

## EFFECTS OF ESSENTIAL OILS ON POST HARVEST QUALITY AND SHELF LIFE OF MANGO (*MANGIFERA INDICA* L.)

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### Abstract

Effects of essential oils, namely Cinnamon, Citronella, Peppermint, Eucalyptus, Lavender, Thyme, Rosemary, Basil oil enriched coconut oil emulsion on shelf life and quality of ambient stored mango cv. Rangkuai were evaluated. Citronella oil (*Cymbopogon nardus*) @ 0.5% (v/v) was found to maintain low weight loss (5.14%), high fruit firmness (52.85 N/cm<sup>2</sup>), ascorbic acid (33.62 mg/100 g), total phenol (89.67 mg/100 g) and least fruit decay (8.33%) at 12 days after storage (DAS) and had delayed accumulation of pulp colour (L: 91.06, a: -2.61, b : 24.03),  $\beta$ -carotene (3.85 mg/100 g) and total sugar (4.46%) for delayed ripening, thus found to extend the shelf life by 7 days compared with control (12.85 days).

### Introduction

Mango (*Mangifera indica* L.), holds around 40% global production with a yield of 19687 thousand metric tonnes from an area of 2263 thousand hectares (Anon. 2017). Mangoes are popular table fruit due to excellent quality, richness in vitamins, minerals, antioxidant and also for therapeutic and medicinal value (Shah *et al.* 2010). In India and other tropical countries, this commercial fruit crop is mostly traded in ambient condition and reported to have faster ripening and high post-harvest losses (Singh *et al.* 2013). However, quite a few research attempts had been made for shelf life extension with reduced spoilage involving chemicals like benomyl, calcium chloride, calcium nitrate, gibberellic acid etc. which now largely being discarded due its ill effect on health and thus alternative, safe, economic and healthy options for maintenance of post-harvest qualities and shelf life is largely demanded. Essential oils both aromatic and volatile from plants have potential antimicrobial uses, thus are used for controlling post-harvest pathogens and storage of food (Solgi and Ghorbanpour 2014). Therefore, the present study was conducted to assess the influence of different essential oils on physico-chemical attributes and shelf life of mango in ambient condition.

### Materials and Methods

Freshly harvested, uniform shape, size, colour, firmness, pest, disease and injury free mature green mango cv. Rangkuai fruits were collected from local mango growers of Siaha District, Mizoram, India. Dust and dirt were removed by thoroughly washing the fruits under running tap water and surface sterilized with ethanol (70% v/v), quick dipping for 30 sec followed by rinsing in double distilled water. Fruits were kept under a stream of dehumidified air for 10 min. Five fruits were kept in ventilated paper box under each replication and replicated four times under ten post-harvest treatments viz. T<sub>1</sub>: Cinnamon (*Cinnamomum zeylanicum*) oil, T<sub>2</sub>: Citronella (*Cymbopogon nardus*) oil, T<sub>3</sub>: Peppermint (*Mentha piperita*) oil, T<sub>4</sub>: Eucalyptus (*Eucalyptus globulus*) oil, T<sub>5</sub>: Lavender (*Lavandula angustifolia*) oil, T<sub>6</sub>: Thyme (*Thymus vulgaris*) oil, T<sub>7</sub>: Rosemary (*Rosmarinus officinalis*) oil, T<sub>8</sub>: Basil (*Ocimum basilicum*) oil, T<sub>9</sub>: Coconut (*Cocos*

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*nucifera*) oil, T<sub>10</sub>: Control (water dipped) and kept at ambient condition (Temperature: 20 ± 3<sup>0</sup>C; Relative humidity: 70 ± 5%) at Post Harvest Technology Laboratory, Department of Horticulture, Mizoram University, Aizawl, India. The experiment was laid out in complete randomized design (Easterling 2015). The 100% pure, hydro-distilled essential oils of Cinnamon (bark), Citronella (leaves and stems), Peppermint (leaves, flowers and buds), Eucalyptus (leaves), Lavender (flowers), Thyme (leaves and flowers) and Rosemary (leaves, flowers and buds) manufactured by Mesmara Essential Oil, Ramachandrapuram, Sangareddy District, Telangana, India and USDA certified, natural and organic extra virgin coconut oil (manufactured by Earthon Products Pvt. Ltd., Mustafa Bazar, Byculla (E), Mumbai, India) were used for preparation of treatments. Respective essential oil (EO) coating was prepared by mixing EO (0.5% v/v) with Glycerol (1.2% v/v) and Coconut oil (80% v/v) along with sterile water. All formulations were mixed in homogenizer for 5 minutes at 24,500 rpm to form the emulsion for coating by dipping the fruits for 2 minutes. However, coconut oil (100%) and water dipping were followed in T<sub>9</sub> and T<sub>10</sub>, respectively. Observations on physiological weight loss (using digital balance), fruit firmness (using digital Penetrometer), and biochemical parameters *viz.* total soluble solids (TSS; using handheld refractometer), total carbohydrates, protein, total phenol and β-carotene were determined as per method described by Sadasivam and Manickam (2005). Total sugar, titratable acidity and ascorbic acid content (AOAC 2012) were recorded at 4, 8 and 12 days at storage (DAS) whereas, fruit flesh colour (using Digital Colour Meter for L\*, a\*, b\*), antioxidant activity (DPPH scavenging activity (Kato *et al.* 1988) and fruit decay (Mandal *et al.* 2018) were determined at 12 DAS. Shelf life (days) was evaluated depending on the fruit decay, fruit physico-chemical parameters and counting the days from harvest to the day with maximum visual, edible and marketable quality (Mandal *et al.* 2018).

## Results and Discussion

Physiological weight loss (PWL) of mango fruits increased consistently during ambient storage because of loss in moisture due to transpiration, respiration along with metabolic uses. It ranged between 1.56 and 8.82 % at 4 DAS, and ranged between 3.25 and 12.12% at 10 DAS (Table 1). At 12 DAS, minimum PWL (5.14%) was found in Citronella oil treated fruits compared with control (18.92%). Aifaa *et al.* (2013) reported that Citronella oil @ 0.5% caused significantly low PWL (5.01%) in 21 days stored dragon fruit at 10<sup>0</sup>C. Consequently, loss of surface moisture from stored mango caused significant reduction in fruit firmness, however, fruits treated with Citronella oil (T<sub>2</sub>) had reasonably high firmness (52.85 N/cm<sup>2</sup>) compared with control (28.31 N/cm<sup>2</sup>) at 12 DAS. Citronella oil emulsified coating might have reduced the surface moisture loss and maintained the fruit firmness. High firmness of Robusta banana was found to get maintained with post harvest application of Citronella oil at ambient storage (Sangeetha *et al.* 2010). Skin colour of mango cv. Ranguai remained intense green even at ripening, but the flesh colour changed to orange yellow (L: 59.22, a: 34.91, b: 48.00) in control compared with fruits treated with Citronella oil (whitish yellow, L: 91.06, a: -2.61, b: 24.03) at 12 DAS.

Total carbohydrate which was high (14.23-14.83% at 4DAS) initially, reduced (10.89-11.56% at 12 DAS) subsequently because of amylase hydrolysis of starch and resulted in significant increase in total sugar content of stored mango across the treatments. At 12 DAS, total sugar content of mango was maximum in control (8.78 %) followed by coconut oil treated (8.12%) compared with citronella oil treated (4.46%) fruits (Table 2). Enhanced respiration of climacteric mango caused enzymatic conversion of starch to sugar and manifested as increased sugar accumulation in control fruits compared with essential oil treated fruits. Post-harvest ripening of mango caused accumulation in total soluble solids (TSS) with reduction in titratable acidity and resulted in increment of TSS:acid ratio. Thus, faster ripened control mangoes had maximum TSS :

**Table 1. Effect of post-harvest treatments on physiological weight loss, fruit firmness, flesh colour, total carbohydrate content of mango.**

Treatments	Physiological weight loss (%)			Fruit firmness (N/cm <sup>2</sup> )			Fruit flesh colour at 12DAS			Total carbohydrate (%)		
	4DAS	8DAS	12DAS	4DAS	8DAS	12DAS	L	a	b	4DAS	8DAS	12DAS
T <sub>1</sub>	4.81	7.15	9.81	47.45	43.11	37.73	80.55	14.49	40.06	14.35	13.84	11.38
T <sub>2</sub>	1.56	3.25	5.14	58.34	55.12	52.85	91.06	-2.61	24.03	14.83	14.56	11.56
T <sub>3</sub>	3.13	5.76	7.83	52.02	47.92	43.88	73.32	13.02	55.62	14.61	14.24	11.42
T <sub>4</sub>	4.55	6.39	8.45	49.72	45.62	41.21	70.98	8.02	59.00	14.58	14.22	11.39
T <sub>5</sub>	3.25	5.85	8.32	52.48	49.28	45.72	79.12	4.82	64.11	14.62	14.32	11.40
T <sub>6</sub>	2.31	4.38	6.27	53.44	49.84	47.45	90.03	-6.84	45.12	14.78	14.54	11.52
T <sub>7</sub>	4.89	7.12	9.64	48.41	44.82	39.57	76.61	11.80	43.39	14.52	14.35	11.38
T <sub>8</sub>	3.08	5.24	7.16	55.69	51.05	48.91	82.04	-1.16	52.47	14.62	14.48	11.50
T <sub>9</sub>	5.41	7.25	10.14	45.72	39.57	31.71	74.26	28.74	48.27	14.28	13.78	11.32
T <sub>10</sub>	8.82	12.12	18.92	43.11	31.31	28.31	59.22	34.91	48.00	14.23	13.45	10.89
SEm±	0.393	0.529	0.622	1.208	0.994	1.119	-	-	-	NS	0.063	0.028
CD at 5%	0.678	0.913	1.073	2.084	1.715	1.931	-	-	-	NS	0.108	0.048

**Table 2. Effect of post-harvest treatments on total sugar, Total soluble solids (TSS), titrable acidity and TSS: acid ratio of mango.**

Treatments	Total sugar (%)			TSS ( $^{\circ}$ Brix)			Titrable acidity (%)			TSS : Acid Ratio		
	4DAS	8DAS	12DAS	4DAS	8DAS	12DAS	4DAS	8DAS	12DAS	4DAS	8DAS	12DAS
T <sub>1</sub>	5.14	6.52	7.31	8.92	9.80	10.25	2.58	1.46	0.82	3.46	6.71	12.50
T <sub>2</sub>	3.79	4.11	4.46	7.84	8.35	9.12	3.65	2.76	1.34	2.15	3.03	6.81
T <sub>3</sub>	4.89	6.24	7.24	8.83	9.65	10.06	2.67	1.67	0.85	3.31	5.78	11.84
T <sub>4</sub>	4.76	6.12	7.15	8.51	9.43	9.87	2.82	1.86	0.89	3.02	5.07	11.09
T <sub>5</sub>	4.52	5.62	6.42	8.32	9.05	9.65	3.05	1.92	1.02	2.73	4.71	9.46
T <sub>6</sub>	4.26	5.15	6.27	8.04	8.79	9.42	3.12	2.12	1.04	2.58	4.15	9.06
T <sub>7</sub>	4.61	5.83	6.98	8.72	9.56	9.76	2.91	1.82	0.95	3.00	5.25	10.27
T <sub>8</sub>	4.12	4.92	5.84	8.21	8.86	9.56	3.24	2.45	1.12	2.53	3.62	8.54
T <sub>9</sub>	5.78	6.85	8.12	9.12	9.86	10.84	2.49	1.35	0.46	3.66	7.30	23.57
T <sub>10</sub>	6.21	7.67	8.78	9.24	10.23	11.12	2.24	1.32	0.34	4.13	7.75	32.71
SEm $\pm$	0.204	0.164	0.157	0.114	0.225	0.171	0.103	0.079	0.055	0.091	0.154	0.725
CD at 5%	0.351	0.282	0.271	0.196	0.388	0.294	0.177	0.136	0.095	0.157	0.266	1.251

**Table 3. Effects of post-harvest treatments on ascorbic acid, protein, total phenol,  $\beta$ -Carotene content and antioxidant capacity of mango.**

Treatments	Ascorbic acid (mg/100 g)			Protein (%)			Total phenol (mg/100 g)			$\beta$ -Carotene (mg/100 g)			Antioxidant capacity (%)
	4DAS	8DAS	12DAS	4DAS	8DAS	12DAS	4DAS	8DAS	12DAS	4DAS	8DAS	12DAS	12DAS
T <sub>1</sub>	32.27	27.18	21.35	0.52	0.44	0.36	115.32	93.56	72.58	1.56	2.85	3.92	34.23±1.12
T <sub>2</sub>	41.23	39.34	33.62	0.69	0.62	0.51	123.47	119.75	89.67	0.62	2.07	3.85	71.48±1.02
T <sub>3</sub>	33.19	30.62	24.22	0.51	0.46	0.36	115.47	94.54	83.29	0.98	2.52	3.90	38.76±0.73
T <sub>4</sub>	34.27	31.37	25.41	0.50	0.48	0.35	115.42	95.63	80.55	1.12	2.55	3.88	61.23±1.24
T <sub>5</sub>	37.27	33.91	28.39	0.54	0.51	0.39	116.08	98.32	82.34	0.86	2.62	3.85	38.94±2.11
T <sub>6</sub>	38.67	35.12	30.72	0.56	0.52	0.42	118.39	116.18	85.46	0.83	2.12	3.86	46.11±1.82
T <sub>7</sub>	36.35	33.27	26.75	0.52	0.47	0.38	115.45	112.34	81.35	1.34	2.57	3.91	50.49±1.19
T <sub>8</sub>	39.12	37.23	32.41	0.65	0.56	0.45	121.52	116.24	88.51	0.72	2.45	3.87	65.24±1.53
T <sub>9</sub>	30.45	25.48	19.76	0.47	0.42	0.32	114.75	92.56	71.23	1.87	3.21	4.07	25.89±1.91
T <sub>10</sub>	28.79	24.56	18.35	0.43	0.38	0.28	114.25	90.63	70.99	2.35	3.68	4.12	23.46±0.85
SEM±	1.204	1.087	0.959	0.027	0.027	0.023	1.160	0.750	0.681	0.070	0.073	0.017	-
CD at 5%	2.077	1.876	1.653	0.046	0.047	0.039	2.001	1.293	1.175	0.121	0.126	0.029	-

acid ratio (32.71) compared with delay ripened citronella oil treated fruits (6.81) at 12 DAS. Kamel (2014) reported low TSS : acid ratio (9.20) in 0.5 % garlic oil treated Valencia orange compared with control (10.46) at 60 DAS. During storage mango lose ascorbic acid (Khaliq *et al.* 2016); similarly during present study ascorbic acid which ranged between 28.79 and 41.23 mg/100 g at 4 DAS got reduced and ranged between 18.35 and 33.62 mg/100 g at 12 DAS (Table 3). Maximum retention of ascorbic acid was found in citronella oil treated (33.62 mg/100 g) mangoes followed by Basil oil treated (32.41 mg/100 g) fruits at 12 DAS. Essential oil from Neem was reported to retain high ascorbic acid in stored guava and amla fruits by inhibiting the oxidation of ascorbic acid (Sebastian *et al.* 2018). Protein and total phenol content of mango fruits decreased during storage. However, fruits treated with citronella and basil oil was found to retain more protein (0.51, 0.45%) and total phenol (89.67, 88.51 mg/100 g) compared with control (0.32% protein and 70.99 mg/100 g total phenol ) at 12 DAS. Essential oil of geranium was reported to reduce polyphenol oxidase action and delay in oxidation of phenolic substance, therefore, caused better retention of total phenol of peaches under cold storage (El-Gawad and El-Moghazy 2018). Ripening of mango involved accumulation of carotenoids (Singh *et al.* 2013), however in the present study  $\beta$ -carotene was found delayed accumulation in citronella and lavender oil treated fruits, may be because of slow attainment of respiration climacteric. Further, DPPH radical scavenging activity (antioxidant assay) was recorded high in citronella ( $71.48 \pm 1.02$  %) and basil oil ( $65.24 \pm 1.53$ %) treated mango fruits compared with control ( $23.46 \pm 0.85$  %) at 12 DAS. Post harvest use of essential oils like thyme, peppermint and citronella enhanced antioxidant activities in stored avocado due to activation of antioxidant system or secondary metabolites and there by scavenging more free radicals (Sellamuthu *et al.* 2013). Essential oils are potential antimicrobial agent and proved to control post harvest diseases (Solgi and Ghorbanpour 2014) and thus under present study mangoes coated with essential oil emulsion had less fruit decay than control. At 12 DAS, citronella oil treated mangoes had least fruit decay (8.33%) followed by basil oil treated fruits (8.67%) compared with control (44.67%) (Fig.1). Potential use of citronella and lemon grass oil had been reported for post harvest disease control in mango (Lieu *et al.* 2018). Maximum shelf

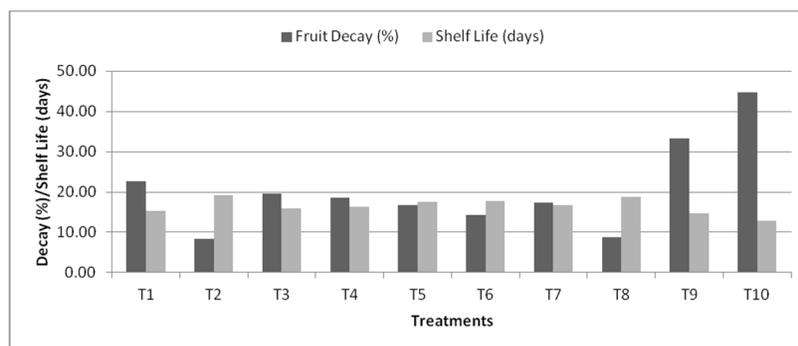


Fig.1. Effects of post harvest treatments on fruit decay and shelf life of stored mango.

life (19.17 days) was recorded in Citronella oil coated mangoes compared with control (12.85 days). Protective barrier for inhibiting moisture loss, reduced respiration may have resulted in delayed ripening and maintenance of fruit quality, while antimicrobial effect controlled the fruit decay and finally resulted in higher shelf life in mangoes coated with citronella oil emulsion. Citronella oil (< 0.2%) was reported for extending the shelf life for 14 days in Dragon fruit (Aifaa *et al.* 2013).

From the experiment it may be concluded that post-harvest coating with citronella oil emulsion (0.5% v/v) can be a suitable method for controlling post-harvest diseases, retaining fruit quality and extending shelf life in mangoes stored at ambient condition.

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