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EFFECT OF *Aloe vera* BASED COMPOSITE EDIBLE COATINGS ON PHYSICAL CHARACTERISTICS OF PEELED CARROTS DURING STORAGE AT ROOM AND REFRIGERATED TEMPERATURES

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Abstract- When carrots are cut and peeled, the whitish appearance or 'white blush' on the surface occurs which reduces consumer acceptance of minimally processed carrots. Aloe gel based composite coatings have shown to prevent loss of moisture, firmness and improves the quality. In the present investigation, three different *Aloe vera* based composite coatings formulations having *Aloe vera* gel viz. 5, 10 and 15%, 0.5% carboxymethyl cellulose, 5% peanut oil and 2% glycerol monostearate were prepared. Glycerol was used as a plasticizer. Uniform healthy peeled carrots coated with *Aloe vera* based composite coatings were packed in low density polythene (400 gauge) bags and stored at room (14±3°C, 47±8%) and refrigerated (5±2°C, 55±2%) conditions. The samples were analyzed for various parameters viz. physiological loss in weight, decay loss and hunter L, a and b value on every 2nd day under room condition and on every 4th day under refrigerated condition. During storage, at both room and refrigerated conditions, physiological loss in weight, decay loss, Hunter L value increased while Hunter a and b value decreased. In coated samples at room and refrigerated temperature, 15% AvCC was most effective in reducing physiological loss in weight (14.3% and 10.9%), decay loss (11.6% and 10.2%), Hunter L a b value (55.9 and 56.0; 33.6 and 34.2; 41.9 and 41.7) followed by 10% and 5% *Aloe vera* based composite coatings as compared to uncoated peeled carrots.

Keywords- *Aloe vera*, Carrots, Minimal processing, Edible coatings, Physiological loss in weight, decay loss, hunter L a b value

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Introduction

Carrots (*Daucus carota*) belongs to family Umbelliferae is one of the most important root crops. The carrot is said to possess many 'ayurvedic medicinal properties'. They are major source of carotenoid [1]. Tremendous growth in the minimally processed (MP) or ready-to-use (RTU) vegetables industry has been largely due to increasing demand for fresh, healthy and convenient foods. However, when carrots are cut and peeled, the whitish appearance or 'white blush' on the surface occurs which is a major factor reducing consumer acceptance of MP carrots. The product loses its firmness and develops odors characteristics of anaerobic catabolism, due to the high respiration rate and microbiological deterioration during storage [2].

High perishability of minimally processed fruits and vegetables makes it necessary to develop methods to preserve commodities for longer time storage. One of the methods is application of edible coatings. The edible coatings are thin layer of edible material applied to the product surface in addition to or as a replacement for natural protective waxy coatings [3]. Edible coatings serves as a partial barrier to gases (like O_2 and CO_2), water vapor and aroma compounds, creating a modified atmosphere around the commodity, decreasing respiration rate of the fruits and the water loss, and preserving texture and flavor. Edible coatings may be composed of hydrocolloids (polysaccharides and proteins), hydrophobic compounds (Lipids or waxes) or of combination of both (composite coatings) [4]. Composite coatings have been successfully employed as a means to improve the barrier characteristics of edible coatings covering fresh fruit. Such strategy takes advantage of the good water barrier properties of lipids and the good gas barrier properties of hydrocolloids. The composite coating are more convenient to apply since they adhere better to a larger number of surfaces due to both polar and non-polar characteristics [5]. Thus, use of composite coatings represents a sound strategy to enhance the coating properties.

Aloe vera belongs to family Liliaceace. The leaves of *Aloe vera* are the source of *Aloe vera* gel. *Aloe vera* gel due to moisturizing effect, antibacterial and antifungal properties [6] can be used to develop novel edible coatings for fruits and vegetables to extend their shelf life. Aloe gel based coatings have shown to prevent loss of moisture and firmness, control respiration rate and maturation development, delay oxidative browning and reduce microorganism proliferation [7]. The literature on the use of *Aloe vera* based composite coatings on minimally processed carrots is very scanty. However, the available literature on the *Aloe vera* coating has been patented. Therefore, to find the effect of *Aloe vera* composite coatings on quality and shelf life of peeled carrots, the present investigation was undertaken with the objective to develop *Aloe vera* based composite coating to evaluate its effect on physical characteristics of minimally processed carrots.

Materials and Methods

The carrots were purchased from local market and the fresh *Aloe vera* leaves were procured from the Department of MA & UUP, CCSHAU, Hisar.

Preparation of *Aloe vera* Gel

The upper epidermis of *Aloe vera* leaves was removed and inner mucilaginous material was cut into small cubes. The mucilaginous cubes were heated up to 80°C for 10 min. The extract was ground and gel was obtained.

Preparation of Composite Coatings

The three composite coating formulations of *Aloe vera* were prepared using 5%, 10% and 15% *Aloe vera* gel with, 0.5% CarboxyMethyl Cellulose (CMC), 5% peanut oil and 2% Glycerol Monostearate (GMS) (emulsifier) and homogenized at 4000 rpm for 30 sec in hot water. The glycerol was used as a plasticizer. Water was used as a solvent for preparation of various coatings. Before coating, all the formulations were cooled to ambient temperature and were applied on carrots using brush.

Preparation of Controls and Coated Carrots

Uniform and healthy red carrots were procured in the month of January. Injured and diseased carrots were discarded. The treatments were washing, peeling, coating with *Aloe vera* composite coatings (5%, 10% and 15%). The control used for comparing the performance of the coated carrots which was peeled uncoated carrots. The control was kept in low density polyethylene (LDPE) (400 gauge) bags. The carrots were washed, peeled and coated with various *Aloe vera* composite coatings. The coated carrots were air dried and kept in LDPE (400 gauge) bags. The packaged carrots were stored at room and refrigerated conditions.

There were six carrots per pack (500±40g) and six replicates per treatment. The carrots were stored for 12 days at room (14±3°C, 47±8%) and 24 days at refrigerated (5±2°C, 55±2%) conditions. The various observations were recorded on every 2nd day under room condition and on every 4th day under refrigerated condition.

Each of the control and coated commodity was tested for three replicates at both the storage conditions and each variable was tested on three randomly selected carrots. Initial baseline values of each tested variable were established on zero day of the test period. The methodologies adopted for various parameters have been described below:

Analysis of Control and Coated Carrots

Physiological Loss in Weight (PLW %)

At the beginning of the storage period, initial weight of the carrots was recorded along with the polyethylene bags. On the day of the analysis, the carrots were weighed along with the bags and the change in weight of carrots was calculated as per cent PLW. The PLW at each of the storage period was commuted with that of the preceding storage period to have total PLW on that day of storage. The PLW (%) for each observation was calculated as:

$$\text{PLW (\%)} = \frac{\text{Initial weight - Final weight}}{\text{Initial weight}} \times 100$$

Decay Loss (%)

The decay loss at each period of analysis during storage was commuted with that of preceding storage period to have total decay loss on the day of storage. After determining PLW, the rotted, decayed carrots were removed from the polyethylene bags and weighed (final weight). Decay loss for each treatment was expressed in terms of percent and calculated as:

$$\text{Decay loss (\%)} = \frac{\text{Initial weight - Final weight}}{\text{Initial weight}} \times 100$$

Color (Hunter L a b Value)

The color of coated and uncoated carrots was measured by using a hand held hunter lab colorimeter (ColorTec-PCM ™, Accuracy Microsensors, Inc. Pittsford, New York). The color was recorded as a three dimensional L a b color solid where, L indicates lightness which is a pole from south to north where zero (south pole) is absolute black and 100 (north pole) is absolute white; a, chromaticity on a green (-) to red (+) axis; b the chromaticity on blue (-) to yellow (+) axis. Six reading on different sites of three carrots were averaged for color measurement of one carrot.

Results and Discussion

Analysis of Control and Coated Carrots

Physiological Loss in Weight (PLW %)

The physiological loss in weight increased significantly with increase in storage at room temperature [Fig-1]. It may be due to high transpirational and respiratory substrate losses. At room temperature, on the final day of storage, maximum PLW was found in peeled carrots and least in unpeeled carrots. Similar trend of increase in PLW was observed during storage at refrigerated temperature. However, the magnitude of losses was much lower at refrigerated temperature in all the treatments with maximum PLW in peeled carrots on 24th day of storage . The higher PLW in uncoated peeled carrots (control) was due to injury caused by peeling which resulted in higher respiration and evapo- transpirational rates. Reduction in losses at low temperature may be due to reduced metabolic activities and evapo-transpirational losses.

The edible coatings significantly reduced the PLW that was probably due to the effect of coatings as a semi permeable barrier against moisture, oxygen, carbon dioxide and solute movement, thereby reducing water loss, respiration and oxidation reaction rates [8]. 15% AvCC had least PLW which may be due to the effective hygroscopic property of *Aloe vera* gel. Thus, resulting in reduced water loss. Jagannath and Gupta [9] showed that uncoated carrots lost a significant amount of weight than the coated material during storage. The respiration and transpiration rate was much lower in peaches coated with sodium alginate and methyl cellulose as compared with the control, which resulted in lower PLW of coated peaches [10].

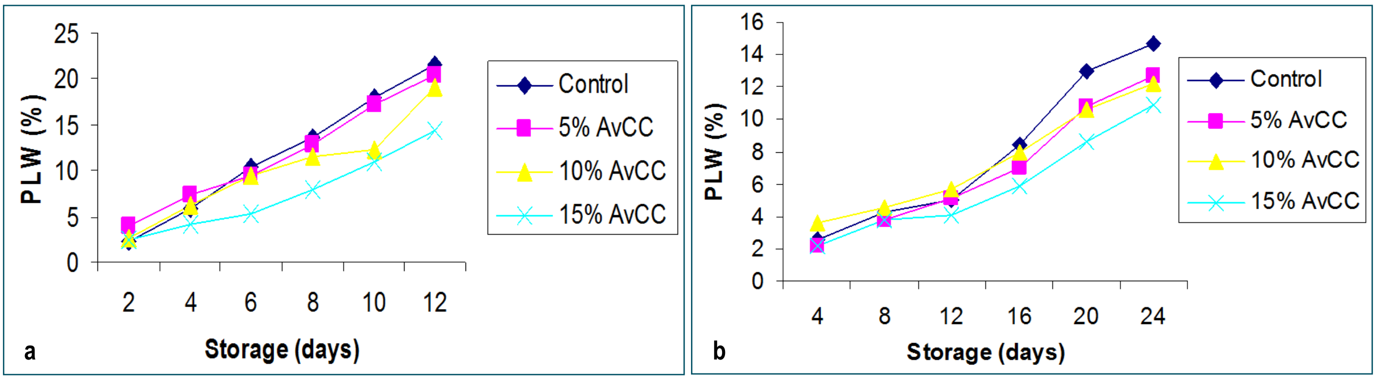

Fig. 1- Effect of *Aloe vera* composite coatings (AvCC) on PLW of peeled carrots during storage at **(a)** room temperature **(b)** refrigerated temperature.

PLW (zero day) = nil; AvCC = Aloe vera based composite coating

Decay Loss (%)

The decay loss was observed on 10th day of storage in all the treatments at room temperature [Table-1]. The maximum pathologicaldecay loss was observed in uncoated peeled carrots (control) because of injury caused by peeling which made the commodity susceptible to decay. The loss was lesser in coated commodity (15% AvCC recorded minimum) as compared to peeled carrots that could be attributed to effective antimicrobial property of *Aloe vera* gel.

Table 1- Effect of *Aloe vera* composite coatings (AvCC) on decay loss of peeled carrots during storage

Treatments	Room Temperature						Refrigerated Temperature					
	Storage (days)											
	2	4	6	8	10	12	4	8	12	16	20	24
Uncoated												
Peeled	No Decay loss				16.3	28.7	No Decay loss					
Coated												
5% AvCC					9	22.6						15.2
10% AvCC					9.4	17						13.8
15% AvCC					6	11.6						10.2

At refrigerated temperature, the decay loss was observed on 24th day of storage. And the lower magnitude of decay loss was found at refrigerated temperature due lower temperature resulting in reduced microbial growth. El-Anany, et al [11] found decrease in decay percentages of coated apples due to the effects of coatings on delaying senescence, which made the commodity less vulnerable to pathogenic infection. Dhall & Mahajan [3] reported reduced decay loss and improved appearance of carrots by chitosan coating.

Color (Hunter L a b Value)

The data revealed that storage had significant effect on the Hunter L a b value of peeled carrots. The Hunter L value, which represents lightness, increased during storage at room and refrigerated temperature [Fig-2]. Significant differences were observed among the treatments with respect to the color of peeled carrots. The maximum increase in Hunter L values in uncoated peeled carrots (control) (59.5) during storage at both room and refrigerated conditions in the present study could be due to the formation of a new protective layer, known as 'white blush', which results in color change due to reversible surface dehydration. Among the coated carrots, the minimum L value observed in 15% AvCC (55.9) could be due to more concentration of *Aloe vera* gel, which has hygroscopic and moisturizing effect resulting in reduction of dehydration on the carrot surface. Howard and Dewi [12] found that carrots treated with edible coatings had lower L values than uncoated carrots because edible coating treatment effectively retarded surface discoloration on mini- peeled carrots and the senescence delay, evidenced by the decrease in color changes, demonstrating the effectiveness of coatings. Similar trend of increase in L value was observed during storage at refrigerated temperature but the magnitude was slightly lower.

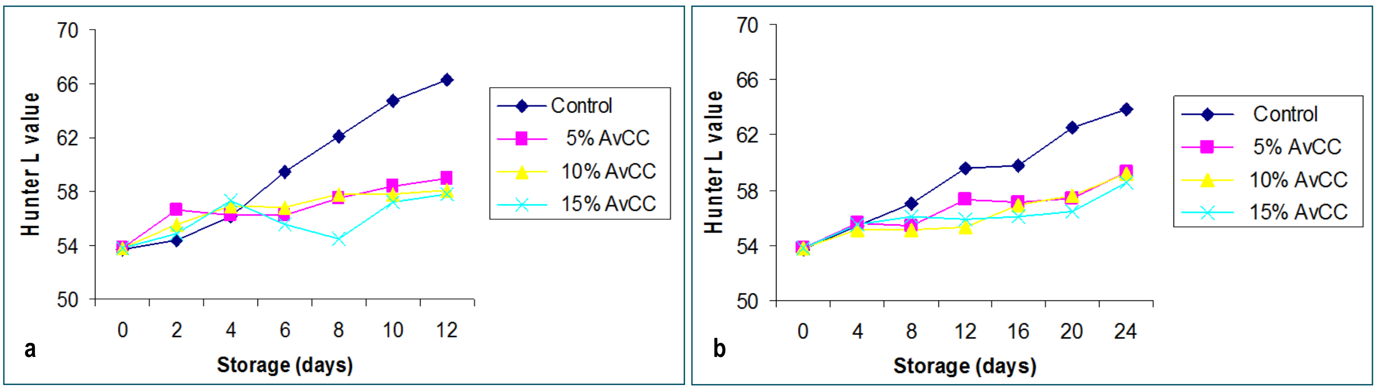

Fig. 2- Effect of *Aloe vera* composite coatings (AvCC) on Hunter L value of peeled carrots during storage at **(a)** room temperature **(b)** refrigerated temperature.

A significant difference in chromaticity coordinates a and b values was found in all the treatments at room as well as refrigerated temperature [Fig-3], [Fig-4]. The a and b values which represents the redness and yellowness, decreased during the storage at both the storage conditions. This may be due to the formation of white blush on the carrot surface. Jagannath and Gupta [9] found that the Hunter values (a/b values) of uncoated carrots decreased drastically. The color change of uncoated carrots was 80% during storage for 7 days. This could have been because of microbial growth and enzyme synthesis leading to discoloration at a much faster rate in the absence of coating. The coated samples showed only 20% change during the storage period. Similar findings were obtained by Cliffe-Byrness & O'Beirne [13] in which L values, increased during storage for 6 days at 4 and 8°C. At both 4 and 8°C, carrots packaged in PA-60 film had higher L values compared with carrots packaged in oriented polypropylene film. The chromaticity coordinates a and b values were found to decrease over storage.

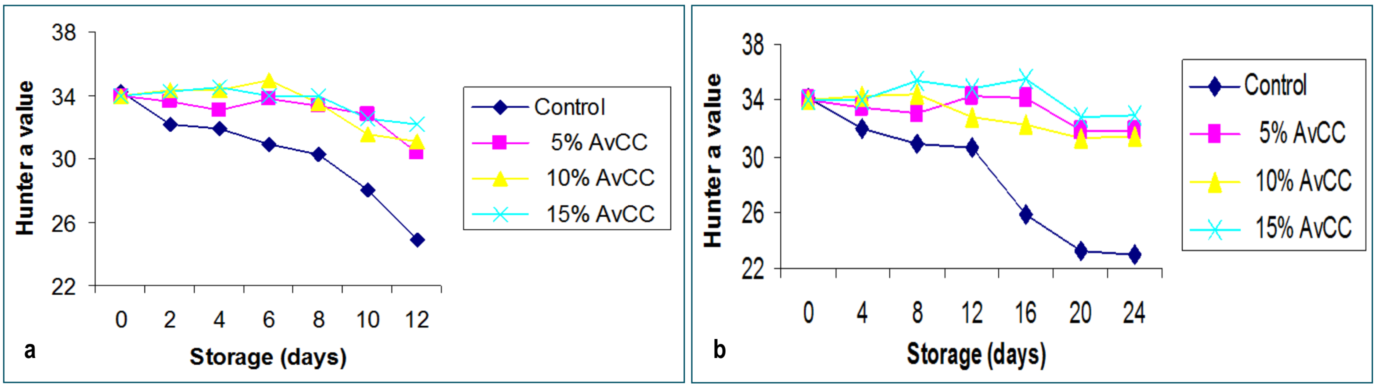

Fig. 3- Effect of *Aloe vera* composite coatings (AvCC) on Hunter a value of peeled carrots during storage at **(a)** room temperature **(b)** refrigerated temperature.

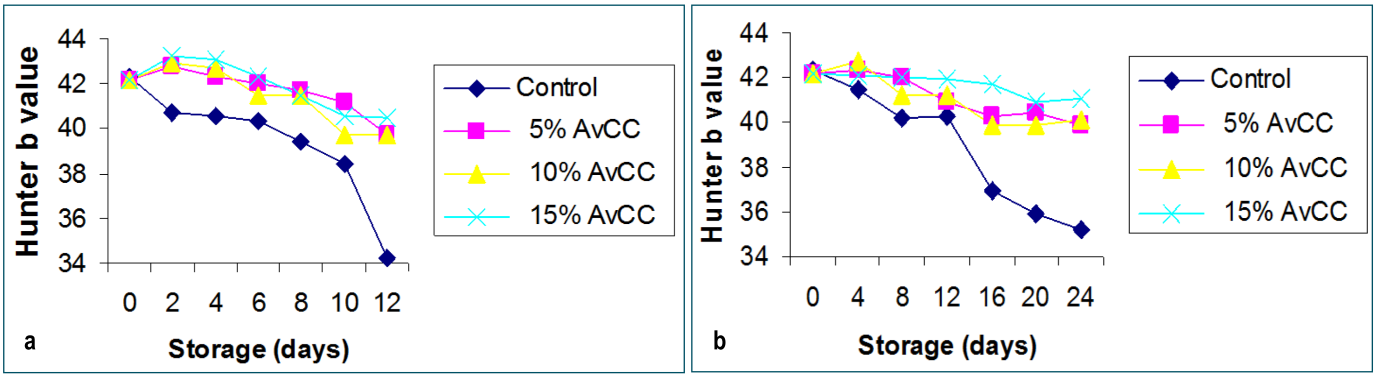

Fig. 4- Effect of *Aloe vera* composite coatings (AvCC) on Hunter b value of peeled carrots during storage at **(a)** room temperature **(b)** refrigerated temperature.

Conclusion

A significant increase in PLW was found with increase in storage at both room and refrigerated temperature. Among coated carrots, 15% AvCC (14.3%) was found to have minimum PLW. The decay loss (%) was observed on 10th and 24th day of storage at room and refrigerated temperature, respectively. The coating having 15% *Aloe vera* showed the least decay loss followed by 10% AvCC and 5% AvCC. The Hunter L value, which represents lightness, increased during storage at room and refrigerated temperature. Among the coated carrots, the maximum L value was observed in 5% AvCC followed by 10% AvCC and 15% AvCC. The a and b values, which represents the redness and yellowness, decreased during the storage at both the room and refrigerated temperature. However, the trend was lowered at refrigerated temperature. Thus, from the results it could be concluded that minimally processed carrots coated with 15% AvCC could be kept wholesome till 12 days at room temperature and 24 days at refrigerated temperature, respectively.

Abbreviations

AvCC: *Aloe vera* composite coatings

CMC: CarboxyMethyl Cellulose

GMS: Glycerol Monostearate

LDPE: Low Density Polyethylene

MA&UUP: Medical Aromatic and Under Utilized Plants

MP: Minimally processed

PLW: Physiological loss in weight

RTU: ready-to-eat

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Conflicts of Interest: None declared.

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