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EFFECT OF POST HARVEST TREATMENTS AND PACKAGES ON PHYSICAL PARAMETERS AFFECTING STORAGE LIFE OF MANGO (*MANGIFERA INDICA* L.) CVS. SENDHURA AND NEELUM

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Abstract

Investigations were carried out to study the effect of postharvest treatments and packages on storage life (*Mangifera indica* L.) cvs. Sendhura and Neelum in the Department of Horticulture, Faculty of Agriculture, Annamalai University during 2016-2018. The experiment was carried out by adopting Randomised Block Design with thirteen treatments with three replications. Fruits which were treated with aqueous solution of calcium chloride and calcium nitrate at (1%, 1.5%, 2%) respectively for five minutes and stored under room temperature for 12 days. The stored fruits were analysed after 3th, 6th, 9th and 12th days of storage. The results revealed that polythene packed fruits recorded significantly lower PLW as compared to other treatments. The fruit treated with calcium chloride 1.5 per cent and polythene packaging was found most effective in extending the shelf life of mango cvs. Sendhura and Neelum fruits with excellent fruit quality upto 12 days.

Key words : Physical parameters, *Mangifera indica* L., Post harvest treatments

Introduction

Mango *(Mangifera indica*) belongs to the family Anacardiaceae is popularly called as "King of fruits" is a major fruit of tropical Asia. The leading mango producing countries in the world are India, China, Thailand, Indonesia and Mexico. Mango is now cultivated in most frost-free tropical and warmer subtropical climates almost half of the world's mango is cultivated in India. In India, mango is cultivated in almost all the states *viz.,* Uttar Pradesh, Andhra Pradesh, Karnataka, Bihar, Gujarat, Tamil Nadu, Odisha, West Bengal, Jharkhand and Maharashtra. Uttar Pradesh ranks first in mango production with a share of 23.47% and highest productivity. India's exports of processed food was Rs. 27,263.94 crores in 2016-17, which includes the share of products like mango pulp (Rs. 864.97 crores). India is the largest mango producing country in the world with an annual production of about 16,337,400 tons accounting for 42.2% of the world's total production. The major post-harvest losses of mango are due to improper handling, transportation and grading, packaging and storage. Total average loss was found as much as 34%. Of the losses, damages of mango occurred due to impact bruising, sap burn, dropped mango. The total loss due to post harvest pathological diseases was found as anthracnose, stem end rot, transit rot and dendritic spot. The total loss due to post harvest pathological disease from producer to consumer was about 27%. Harvest injury, defective handling affect the storage life of the mango fruits. Presence of blemished fruits contributes to the decay and damage. Micro-organisms such as bacteria, yeast and molds invade into surface bruise or injury of the fruit it and cause internal decay. Post-harvest temperature management and proper handling during storage and transportation are equally important to reduce the post harvest losses in fruits. Various chemicals have been used to hasten or delay the ripening to reduce losses and to improve and maintain the colour and quality. This could be achieved by reducing the metabolic activity of the produce, arresting the growth and spread of microorganisms and fungal spores. Research efforts are needed to achieve minimum loss for domestic as well as for export market. Keeping the above facts in view a study has been carried out at the Department of Horticulture, Faculty of Agriculture, Annamalai University, during the year 2016-2018 with the objectives to study the effect of calcium salts ($CaCl_2$

and $Ca(NO_3)_2$ on shelf life of mango and to study the post-harvest treatments effects on the quality and shelf life of mango.

Materials and Methods

The experiment was conducted in the laboratory of Department of Horticulture, Faculty of Agriculture, Annamalai University during 2016-2018 by using Randomised Block Design with thirteen treatments replicated thrice. The treatment details are T_1-$CaCl_2$ 1% + 0.1% carbendazim in polythene bag stored under room temperature, T_2-$CaCl_2$ 1% + 0.1% carbendazim in news paper stored under room temperature, T_3-$CaCl_2$ 1.5% + 0.1% carbendazim in polythene bag stored under room temperature, T_4-$CaCl_2$ 1.5% + 0.1% carbendazim in news paper stored under room temperature, T_5-$CaCl_2$ 2% + 0.1% carbendazim in polythene bag stored under room temperature, T_6-$CaCl_2$ 2% + 0.1% carbendazim in news paper stored under room temperature, T_7-$Ca(NO_3)_2$ 1% + 0.1% carbendazim in polythene bag stored under room temperature, T_8-$Ca(NO_3)_2$ 1% + 0.1% carbendazim in news paper stored under room temperature, T_9- $Ca(NO_3)_2$ 1.5%+ 0.1% carbendazim in polythene bag stored under room temperature, T_{10}-$Ca(NO_3)_2$ 1.5%+ 0.1% carbendazim in news paper stored under room temperature, T_{11}-$Ca(NO_3)_2$ 2% + 0.1% carbendazim in polythene bag stored under room temperature, T_{12} - $Ca(NO_3)_2$ 2% +0.1% carbendazim in news paper stored under room temperature, T_{13}-Control. Observations on physical characters of mango fruits with different treatments were recorded at 0 (initial), 3, 6, 9, and 12 days intervals.

Results and discussion

The mean minimum PLW was observed in T_3 ($CaCl_2$ 1.5% wrapping

Table 1: Effect of post-harvest treatment and packages on physiological loss in weight (PLW) % and fruit firmness (kg/cm^2) in mango cvs. Sendhura and Neelum under room temperature

T.No	Physiological loss in weight (PLW)								%Fruit firmness (kg/cm^2)							
	Sendhura				Neelum				Sendhura				Neelum			
	3rd day	6th day	9th day	12th day	3rd day	6th day	9th day	12th day	3rd day	6th day	9th day	12th day	3rd day	6th day	9th day	12th day
T_1	3.79	4.97	10.64	16.12	3.98	4.68	9.65	14.93	10.34	6.82	4.64	3.47	11.75	8.29	5.71	4.22
T_2	7.59	9.57	23.94	35.77	9.08	10.88	18.3	27.48	7.99	4.52	2.84	2.22	9.00	5.74	3.81	2.67
T_3	2.27	3.13	5.32	8.26	1.94	2.2	6.19	9.95	11.28	7.74	5.36	3.97	12.85	9.31	6.47	4.84
T_4	8.35	10.49	26.60	39.70	10.1	12.12	20.03	30.07	7.52	4.06	2.48	1.97	8.45	5.23	3.43	2.36
T_5	3.03	4.05	7.98	12.19	2.96	3.44	7.92	12.34	10.81	7.28	5.00	3.72	12.30	8.8	6.09	4.53
T_6	6.83	8.65	21.28	31.84	8.06	9.64	16.57	25.09	8.46	4.98	3.20	2.47	9.55	6.25	4.19	2.98
T_7	4.55	5.89	13.30	20.05	5.00	5.92	11.38	17.52	9.87	6.36	4.28	3.22	11.20	7.78	5.33	3.91
T_8	10.63	13.25	34.58	51.49	13.16	15.84	25.22	37.84	6.11	2.68	1.40	1.22	6.80	3.70	2.29	1.43
T_9	5.31	6.81	15.96	23.98	6.02	7.16	13.11	20.11	9.40	5.9	3.92	2.97	10.65	7.27	4.95	3.60
T_{10}	9.11	11.41	29.26	43.63	11.12	13.36	21.76	32.66	7.05	3.60	2.12	1.72	7.90	4.72	3.05	2.05
T_{11}	6.07	7.73	18.62	27.91	7.04	8.4	14.84	22.50	8.93	5.44	3.56	2.72	10.10	6.76	4.57	3.29
T_{12}	9.87	12.33	31.92	47.56	12.14	14.60	23.49	35.25	6.58	3.14	1.76	1.47	7.35	4.21	2.67	1.74
T_{13}	11.39	14.17	37.24	55.42	14.18	17.08	26.95	40.43	5.64	2.22	1.04	0.97	6.25	3.19	1.91	1.12
S.Ed.	0.28	0.36	1.23	1.86	0.41	0.52	0.76	1.19	0.18	0.17	0.13	0.07	0.17	0.15	0.09	0.05
CD (p=0.05)	0.56	0.72	2.46	3.73	0.82	1.04	1.53	2.39	0.37	0.35	0.26	0.15	0.35	0.31	0.18	0.11

T_1 - $CaCl_2$ 1% + 0.1% carbendazim wrapped in polythene bag, T_2 - $CaCl_2$ 1% + 0.1% carbendazim wrapped in newspaper , T_3 - $CaCl_2$ 1.5% + 0.1% carbendazim wrapped in polythene bag, T_4 - $CaCl_2$ 1.5 + 0.1% carbendazim wrapped in newspaper, T_5 - $CaCl_2$ 2% + 0.1% carbendazim wrapped in polythene bag, T_6 - $CaCl_2$ 2% + 0.1% carbendazim wrapped in newspaper, T_7 - $Ca(NO_3)_2$ 1% + 0.1% carbendazim wrapped in polythene bag, T_8 - $Ca(NO_3)_2$ 1% + 0.1% carbendazim wrapped in newspaper, T_9 - $Ca(NO_3)_2$ 1.5% + 0.1% carbendazim wrapped in polythene bag ,T_{10} - $Ca(NO_3)_2$ 1.5% + 0.1% carbendazim wrapped in newspaper ,T_{11} - $Ca(NO_3)_2$ 2% + 0.1%carbendazim wrapped in polythene bag , T_{12} - $Ca(NO_3)_2$ 2% + 0.1% carbendazim wrapped in newspaper, T_{13} - Control

Table 2: Effect of post-harvest treatment and packages on degreening (days), days taken for ripening and shelf life (days) in mango cvs. Sendhura and Neelum under room temperature

T.No.	Degreening (days)		Days taken for ripening		Shelf life (days)	
	Sendhura	Neelum	Sendhura	Neelum	Sendhura	Neelum
T_1	11.13	9.43	6.23	7.58	11.54	12.05
T_2	9.08	6.43	6.79	8.06	9.34	10.60
T_3	11.95	10.63	11.83	12.38	12.42	12.63
T_4	8.67	5.83	9.59	10.46	8.90	10.31
T_5	11.54	10.03	5.67	7.10	11.98	12.34
T_6	9.49	7.03	9.03	9.98	9.78	10.89
T_7	10.72	8.83	11.27	11.90	11.10	11.76
T_8	7.44	4.03	7.91	9.02	7.58	9.44
T_9	10.31	8.23	8.47	9.50	10.66	11.47
T_{10}	8.26	5.23	10.71	11.42	8.46	10.02
T_{11}	9.90	7.63	7.35	8.54	10.22	11.18
T_{12}	7.85	4.63	10.15	10.94	8.02	9.13
T_{13}	7.03	3.43	5.11	6.62	7.14	9.15
S.Ed.	0.10	0.20	0.23	0.19	0.17	0.11
CD (p = 0.05)	0.21	0.40	0.46	0.38	0.34	0.23

T_1 - $CaCl_2$ 1% + 0.1% carbendazim wrapped in polythene bag, T_2 - $CaCl_2$ 1% + 0.1% carbendazim wrapped in newspaper , T_3 - $CaCl_2$ 1.5% + 0.1% carbendazim wrapped in polythene bag, T_4 - $CaCl_2$ 1.5 + 0.1% carbendazim wrapped in newspaper, T_5 - $CaCl_2$ 2% + 0.1% carbendazim wrapped in polythene bag, T_6 - $CaCl_2$ 2% + 0.1% carbendazim wrapped in newspaper, T_7 - $Ca(NO_3)_2$ 1% + 0.1% carbendazim wrapped in polythene bag, T_8 - $Ca(NO_3)_2$ 1% + 0.1% carbendazim wrapped in newspaper, T_9 - $Ca(NO_3)_2$ 1.5% + 0.1% carbendazim wrapped in polythene bag ,T_{10} - $Ca(NO_3)_2$ 1.5% + 0.1% carbendazim wrapped in newspaper ,T_{11} - $Ca(NO_3)_2$ 2% + 0.1%carbendazim wrapped in polythene bag , T_{12} - $Ca(NO_3)_2$ 2% + 0.1% carbendazim wrapped in newspaper, T_{13} - Control

with polythene bag under room temperature). Maximum weight loss was noticed in the untreated fruits (T_{13}) in both cultivars (Table.1). This might be due to maximum loss of moisture caused by higher rate of transpiration and respiration through uninterrupted atmospheric column, higher temperature and less relative humidity in comparison to wrapped and treated fruits. Similarly, Polythene packaging treatments recorded significantly lower PLW when compared to the respective treatments applied without packaging. The results reported on the physiological loss in weight are in line with the findings of Vala *et al.* (2002) in mango, Santos *et al.* (2004) in mango, Pfaffenbach *et al.* (2004) in mango, Vali Rabiei (2011) in apple, Ahamed Gayed *et al.* (2017) in peach fruit.

In the present study, fruit treated with T_3 ($Cacl_2$ 1.5% wrapping with polythene bag under room temperature) had the highest firmness Table 1 in both the cultivars. Hojo *et al.* (2009) who found that calcium is known to delay senescence resulting in firmer fruits and that mango fruit firmness increased with treatment of calcium as compared to the control. Similar result was obtained by Savani (2008). Polythene packaging treatments recorded significantly higher fruit firmness when compared to the respective treatments applied without packaging. The $CaCl_2$ treatments avoided softening and maintained the structures of cell walls through cross-linking the pectic acid in the cell wall (Gunes *et al.,* 2001). The results are in agreement with Santos *et al.* (2004) in mango. Mahmud *et al.* (2008) in papaya, Attiqakhtar (2010) in loquat, Vali Rabiei (2011) in apple, Elham shirzadesh *et al.* (2011) in apple, Kumar *et al.* (2012), Tsomu Patel (2014) in sapota.

Colour changes in all the treatments were closely associated with climacteric peak. The colour development, which started prior to the onset of climacteric, was complete at the peak climacteric. A close observation on the data indicates that the changes in colour was much faster in control fruits whereas it was markedly slower in fruits treated with T_3 ($CaCl_2$ 1.5% wrapping with polythene bag under room temperature). Mango fruits treated with calcium delayed the ripening for better skin and pulp colour (Table.2). Similar results were also obtained by Anjum and Ali (2004) in mango.

In the present study, fruits treated with T_3 ($CaCl_2$ 1.5% wrapping with polythene bag under room temperature) remained green for more number of days (Table.2). Slow ripening percentage for extending shelf life $CaCl_2$ has mostly been manifested in protecting the cell from collapse during long storage and its compounds extended the ripening by maintaining their firmness and minimizing the rate of respiration as well as ethylene production. Similar results was also found by Maqbool *et al.* (2009) and Mohamed Eluzubeir *et al.* (2017) in mango.

In the present study, fruits treated with T_3 ($CaCl_2$ 1.5% wrapping with polythene bag under room temperature) had extended the shelf life comparing to other treatments (Table.2). Shelf life of fruits was significantly influenced by mode of storage irrespective of *in vivo* calcium content of tissue cell wall, substantially increased concentration might have provide additional strength facilitating delayed degradation followed by increased permeability of cell wall and hence reduce the spoilage and delayed the ripening process of fruits. The results of the present investigation are in consonance with the result of Shweta Chauhan *et al.* (2014) in mango, Dhillon and Kaur (2013), in mango. The mean

Table 3: Effect of post-harvest treatment and packages on spoilage of fruits (%) and Total soluble solids (^{0}Brix) in mango cvs. Sendhura and Neelum under room temperature

T.No	Spoilage of fruit (%)						Total soluble solids (^{0}Brix)							
	Sendhura			Neelum			Sendhura				Neelum			
	3rd day	6th day	9th day	3rd day	6th day	9th day	3rd day	6th day	9th day	12th day	3rd day	6th day	9th day	12th day
T_1	12.40	26.36	46.58	15.09	34.52	51.83	9.72	10.91	14.77	15.42	11.4	13.01	13.38	15.35
T_2	21.40	39.06	57.28	28.79	50.57	62.18	11.12	12.86	16.32	16.22	13.50	15.56	16.18	16.10
T_3	8.80	21.28	42.30	9.61	28.10	47.69	9.16	10.13	14.15	15.10	10.56	11.99	12.26	15.05
T_4	23.20	41.60	59.42	31.53	53.78	64.25	11.40	13.25	16.63	16.38	13.92	16.07	16.74	16.25
T_5	10.60	23.82	44.44	12.35	31.31	49.76	9.44	10.52	14.46	15.26	10.98	12.50	12.82	15.20
T_6	19.60	36.52	55.14	26.05	47.36	60.11	10.84	12.47	16.01	16.06	13.08	15.05	15.62	15.95
T_7	14.20	28.90	58.72	17.83	37.73	53.90	10.00	11.30	15.08	15.58	11.82	13.52	13.94	15.5
T_8	28.60	49.22	65.84	39.75	63.41	70.46	12.24	14.42	17.56	16.86	15.18	17.60	18.37	16.70
T_9	16.00	31.44	50.86	20.57	40.94	55.97	10.28	11.69	15.39	15.74	12.24	14.03	14.50	15.65
T_{10}	25.00	44.14	61.56	34.27	56.99	66.32	11.68	13.64	16.94	16.54	14.34	16.58	17.25	16.40
T_{11}	17.80	33.98	53.00	23.31	44.15	58.04	10.56	12.08	15.70	15.70	12.66	14.54	15.06	15.80
T_{12}	26.80	46.68	63.70	37.01	60.20	68.39	11.96	14.03	17.25	16.70	14.76	17.09	17.81	16.55
T_{13}	30.40	51.76	67.98	42.49	66.62	72.53	12.52	14.81	17.87	17.02	15.60	18.11	18.93	16.85
S.Ed.	0.80	1.27	1.05	1.27	1.50	0.93	0.12	0.16	0.13	0.05	0.11	0.15	0.18	0.03
CD (p = 0.05)	1.60	2.34	2.10	2.54	3.01	1.87	0.24	0.32	0.26	0.10	0.22	0.31	0.36	0.05

T_1 - $CaCl_2$ 1% + 0.1% carbendazim wrapped in polythene bag, T_2 - $CaCl_2$ 1% + 0.1% carbendazim wrapped in newspaper , T_3 - $CaCl_2$ 1.5% + 0.1% carbendazim wrapped in polythene bag, T_4 - $CaCl_2$ 1.5 + 0.1% carbendazim wrapped in newspaper, T_5 - $CaCl_2$ 2% + 0.1% carbendazim wrapped in polythene bag, T_6 - $CaCl_2$ 2% + 0.1% carbendazim wrapped in newspaper, T_7 - $Ca(NO_3)_2$ 1% + 0.1% carbendazim wrapped in polythene bag, T_8 - $Ca(NO_3)_2$ 1% + 0.1% carbendazim wrapped in newspaper, T_9 - $Ca(NO_3)_2$ 1.5% + 0.1% carbendazim wrapped in polythene bag ,T_{10} - $Ca(NO_3)_2$ 1.5% + 0.1% carbendazim wrapped in newspaper ,T_{11} - $Ca(NO_3)_2$ 2% + 0.1%carbendazim wrapped in polythene bag , T_{12} - $Ca(NO_3)_2$ 2% + 0.1% carbendazim wrapped in newspaper, T_{13} - Control

maximum sugar: acid ratio recorded in control fruits which was significantly higher than all treatments while the mean minimum sugar: acid ratio was recorded in T_3 ($CaCl_2$ 1.5% wrapping with polythene bag under room temperature). These results are in agreement with Ram *et al.* (2011) in aonla.

Spoilage percentage was lowest in fruits treated with calcium chloride. Among the various treatments, fruits treated with T_3 ($CaCl_2$ 1.5% wrapping with polythene bag under room temperature) has less spoilage when compared to other treatments (Table.3). Irrespective of *in vivo* calcium content of tissue cell wall, substantially increased concentration might have provide additional strength facilitating delayed degradation followed by increased permeability of cell wall. Similar results were found by Sakhale *et al.* (2009), Anjum and Ali (2004), Patel (2008), Vala *et al.* (2002) and Jain *et al.* (2001) in mango fruits. Significantly higher fruit spoilage (16.67 %) was noticed in control fruits as compared to others while fruits under polythene packaging recorded no spoilage. The current study demonstrates that the packaging of mango fruits in polythene packaging has merit in reducing spoilage, which may be due to their positive role in delaying the process of senescence of fruits by maintaining cell wall integrity, thus lowering the spoilage. These results are in agreement with the findings of Kumar *et al.* (2003) in guava, Sandhu *et al.* (2004) in pear, Singh *et al.* (2007) in strawberry, Singh *et al.* (2008) in aonla.

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