depth (5 mm) was recorded as firmness. Measurements were done in triplicate.

The DPPH radical scavenging activity of strawberry juice was measured according to the DPPH method (Matthus, 2002) [8] with slight modifications.

DPPH scavenged (%) was calculated as:

$$\text{AA (\% inhibition)} = \frac{\text{Absorbance of control} - \text{Absorbance of sample}}{\text{Absorbance of control}} \times 100$$

Statistical analysis

The experiments were carried out in triplicates. The significant differences were obtained by one -way analysis of variance (ANOVA) followed by Duncan's multiple range test (p<0.05) using Statistica V.7.

Results and Discussion

Decay percentage

From the results it was noticed that the decay percentage increased with in all treatments with storage. However, coatings significantly reduced the decay percentage compared to the control (Fig.1). Researcher (Hernandez-Munoz *et al.*, 2008) [4] reported no sign of fungal decay for strawberry fruit coated with 1.5% chitosan during the storage period.

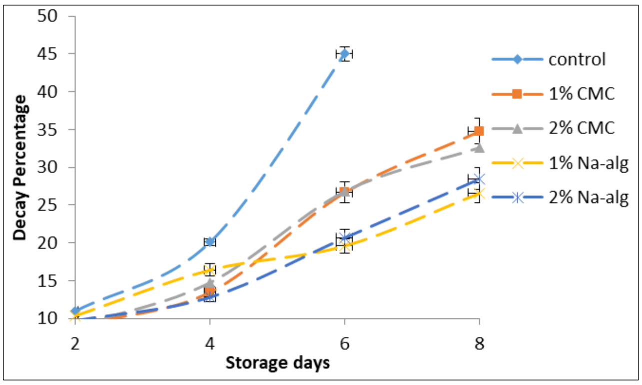

Fig 1: Effect of coatings on decay percentage of coated and uncoated strawberry during storage

Browning index

Browning index is an indicator of brown color intensity. Darkening is main issue particularly in fruits. Fig. 2 shows changes in browning index of coated and uncoated strawberry fruits during storage period of eight days. Results verified that from the 4th storage day, there was a significant reduction (p ≤0.05) of browning index in fruits coated with nano biopolymer coatings compared to the control sample (Fig.2). It was concluded that nano biopolymer coatings incorporated with anti-browning agent were efficient to avoid enzymatic darkening of the tissues.

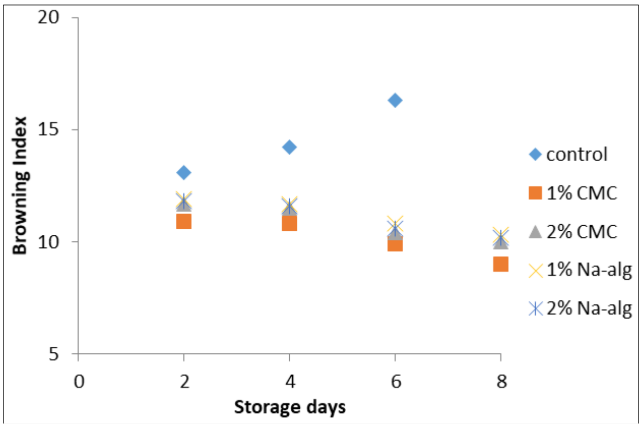

Fig 2: Effect of coatings on browning index of strawberry during storage

Firmness

Results of flesh firmness of coated and uncoated strawberry fruit during storage are shown in (Fig. 3). Firmness is regarded as most desirable quality attribute. Significant differences (P≤0.05) were observed in firmness of coated and uncoated strawberry fruit during storage. Control sample showed sharp decrease in firmness from 13 N-9 N till 6 th day. Moreover it was noticed that nano-coated samples retained firmness during the storage. This may be due to addition of calcium salts which induced biopolymer cross-linking prevents cell wall degradation, thus enhanced fruit firmness.

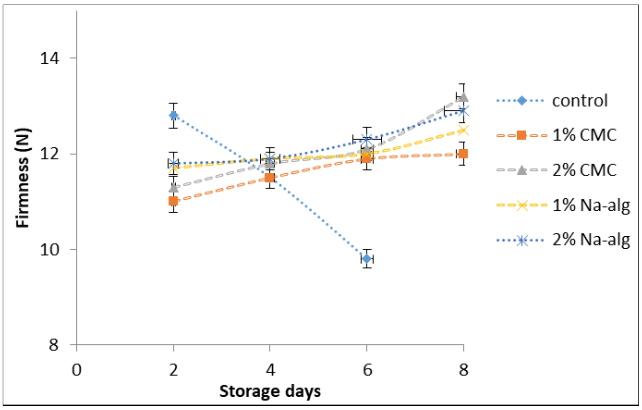

Fig 3: Changes in firmness of coated and uncoated strawberry during storage

DPPH radical scavenging activity

Variation in DPPH radical scavenging activity as a function of coatings and storage time for strawberry fruit are presented in (Fig.4). The main phenolic compounds responsible for the red color in strawberry are anthocyanin's (Lopes da Silva *et al.*, 2007) [5]. Although DPPH radical scavenging of both coated and uncoated strawberry remained maintained up to 4 th storage days, but then decreased sharply until the end of storage days. It was noticed that biopolymer coatings incorporated with N-acetylcysteine maintained the antioxidant capacity of coated strawberry fruit. This may be because coatings reduced oxygen supply for enzymatic oxidation of phenolics. By forming protective barrier on the fruit surface (Zhang and Quantick, 1997) [15]. Oms-Oliu *et al.*, 2008 [9] also reported that antioxidant capacity remained maintained by incorporation of anti-browning agents in coated pears.

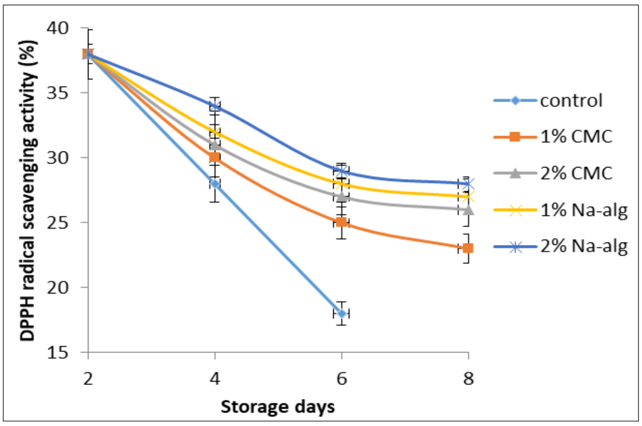

Fig 4: Changes in DPPH activity of coated and uncoated strawberry fruit during storage

Conclusion

Present study revealed that car boxy methyl cellulose and alginate based coatings incorporated with anti-browning agent at 0.75% w/v was effective in maintenance of strawberry fruit quality during storage. Coatings showed superiority in retaining firmness and reduced browning index Thus it is concluded here that car boxy methyl cellulose and alginate are most suitable coating substance for extending shelf life of strawberries.

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