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## Storage behavior of Nagpur mandarin fruits as affected by post-harvest application of plant leaf extracts under cold storage condition

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### Abstract

Use of plant leaf extracts could be a useful alternative in post-harvest handling and storage of Nagpur mandarin fruits. The experiment was conducted at Post Harvest Technology Laboratory, Department of Fruit Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, and Akola with the objective to access the efficacy of extracts obtained from leaves of four plants (Neem, Tulsi, Custard apple and Guava) on the extension of shelf life of Nagpur mandarin fruits obtained mainly from Mrig bahar. Fruits of Nagpur mandarin are available up to March - April and after that there is unavailability of fruits up to September. So by increasing shelf life of fruits one can get fulfill the demand and also farmers get benefited by getting extra rates to their produce. The fruits were treated with 20 % leaf extracts and guar gum used as sticking material. The fruits coated with Neem leaf extract in combination of cold storage gave encouraging results up to the end of the storage period. There was minimum physiological loss in weight (5.55%), maximum total soluble solids (14.08 ° Brix), maximum retention of acidity (0.26%), maximum ascorbic acid content (36.70 mg/100 ml), maximum total sugars (9.25%), reducing sugar (5.23%) and best organoleptic score (8.39) up to 45 days and it decrease after 45 days of storage followed by Tulsi leaf extract coating. This inhibitory effect of Neem leaf extract was recorded due to presence of active principle compound azadiractin.

**Keywords:** Nagpur mandarin, plant extracts, mrig bahar, neem, tulsi, custard apple, guava

### Introduction

Citrus fruits are most important fruit crop in the subtropical region of India (Kahn *et al.*, 2001). The important citrus fruits grown are sweet orange, mandarin and acid lime sharing 35 per cent, 31 per cent and 25 per cent, respectively of total citrus fruit production in country. Mandarin is one of the most important fruit crop of the citrus industry.

Nagpur mandarin is popularly known as Nagpur santra. Nagpur mandarin is the only cultivar of mandarin grown in Vidarbha for last 200 years in around 1.85 lakh ha and considered as one of the best mandarins in the world, because of its attractive colour, pleasant flavour and good taste. Cultivation of Nagpur mandarin is mostly concentrated in Amravati, Nagpur, Wardha, Yeotmal, Akola and Buldhana districts of Vidarbha region and adjoining states like Madhya Pradesh as well as Rajasthan. It is grown in 0.148 M ha area (fruit bearing area is 0.086 M ha) (Shirgure *et al.* 2014) <sup>[17]</sup>. Mandarins can be kept in good condition under ambient storage for only 7-8 days and have the shortest storage life among all the fruits of the citrus family. To extend the storage life of mandarins, the extracts obtained from plants are used due to their antifungal and antibacterial activity (Lee *et al.*, 2007) <sup>[9]</sup>. The antimicrobial activity of many plants against post-harvest pathogens have been demonstrated in citrus (Singh *et al.*, 2011) <sup>[18]</sup>. Therefore the main objective of this study was to evaluate the influence of these plant leaf extracts on the post-harvest life of Nagpur mandarin.

### Materials and Methods

#### Procurement of Fruits

Fresh Nagpur mandarin fruits with uniform size and at colour break stage were brought from farmer's field. In the laboratory, the fruits were sorted for uniform size then disinfected by treatment with Sodium Hypochlorite (200 ppm for two min) to remove contamination, dust etc. from their surface.

### Preparation of Leaf Extract

Fresh leaves of Neem, Tulsi, Custard apple and Guava brought from Main Garden Department of Fruit Science, washed with distilled water and finely cut. 20g of leaves added to 100 ml of distilled water and boiled for 10 minutes in a water bath. After cooling, it was filtered through Whatman Filter paper no. 1 to obtain aqueous extract for coating (Gupta and Jain, 2014)<sup>[4]</sup>.

### Coating Application

Prepare 20 % concentration solution and add 2% guar gum which acts as sticking agent. Samples treated with only distilled water were consider as control and coating applied to the fruit surface by dipping technique in respective treatment for 2 min followed by placing them on newspaper sheet for drying for 30 min (Nandane *et al.*, 2017 and Gupta and Jain, 2014)<sup>[12, 4]</sup>.

### Analytical Methods

The weight loss, TSS, Acidity, Ascorbic acid, Sugars and fruit decay rate were recorded after 15 days interval during storage. Weight loss percent was calculated by weighing the fruits on physical balance, TSS measured by using digital refractrometer (Motras Scientific Instruments Pvt. Ltd.) by taking a drop of juice on digital refractrometer and recorded the reading, titratable acidity and ascorbic acid determined according to Ranganna (1986)<sup>[14]</sup>, Sugars was determined by colorimetric methods (Sadasivam and Manickam, 1992) and Nagpur mandarin fruits showing greenish-gray mold spots on the fruit surface were counted for each treatment and the percentage of fruit rotting was calculated according to the formula given by Metak (2015)<sup>[10]</sup>.

### Statistical Analysis

The data recorded in respect of all the above parameters were subjected to statistical analysis and for interpretation of results (Gomez and Gomez, 1984)<sup>[3]</sup>.

### Results and Discussion

The data from Table 1 showed the effect of leaf extract coating on PLW (%), TSS and Titrable acidity of Nagpur mandarin fruits

#### Weight Loss

Neem extract coated fruits showed minimum loss in weight during period of storage (0.59, 1.09, 3.19 and 5.55%) which was followed by the fruits coated with Tulsi leaf extract (0.70, 1.77, 3.76 and 6.29 %) and maximum i.e. (1.35, 3.55, 5.22 and 9.28%) physiological loss in weight observed in control i.e. water spray after 15, 30, 45 and 60 days of storage respectively.

Weight loss is mostly due to the evaporation of water facilitated by a water vapour pressure gradient (Naknaen 2014). The edible coating applied on fruit surface delayed migration of moisture from the fruit surface into environment (Garcia *et al.*, 1998) and also the low temperature and high humidity prevalent in cold storage might have bought the reduction in weight loss by reducing the moisture loss through decrease in respiration and transpiration (Gupta and Jain, 2014)<sup>[4]</sup>.

#### TSS

Initially during cold storage the TSS content of Nagpur mandarin fruits increases upto 45 days and after that it decrease. When Nagpur mandarin fruits were coated with leaf

extract, Neem leaf extract showed gradual increment in TSS (12.98, 14.08, 13.24 and 14.08° Brix) during 15 days, 30 days, 45 days and 60 days of storage period followed by Tulsi leaf extract (12.83, 13.84, 14.35 and 13.86° Brix) and minimum increase observed in control i.e. only water spray (12.62, 12.95, 13.46 and 10.17° Brix) after 15, 30, 45 and 60 days of storage respectively.

Fruit give an account of its sweetness. The initial increase in TSS may be due to hydrolysis of starch into mono and disaccharides and on complete hydrolysis of starch and afterword decreases due to decline in amount of carbohydrates and pectin, partial hydrolysis of protein and decomposition of glycosides into subunits during respiration. The results of the present study are in line with those of Jhalegar *et al.*, (2015)<sup>[6]</sup> in Kinnow mandarin, Gupta and Jain (2014)<sup>[4]</sup> in mango, Ladaniya (2011)<sup>[8]</sup> in Nagpur mandarin fruits and Sagili *et al.*, (2018)<sup>[16]</sup> in *Ficus carica*.

#### Acidity

The acidity content decreased with advancement of storage period. Maximum retention in titrable acidity observed in Neem leaf extract (0.28%) followed by Tulsi leaf extract (0.26%) while minimum recorded in treatment wax 6% + carbendazim 0.1% (0.20%) during end of storage period.

This might be due to the utilization of organic acids for respiration and utilization of organic acid in pyruvate decarboxylation reaction occurring during the ripening process of fruits (Jhalegar *et al.*, 2015)<sup>[6]</sup>. These agreements are findings with Gupta and Jain (2014)<sup>[4]</sup> in Mango, Jadhao *et al.*, (2008)<sup>[5]</sup> in Kagzi lime.

The data from Table 2 revealed the effect of leaf extract coating on ascorbic acid and sugars of Nagpur mandarin fruits

#### Ascorbic Acid

After 15 days of storage there was no significant difference observed in the Ascorbic acid content of Nagpur mandarin fruits treated with different leaf extract coating. After 30 days and 45 days of storage, Neem extract coated fruits recorded gradual increase in Ascorbic acid (36.25 and 37.28 mg/100 ml) followed by Tulsi leaf extract coated fruits (36.00 and 36.56 mg/100 ml) while minimum increase was observed in control (35.40 and 35.72 mg/100 ml) after 15, 30, 45 and 60 days of storage respectively.

The decreasing pattern of Ascorbic acid was observed during 60 days of storage, Neem leaf extract coated fruits (36.70 mg/100ml) showed minimum decrease in Ascorbic acid followed by Tulsi leaf extract coated fruits (36.21 mg/100 ml) while maximum decrease observed in control (34.90 mg/100 ml). This increase might be due to an indirect activation of ascorbic acid biosynthesis by the production of reducing and non-reducing sugars. The release of D-glucose, L-galacturonic acid acts as a precursor to ascorbic acid, helping to maintain or even increase ascorbic acid content. The similar results found by Natalia *et al.*, (2014)<sup>[13]</sup> in Cavendish banana.

#### Sugars

There was increasing trend found in case of total and reducing sugar content of Nagpur mandarin fruits after 15, 30, 45 and 60 days of storage respectively. An increase in total sugars and reducing sugar was reported due to enzymatic breakdown of complex carbohydrates of the cell wall structure into simpler sugars during storage. Total sugars increased with the progress of storage period and then decreased in last week. These findings are supported by the results of Gad and

Zagzog (2017)<sup>[1]</sup> in Guava fruits and Gupta and Jain (2014)<sup>[4]</sup> in mango.

Data from Table 3 revealed the effect of leaf extract coating on fruit decay rate of Nagpur mandarin fruits

### Fruit decay Rate

There was no fruit decay per cent observed up to 45 days except control. After 30 days control showed some amount of fruit decay (3.5%) this rate was increases as increase in storage period for control i.e. (29.41 and 73.33%) after 45 and 60 days after storage respectively. After 45 days of storage, treatment wax 6% +Carbendazim 0.1 % (18.18 %) fruit decay rate reported and it increases up to 35.29 % after 60 days of storage whereas, Neem leaf extract coated fruits showed minimum fruit decay (7.62%).

Reduction in fruit decay rate in Neem leaf extract coated fruit may be attributed to the presence of principle compound Azadiractin which has the ability to check the growth of pathogenic microorganisms responsible for fruit decay. Similar findings reported by Gupta and Jain (2014)<sup>[4]</sup> and Jhalegar *et al.*, (2015)<sup>[6]</sup>

### Conclusion

It is concluded that surface coating of leaf extract can extend the shelf life of Nagpur mandarin fruits without affecting its quality. The results obtained from this study indicate that Neem leaf extract coating showed greater degree of spoilage inhibition and slow down the associated changes in chemical composition of Nagpur mandarin fruits during cold storage.

**Table 1:** Effect of leaf extract coating on PLW (%), TSS and Titrable acidity of Nagpur mandarin fruits

Treatment	PLW (%)				TSS (°Brix)				Titrable acidity			
	15 DAT	30 DAT	45 DAT	60 DAT	15 DAT	30 DAT	45 DAT	60 DAT	15 DAT	30 DAT	45 DAT	60 DAT
T <sub>1</sub> Neem extract coating (20 %)	0.59 (1.263)*	1.09 (1.446)	3.19 (2.047)	5.55 (2.559)	12.98	14.08	14.87	14.08	0.38 (1.175)	0.31 (1.114)	0.30 (1.131)	0.26 (1.122)
T <sub>2</sub> Tulsi extract coating (20 %)	0.70 (1.303)	1.77 (1.663)	3.76 (2.181)	6.29 (2.700)	12.83	13.84	14.35	13.86	0.36 (1.166)	0.31 (1.145)	0.29 (1.136)	0.28 (1.131)
T <sub>3</sub> Annona extract coating (20 %)	0.95 (1.395)	1.83 (1.682)	4.06 (2.250)	6.40 (2.721)	12.68	13.27	13.92	13.18	0.37 (1.170)	0.32 (1.149)	0.25 (1.118)	0.23 (1.109)
T <sub>4</sub> Guava extract coating (20%)	0.83 (1.352)	1.96 (1.720)	3.95 (2.225)	6.85 (2.802)	12.56	13.18	14.01	13.62	0.37 (1.170)	0.34 (1.157)	0.26 (1.122)	0.25 (1.118)
T <sub>5</sub> Wax 6% + Carbendazim 0.1%	0.88 (1.372)	2.42 (1.850)	4.40 (2.324)	7.05 (2.837)	12.72	13.06	13.67	12.89	0.35 (1.162)	0.31 (1.144)	0.24 (1.113)	0.20 (1.095)
T <sub>6</sub> Control (Water spray)	1.35 (1.533)	3.55 (2.133)	5.22 (2.494)	9.28 (3.206)	12.62	12.95	13.46	10.17	0.39 (1.180)	0.35 (1.162)	0.30 (1.140)	0.22 (1.105)
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	0.001	0.001	0.002	0.003	0.025	0.026	0.028	0.024	0.001	0.000	0.000	0.000
CD at 1%	0.002	0.004	0.006	0.008	0.100	0.110	0.110	0.100	0.002	0.001	0.001	0.001

\*Fig in parenthesis are square root transformation

**Table 2:** Effect of leaf extract coating on ascorbic acid and sugars of Nagpur mandarin fruits

Treatment	Ascorbic acid (mg/100 ml)				Total Sugar (%)				Reducing Sugar (%)			
	15 DAT	30 DAT	45 DAT	60 DAT	15 DAT	30 DAT	45 DAT	60 DAT	15 DAT	30 DAT	45 DAT	60 DAT
T <sub>1</sub> Neem extract coating (20 %)	35.21	36.25	37.28	36.70	8.86 (3.140)*	9.23 (3.198)	9.62 (3.259)	9.25 (3.202)	4.65 (2.377)	4.89 (2.427)	5.43 (2.536)	5.23 (2.496)
T <sub>2</sub> Tulsi extract coating (20 %)	35.13	36.00	36.56	36.21	8.83 (3.135)	9.07 (3.173)	9.38 (3.222)	9.03 (3.167)	4.66 (2.379)	4.82 (2.412)	5.22 (2.494)	5.16 (2.482)
T <sub>3</sub> Annona extract coating (20 %)	35.09	35.78	36.12	36.01	8.74 (3.121)	8.92 (3.150)	9.12 (3.181)	8.68 (3.111)	4.60 (2.366)	4.76 (2.400)	5.08 (2.466)	5.02 (2.454)
T <sub>4</sub> Guava extract coating (20%)	35.10	35.81	36.06	35.87	8.75 (3.123)	8.86 (3.140)	9.08 (3.175)	8.72 (3.118)	4.56 (2.358)	4.78 (2.404)	4.96 (2.441)	4.78 (2.404)
T <sub>5</sub> Wax 6% + Carbendazim 0.1%	35.03	35.52	35.91	35.71	8.79 (3.129)	8.97 (3.157)	9.03 (3.167)	8.97 (3.157)	4.58 (2.362)	4.73 (2.394)	4.98 (2.445)	4.60 (2.366)
T <sub>6</sub> Control (Water spray)	35.01	35.40	35.72	34.90	8.74 (3.121)	8.81 (3.132)	8.98 (3.159)	8.36 (3.059)	4.53 (2.351)	4.67 (2.381)	4.81 (2.410)	4.2 (2.280)
'F' test	NS	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	-	0.071	0.072	0.071	0.003	0.003	0.003	0.003	0.005	0.002	0.002	0.002
CD at 1%	-	0.290	0.290	0.290	0.009	0.009	0.009	0.009	0.014	0.006	0.006	0.006

\*Fig in parenthesis are square root transformation

**Table 3:** Effect of leaf extract coating on fruit decay rate of Nagpur mandarin fruits

Treatment	Fruit Decay Rate (%)		
	30 DAT	45 DAT	60 DAT
T <sub>1</sub> Neem extract coating (20 %)	0	0	7.62 (2.936)
T <sub>2</sub> Tulsi extract coating (20 %)	0	0	8.69 (3.113)
T <sub>3</sub> Annona extract coating (20 %)	0	3.50 (2.120)	27.77 (5.364)
T <sub>4</sub> Guava extract coating (20%)	0	8.76 (3.124)	15.78 (4.096)
T <sub>5</sub> Wax 6% + Carbendazim 0.1%	0	18.18 (4.379)	35.29 (6.024)
T <sub>6</sub> Control (Water spray)	3.50 (2.120)*	29.41 (5.514)	73.33 (8.621)
'F' test	Sig	Sig	Sig
SE (m) ±	0.001	0.006	0.006
CD at 1%	0.004	0.018	0.019

\*Fig in parenthesis is square root transformati

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