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Edible coatings and plant extract influence decay and biochemical attributes of nectarines

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ABSTRACT

Nectarine has a limited storage life of 3-4 days. During storage, it is infested by several pathogens which cause huge postharvest losses. In addition, fruits lose their quality adversely. Therefore, there is urgent need to reduce losses caused by postharvest pathogens and improve marketability of nectarine fruits by using appropriate eco-friendly approaches. Hence, we attempted the use of different coatings (carboxy methylcellulose, (CMC) and chitosan, (CH) alone and in combination with mixed plant extract (MPE) on 'Snow Queen' nectarine fruits stored at supermarket conditions (18±2ºC 85–90% RH) for 16 days. Our results revealed that the fruit decay increased with the increase in storage period and fruits coated with layer-by-layer coatings of CMC-CH-MPE exhibited the lowest fruit decay (6.80 ± 0.20%) which was the highest in the non-coated (control) fruits (16.10 ± 0.60 %). The respiration rate showed increasing trend up to certain storage period but then it declined in all the treatments. Similarly, total phenolics and total antioxidant activity was the highest in the CMC-CH-MPE coated fruits and the lowest in non-coated fruits whereas the PME activity was the lowest in CMC-CH-MPE coated fruits and the highest in control fruits. In all, it can be concluded that layer-by-layer coating of CMC-CH-MPE was the best treatmentfor reducing fruit decay and maintaining desirable level of biochemical attributes in Snow Queen nectarine fruits up to 16 days of storage at supermarket conditions.

Keywords: Biochemical attributes, Carboxy methylcellulose, Chitosan, Fruit decay, Fruit decay, Plant extracts, Storage

Nectarine (*Prunus persica* var. *nucipersica*) is an important stone fruit. It is commonly called as a smooth-skinned or fuzzless peach. Nectarines are highly perishable due to its succulent nature (Sharma and Krishna 2018). Hence, postharvest quality losses in nectarines are high predominantly due metabolic changes, mechanical damage, and decay during storage. The postharvest storage life is limited to 3-4 days at ambient conditions and about 3 weeks under cold storage conditions. In addition, several postharvest pathogens such as *Monilinia fructicola, Rhizopus stolonifer*, *Penicillium expansum* and *Botrytis cinerea* infest nectarines and thereby cause severe losses to the growers (Zhang *et al*. 2007). Although, several fungicides are used to control postharvest diseases of fruits but pesticidal residue is a major concern among the consumers (Sharma *et al*. 2009). Thus, there is a need to develop and use safe and consumer-friendly methods to reduce fruit decay and maintain quality of fruits throughout the storage period.

Several methods have been employed to reduce postharvest losses but use of edible coatings appears to be a promising and safe method to reduce postharvest decay (Dhall 2012). It is an environment and farmer-friendly technology that can be applied easily to the fruits to control diseases, and moisture loss (Dhall 2012, Jhalegar *et al*. 2015, Kumar *et al*. 2017)**.** Additionally, edible coatings impart glossiness to the fruits which may attract the consumer. It is well documented that hydrocolloid-based coatings such as carboxy methylcellulose (CMC), xanthan gum (XG), gum Arabic (GA), and carrageenan are commonly used in fruits and vegetables but now use of edible coatings plus plant extracts, edible herbs, antimicrobial compounds, nutrients, and antioxidant compounds is becoming popular (Dhall 2012). Hence, we planned an experiment to observe the effect of hydrocolloid-based coatings alone and in combination with mixed plant extract (MPE) on fruit decay and biochemical attributes of Snow Queen nectarine fruits under supermarket storage conditions.

MATERIALS AND METHODS

The study was conducted at Division of Food Science and Postharvest Technology, ICAR-Indian Agricultural Research Institute, New Delhi during 2018–19. The fruits of Snow Queen nectarine were manually harvested at fully mature stage from the orchard of Regional Horticultural

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Research Station (Dr Y S Parmar University of Horticulture and Forestry), Bajaura, H P. The harvested fruits were sorted, packed in five kg CFB boxes and transported to New Delhi. In the laboratory, fruits were divided into 8 lots of 60 fruits each, and coated with different edible coatings such as MPE (Mixed plant extract of moringa, marigold and eucalyptus), chitosan (CH) alone, carboxy methylcellulose (CMC) alone, CH-MPE (Layer-by-layer), CMC-MPE (Layer-by-layer), CMC-CH (Layer-by-layer), CMC-CH-MPE (Layer-by-layer) and control (Water dip). The details of methodology are as under.

Preparation of edible coatings: The coating of chitosan (CH, 1%) was prepared by dissolving 10g of chitosan in 900ml of distilled water containing 10ml of glacial acetic acid with the aid of magnetic stirrer and finally volume was made upto 1000 ml. The coating of carboxy methylcellulose (CMC, 1.5%) was prepared by dissolving 15 g of CMC in mild hot distilled water and the volume was made up to 1000 ml.

Preparation of mixed plant extract: Preparation of mixed plant extract was done by taking 10g dried powder of each plant, i.e. moringa, marigold, eucalyptus, was dissolved in 40 ml of methanol and filtered and volume was make up to 50 ml. Mixed plant extracts was prepared by mixing each methanolic plant extracts in equal proportion (13.3 g each) and final volume was made up to 1000 ml with distilled water.

Coating of nectarines: Nectarine fruits having similar size and no visual defects, were selected and randomly divided into 8 lots with 60 fruits in each lot, and coated with different plant extracts and edible coatings at room temperature for 10 min, dried under fan, placed in plastic trays which were finally kept at supermarket conditions (18 ± 2ºC, 85–90% RH) for 16 days. Layer-by-layer coating of fruits were carried out by dipping the fruits in one coating for 10 min, air-drying for 15–20 min, followed by dipping in another coating, air-drying for 15–20 min and finally storing in supermarket conditions as above. All the treatments were replicated thrice and each replication had 20 fruits. The control fruits were simply dipped in distilled water. Observations on different attributes were recorded at 4 day's interval. For observations, nectarines were removed randomly from each replication/treatment and analyzed for fruit decay, respiration rate, total phenolics, total antioxidant activity and pectin methylesterase (PME) activity.

*Determination of fruit decay and respiration rate:*Fruitdecay in coated and non-coated nectarine fruits was determined by counting the rotten fruits which was represented as percentage (%) using the following formula (TF – DF)/TF×100, where TF was the total fruit count, and DF was the decayed fruit count in a lot. The respiration rate of coated as well as non-coated nectarines was estimated by using, auto gas analyzer (Model: Checkmate 9900 O_2/CO_2 PBI Dansensor, Denmark) and expressed as ml CO_2 /kg/h*:*

Determination of functional attributes: The total phenolics were estimated by method and expressed in mg of gallic acid equivalents (GAE)/100g of extract (Jhalegar *et al*. 2015). Total antioxidant activity in the nectarines was estimated by using CUPRAC (Cupric Reducing Antioxidant Capacity) method as standardized by Apak *et al.* (2004) and expressed as µmol Trolox equivalent/g fresh weight (FW). The pectin methylesterase (PME) activity in nectarines was estimated by the method standardized by Totad *et al*. (2019) and expressed as $(0.328 \times \Delta A_{620} - 0.003)$ µmol/min/g FW.

Statistical design and analysis of data: The experiment was laid out in factorial CRD design with each treatment consisting of 60 fruits with 3 replications. The data obtained from the experiments were analysed as per design and the results were compared from ANOVA by calculating the MSD (minimum significant difference) using the SAS (Statistical Analysis System).

RESULTS AND DISCUSSION

Effectson fruit decay and respiration rate: The fruit decay in nectarine fruits was significantly influenced by the coatings, storage period and the interaction, coating × storage period (Table 1). Fruit decay was the minimum in fruits which were coated by layer-by-layer coating of CMC-CH-MPE (6.80 ± 0.20%) and the highest in the non-coated (control) fruits (16.10 ± 0.60% (Table 1). Furthermore, irrespective of coatings, fruit decay increased with the increase in storage period and was the minimum on 4th day

Table 1 Impact hydrocolloid-based coating alone and in combination with mixed plant extract on fruit decay (%) of Snow Queen nectarines stored at super market conditions (18 ± 2°C and RH 85-90%).

Treatment	Storage period (days)				
	4th	8th	12th	16th	Mean
Mixed plant extract (MPE)	3.50 ±0.78	5.90±0.70	12.80±0.62	14.20±0.45	9.10±0.28
Chitosan (CH)	4.80 ±0.60	8.20 ±0.82	10.50 ±0.70	16.20 ±0.48	9.90 ± 0.45
Carboxy methylcellulose (CMC)	4.90 ±0.59	6.80 ±0.35	10.40 ±0.80	15.20 ±0.70	9.30 ± 0.40
CMC+MPE	3.90 ±0.56	6.40±0.60	9.40 ±0.45	13.20 ±0.65	8.20 ± 0.50
CH+MPE	3. 20 ±0.63	6.70 ±0.64	9.50 ±0.64	14.20 ±0.60	8.40 ± 0.30
CMC+CH	3.80 ±0.70	6.50 ±0.54	10.90 ±0.52	18.60±0.62	8.30 ± 0.50
CMC+CH +MPE	1.00 ±0.42	2.70 ± 0.45	6.30 ±0.65	8.30 ± 0.46	6.80 ± 0.20
Control	4.91±0.74	9.90 ±0.75	16.80 ±0.78	32.80 ±0.72	16.10 ± 0.60
Mean	4.90 ± 0.33	6.60 ± 0.42	10.80 ± 0.36	16.60 ±0.44	

Tukey MSD (5%) for Treatment (T) =0.56; Storage (S) = 0.58 ; T × S=1.15

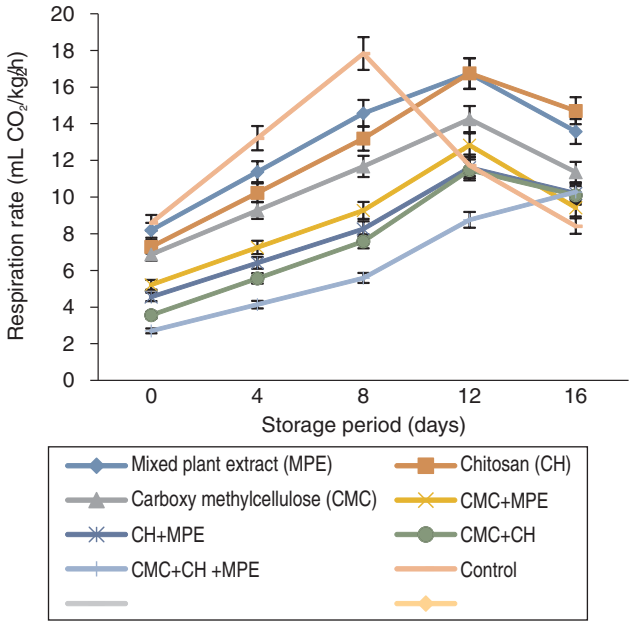

Fig 1 Influence of hydrocolloid-based coatings alone and in combination with mixed plant extract on respiration rate of Snow Queen nectarine fruits at supermarket conditions (18±2ºC and 85–90% RH).

of storage (4.90 ± 0.33%) and the maximum on 16th day of storage (16.60 ±0.44%). The respiration rate of the Snow Queen nectarine fruits was also influenced by the coatings, storage period and the interaction between coatings and storage period (Fig 1). Respiration rate increased up to a certain period and thereafter, it started decreasing slowly. The peak CO_2 output was observed in control fruits (11.73 ± 0.68 mL CO_2/kg/h) on 12th day storage and the least CO_2output was observed in layer-by-layer CMC-CH-MPE coated fruits (2.70 ± 0.53 mL CO_2/kg/h) on the first day of storage (Fig 1).

Edible coatings have barrier properties which resist entry of pathogens for fruit decay. Hence, fruit decay of nectarine fruits was low in all the coatings. Furthermore, addition of MPE (moringa, eucalyptus and tulsi) increased the inhibitory properties more effectively, thus all coatings containing MPE exhibited lower fruit decay than when they were used alone. Similarly, least fruit decay by layer-by-layer coating of CMC-CH-MPE might be due to synergistic influence of coatings and MPE on pathogens which cause fruit decay in nectarines (Zhang *et al*. 2007, Jhalegar *et al*. 2014). Respiration rate was significantly reduced in CMC-CH-PME coated fruits primarily because surface coatings have been reported to increase resistance of fruit peel to gas diffusion and the creation of a modified internal atmosphere or formation of a barrier to diffusion of gasses and water vapour between fruit and environment (Jhalegar *et al*. 2015).

Effects on functional attributes: Our study showed that irrespective of storage period, 'Snow Queen' nectarine fruits treated with layer-by-layer coating of CMC-CH-MPE showed the highest total phenolic content (15.17±0.15 mg GAE/100gFW) and the non-coated fruits exhibited the lowest (13.85±0.17 mg GAE/100 g FW) (Table 2). In general, all the coated as well as non-coated fruits showed a declining trend in total phenolic content with the progressive increase in storage period which was the maximum on the initial day (18.26 ±0.14 mg GAE/100 g FW) and the minimum on 16th day of storage (11.24±0.14 mg GAE/100 g FW) (Table 2). Furthermore, this decline in total phenolic content was significantly slower in CMC-CH-MPE coated fruits than other coatings or non-coated fruits. The AOX activity was the highest in layer-by-layer coated fruits with CMC-CH-MPE (20.24 ± 0.16 µmol TE/g FW) and the lowest in control fruits (17.62±0.16 µmol TE/g FW) (Table 2). Like total phenolics and total antioxidant activity, the PME enzyme activity was also significantly influenced by coatings. Irrespective of storage period, the CMC-CH-MPE coated fruits had the lowest PME activity on the 0th day of storage (0.14 ± 0.02 µmol/min/g FW) and the highest activity was exhibited by control fruits on 16th day of storage (0.62 ± 0.027 µmol/min/g FW) (Fig 2).

In this study, layer-by-layer coated fruits with CMC-CH-MPE had the highest total phenolics and total antioxidant activity and the lowest activity was observed in control fruits. The reduction in the level of total antioxidants may be due to increased activity of cytochrome oxidase, ascorbic acid oxidase and peroxidase enzymes (Dhall 2012) whereas, reverse may be true for coated fruits. Several coatings have been reported to increase the level of total phenolics and antioxidant activity in fruits (Dhall 2012, Kumar *et al*. 2018, Totad *et al*. 2019). PME is an important enzyme which is related to the softening of fresh produce. CMC-CH-MPE coated fruits exhibited the lowest PME activity in comparison to all other coatings. The control fruits exhibited the highest PME activity which may be due to the softness of the fruit tissuesand increased senescence of the fruits

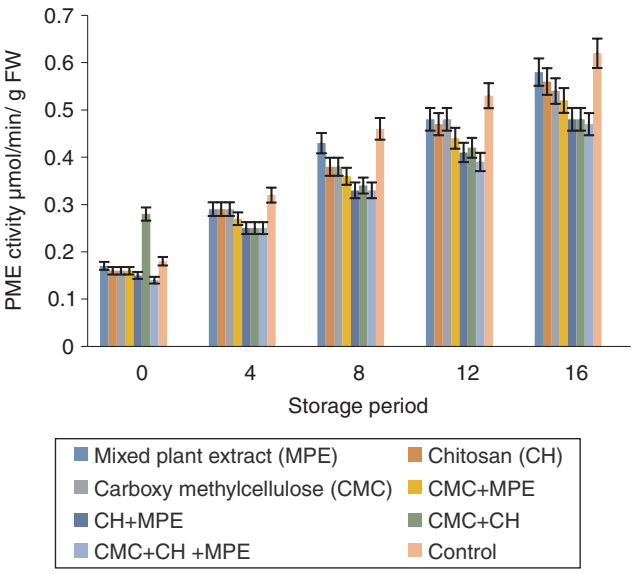

Fig 2 Effectof plant extract alone and in combination with hydrocolloid-based coatings on pectin methylesterase enzyme activity of Snow Queen nectarine during storage at supermarket conditions.

Table 2 Total phenolic content (mg GAE 100/g FW) and total antioxidant activity (µmol TE/g FW) of Snow Queen nectarine as influenced by hydrocolloid-based coatings and mixed plant extract when stored at 18 ± 2° C and RH 85–90%

Treatment	Total phenolic content						Total antioxidant activity					
	Storage period (days)											
	0th	4th	8th	12th	16th	Mean	0th	4th	8th	12th	16th	Mean
Mixed plant extract (MPE)	18.21±0.54	15.43±0.59	13.25±0.64	11.66±0.69	10.85±0.61	13.88±0.15	23.08±0.06	21.17±0.60	18.86±0.71	16.41±0.70	13.63±0.66	18.63±0.16
Chitosan (CH)	18.25±0.64	15.51±0.66	13.42±0.59	11.65±0.72	10.64±0.70	13.90±0.14	23.23±0.11	21.27±0.56	16.86±0.77	13.99±0.27	10.64±0.70	17.20±0.16
Carboxy methylcellulose (CMC)	18.25±0.62	15.57±0.73	13.53±0.61	11.35±0.69	10.86±0.78	13.91±0.17	23.70±0.10	21.49±0.64	19.44±0.77	17.30±0.76	14.62±0.70	19.31±0.16
CMC+MPE	18.23±0.62	15.80±0.68	13.58±0.74	12.73±0.88	11.17±0.68	14.30±0.15	23.58±0.07	21.69±0.80	19.57±0.72	17.31±0.71	15.28±0.60	19.49±0.16
CH+MPE	18.26±0.63	16.29±0.61	14.30±0.60	13.49±0.68	11.27±0.71	14.72±0.16	24.14±0.05	22.38±0.73	20.11±0.61	17.59±0.73	15.36±0.61	19.92±0.16
CMC+CH	18.29±0.58	16.22±0.57	14.39±1.09	13.32±0.54	11.95±0.70	14.83±0.12	23.83±0.06	22.28±0.62	19.84±0.81	17.52±0.73	15.39±0.72	19.77±0.16
CMC+CH +MPE	18.32±0.60	16.43±0.71	15.17±0.70	13.74±0.66	12.18±0.70	15.17±0.15	24.57±0.06	22.79±0.69	20.22±0.68	17.95±0.71	15.65±0.81	20.24±0.16
Control	18.24±0.64	15.18±0.66	12.90±0.78	11.95±0.92	10.99±0.67	13.85±0.17	23.10±0.10	20.48±0.82	17.57±0.68	14.71±0.76	12.24±0.64	17.62±0.16
Mean	18.26±0.14	15.80±0.14	13.82±0.14	12.49±0.14	11.24±0.14		23.65±0.13	21.69±0.13	19.06±0.13	16.60±0.13	14.10±0.13	
Tukey MSD (5%)	Treatment (T) =0.77; Storage (S) = 0.59; T x S=1.32						Treatment (T) =0.73; Storage (S) = 0.59; T x S =1.32					

with respect to increase in storage days. Pectin is the main constituents of the middle lamella and primary cell wall of the fruits which is hydrolyzed by PME to generate de-methylated pectin that can be more easily hydrolyzed by PG and thus causing the de-polymerization of pectin. (Maqbool *et al.* 2011) and similar results had also been reported by Gonzalez-Aguilar *et al*. (2009) who reported that the fresh cut papaya fruit coated with chitosan had reduced PME activity compared to the control fruits.

These results suggest that CMC-CH-MPE can be used successfully as an edible coating for reducing fruit decay and maintaining biochemical attributes of nectarines during storage at supermarket conditions.

REFERENCES

Apak R, Guclu K, Ozyurek M and Karademir S E. 2004. Novel total antioxidants capacity index for dietary polyphenol and vitamins C and E using their cupric ion reducing capability in the presence of neocuprine: CUPRAC method. *Journal of Agricultural and Food Chemistry* **52**: 7970–81.

Dhall R K. 2012. Advances in edible coatings for fresh fruits and vegetables: a review. *Critical Reviews in Food Science and Nutrition* **53**: 435–50.

Gonzalez-Aguilar G A, Valenzuela-Soto E, Lizardi-Mendoza J, Goycoolea F, Martinez-Tellez M A, Villegas-Ochoa M A, Monroy-Garcia I and Ayala-Zavala J F. 2009. Effect of chitosan coating in preventing deterioration and preserving the quality of fresh-cut papaya 'Maradol'. *Journal of the Science of Food and Agriculture* **89**: 15–23.

Jhalegar M J, Sharma R R and Singh D. 2014. Antifungal efficacy of botanicals against major postharvest pathogens of Kinnow mandarin and their use to maintain postharvest quality *Fruits* **69**(3): 223–37

Jhalegar M J, Sharma R R and Singh S K. 2015. Effect of surface coatings on postharvest quality of Kinnow mandarin. *Indian Journal of Horticulture* **72**(2): 267–72.

Kumar P, Sethi S, Sharma R R, Srivastav M and Varghese E. 2017. Effect of chitosan coating on postharvest life and quality of plum during storage at low temperature. *Scientia Horticulturae* **226**:104–09.

Kumar P, Sethi S, Sharma R R, Srivastav M, Singh D and Varghese E. 2018. Edible coatings influence the cold-storage life and quality of 'Santa Rosa' plum (*Prunus salicina* Lindell). *Journal of Food Science and Technology* **55**(6): 2344–50.

Maqbool M, Ali A, Alderson P G, Zahid N and Siddiqui Y. 2011. Effect of a novel edible composite coating based on gum arabic and chitosan on biochemical and physiological responses of banana fruit during cold storage. *Journal of Agricultural and Food Chemistry* **59**: 5474–82.

Sharma R R and Krishna H. 2018. *A Textbook of Temperate Fruits*. CBS Publishers, New Delhi, India.

Sharma R R, Singh D and Singh R. 2009. Biological control of postharvest diseases of fruit and vegetables by microbial antagonists: A review. *Biological Control* **50**: 205–21.

Totad M G, Sharma R R, Sethi S and Verma M K. 2019. Effect of edible coatings on 'Misty' blueberry (*Vaccinium corymbosum*) fruits stored at low temperature. *Acta Physiologiae Plantarum* **41**: 183.

Zhang H, Zheng X and Yu T. 2007.Biological control of postharvest diseases of peach with *Cryptococcus laurentii. Food Control* **18**(4): 287–91.