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EFFECT OF POST HARVEST TREATMENTS AND PACKAGES ON BIOCHEMICAL 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 post harvest 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 : Sendhura and Neelum, 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 were 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 biochemical characters of mango fruits with different treatments were recorded at 0 (initial), 3, 6, 9, and 12 days intervals.

Results and discussion

The TSS content constantly increased during the storage period up to peak and then declined slightly. The rise in TSS could be due to the accumulation of sugar as a consequence of starch hydrolysis. The TSS contents were found maximum in control fruits which were significantly higher as compared to all other treatments (Table.1). Polythene packed fruit recorded significantly lesser total soluble solids contents than fruits given chemical treatments only. The TSS contents were significantly increased with advancement of storage period for 6th day and subsequently declined. The increase in TSS of mangoes with storage could result partly from desiccation of mangoes, which in turn leads to a concentrating effect on the TSS contents. The TSS contents in non LDPE packed mango fruits increased up to 9th days of storage, afterwards declined in TSS was recorded but in polythene packed fruits improvement in

Table 1: Effect of post-harvest treatment and packages on total soluble solids (^{0}Brix) and sugar acid ratio in mango cvs. Sendhura and Neelum under room temperature

T.No	Total soluble solids (^{0}Brix)								Sugar Acid ratio	
	Sendhura				Neelum				Sendhura	Neelum
	3rd day	6th day	9th day	12th day	3rd day	6th day	9th day	12th day		
T_1	9.72	10.91	14.77	15.42	11.4	13.01	13.38	15.35	24.73	26.95
T_2	11.12	12.86	16.32	16.22	13.50	15.56	16.18	16.10	33.29	33.34
T_3	9.16	10.13	14.15	15.10	10.56	11.99	12.26	15.05	22.09	24.76
T_4	11.40	13.25	16.63	16.38	13.92	16.07	16.74	16.25	35.46	34.80
T_5	9.44	10.52	14.46	15.26	10.98	12.50	12.82	15.20	23.37	25.83
T_6	10.84	12.47	16.01	16.06	13.08	15.05	15.62	15.95	31.30	31.95
T_7	10.00	11.30	15.08	15.58	11.82	13.52	13.94	15.5	26.20	28.12
T_8	12.24	14.42	17.56	16.86	15.18	17.60	18.37	16.70	43.30	39.64
T_9	10.28	11.69	15.39	15.74	12.24	14.03	14.50	15.65	26.83	29.34
T_{10}	11.68	13.64	16.94	16.54	14.34	16.58	17.25	16.40	37.83	36.34
T_{11}	10.56	12.08	15.70	15.70	12.66	14.54	15.06	15.80	29.47	30.62
T_{12}	11.96	14.03	17.25	16.70	14.76	17.09	17.81	16.55	40.43	37.95
T_{13}	12.52	14.81	17.87	17.02	15.60	18.11	18.93	16.85	46.48	41.42
S.Ed.	0.12	0.16	0.13	0.05	0.11	0.15	0.18	0.03	0.57	0.51
CD (p = 0.05)	0.24	0.32	0.26	0.10	0.22	0.31	0.36	0.05	1.15	1.03

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 reducing sugars (%) and non reducing sugars (%) in mango cvs. Sendhura and Neelum under room temperature

T.No	Reducing sugars (%)								Non reducing sugars (%)							
	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	3.27	3.84	4.60	4.58	3.45	4.22	5.80	4.91	6.93	7.46	7.85	7.74	5.72	6.3	6.70	6.55
T_2	4.17	5.09	5.05	5.28	4.55	5.62	6.15	5.86	7.38	8.66	8.70	7.94	6.22	7.40	7.45	6.85
T_3	2.91	3.34	4.42	4.30	3.01	3.66	5.66	4.53	6.75	6.98	7.51	7.66	5.52	5.86	6.40	6.43
T_4	4.35	5.34	5.14	5.42	4.77	5.90	6.22	6.05	7.47	8.90	8.87	7.98	6.32	7.62	7.6	6.91
T_5	3.09	3.59	4.51	4.44	3.23	3.94	5.73	4.72	6.84	7.22	7.68	7.70	5.62	6.08	6.55	6.49
T_6	3.99	4.84	4.96	5.14	4.33	5.34	6.08	5.67	7.29	8.42	8.53	7.90	6.12	7.18	7.30	6.79
T_7	3.45	4.09	4.69	4.72	3.67	4.50	5.87	5.10	7.02	7.70	8.02	7.78	5.82	6.52	6.85	6.61
T_8	4.89	6.09	5.41	5.84	5.43	6.74	6.43	6.62	7.74	9.62	9.38	8.10	6.62	8.28	8.05	7.09
T_9	3.63	4.34	4.78	4.86	3.89	4.78	5.94	5.29	7.11	7.94	8.19	7.82	5.92	6.74	7.00	6.67
T_{10}	4.53	5.59	5.23	5.56	4.99	6.18	6.29	6.24	7.56	9.14	9.04	8.02	6.42	7.84	7.75	6.97
T_{11}	3.81	4.59	4.87	5.00	4.11	5.06	6.01	5.48	7.20	8.18	8.36	7.86	6.02	6.96	7.15	6.73
T_{12}	4.71	5.84	5.32	5.70	5.21	6.46	6.36	6.43	7.65	9.38	9.21	8.06	6.52	8.06	7.90	7.03
T_{13}	5.07	6.34	5.50	5.98	5.65	7.02	6.5	6.81	7.83	9.86	9.55	8.14	6.72	8.50	8.20	7.15
S.Ed.	0.04	0.07	0.02	0.03	0.04	0.06	0.01	0.04	0.02	0.08	0.06	0.005	0.02	0.06	0.03	0.01
CD (p = 0.05)	0.08	0.15	0.05	0.07	0.08	0.13	0.03	0.08	0.04	0.17	0.12	0.01	0.05	0.12	0.06	0.03

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 3: Effect of post-harvest treatment and packages on total sugars (%) in mango cvs. Sendhura and Neelum under room temperature

T.No.	Treatments	Total sugars (%)							
		Sendhura				Neelum			
		3rd day	6th day	9th day	12th day	3rd day	6th day	9th day	12th day
T_1	$CaCl_2$ 1% + 0.1% carbendazim wrapped in polythene bag	10.64	11.96	14.1	13.54	9.11	10.08	12.94	12.51
T_2	$CaCl_2$ 1% + 0.1% carbendazim wrapped in newspaper	12.34	14.41	15.65	14.59	11.01	12.43	14.34	13.56
T_3	$CaCl_2$ 1.5% + 0.1% carbendazim wrapped in polythene bag	9.96	10.98	13.48	13.12	8.35	9.14	12.38	12.09
T_4	$CaCl_2$ 1.5 + 0.1% carbendazim wrapped in newspaper	12.68	14.90	15.96	14.8	11.39	12.90	14.62	13.77
T_5	$CaCl_2$ 2% + 0.1% carbendazim wrapped in polythene bag	10.30	11.47	13.79	13.33	8.73	9.61	12.66	12.30
T_6	$CaCl_2$ 2% + 0.1% carbendazim wrapped in newspaper	12.00	13.92	15.34	14.38	10.63	11.96	14.06	13.35
T_7	$Ca(NO_3)_2$ 1% + 0.1% carbendazim wrapped in polythene bag	10.98	12.45	14.41	13.75	9.49	10.55	13.22	12.72
T_8	$Ca(NO_3)_2$ 1% + 0.1% carbendazim wrapped in newspaper	13.70	16.37	16.89	15.43	12.53	14.31	15.46	14.40
T_9	$Ca(NO_3)_2$ 1.5% + 0.1% carbendazim wrapped in polythene bag	11.32	12.94	14.22	13.96	9.87	11.02	13.50	12.93
T_{10}	$Ca(NO_3)_2$ 1.5% + 0.1% carbendazim wrapped in newspaper	13.02	15.39	16.27	15.01	11.77	13.37	14.90	13.98
T_{11}	$Ca(NO_3)_2$ 2% + 0.1%carbendazim wrapped in polythene bag	11.66	13.43	15.03	14.17	10.25	11.49	13.78	13.14
T_{12}	$Ca(NO_3)_2$ 2% + 0.1% carbendazim wrapped in newspaper	13.36	15.88	16.58	15.22	12.15	13.84	15.18	14.19
T_{13}	Control	14.04	16.86	17.20	15.64	12.91	14.78	15.74	14.61
	S.Ed.	0.07	0.14	0.10	0.05	0.09	0.13	0.06	0.05
	CD (p = 0.05)	0.14	0.29	0.21	0.11	0.18	0.27	0.12	0.10

TSS was recorded throughout the storage period. These results are in agreement with the findings of Singh *et al.* (2000) in mango fruit, Santos *et al*. (2004) in mango, Kumar *et al.* (2005) in aonla, Singh *et al.* (2008) in aonla, Sood *et al.* (2012) in strawberry.

The data pertain to the reducing sugar content was continuously increased during the storage period up to peak than decline slightly in fruits (Table.2). This may be a consequence of release of sugar during starch hydrolysis. Mango is a climacteric fruit, rich in starch reserves and during post -harvest storage starch is hydrolyzed liberating reducing sugars with enhancement of storage .Such an increase in the percentage of fruit reducing sugars content in mango could be due to the hydrolysis of sucrose during storage, yielding reducing sugars (glucose and fructose). Polythene treatments showed an increase in reducing sugar contents while other treatments recorded decline in reducing sugars content. Polyethylene packing delayed breakdown of starch and slowed down the formation of reducing sugars (Hiwale and Singh 2003).

The mean maximum non reducing sugars were recorded in control fruits which was significantly higher than all other treatments (Table.3). This indicated that during ripening of fruits, carbohydrates undergo metabolic transformations, both qualitatively and quantitatively. Starch is completely hydrolyzed to glucose, fructose and sucrose as ripening progresses. These results in agreement with Yadav and Singh (2002) and Singh *et al.* (2008) in aonla.

The total sugars content significantly reduced in various treatments as compared to control. The mean minimum total sugars were estimated in fruits treated with T_3 ($CaCl_2$ 1.5% wrapping with polythene bag under room temperature) and the mean maximum total sugars were recorded in control fruits (Table.3). However at the end of storage, polythene bag treatments showed an increase in sugar content while rest of other treatments recorded decline in total sugar content. These results are in agreement with Singh *et al.* (2000) in mango fruits, Sakhale *et al.* (2009) in Kesar mango.

Titrable acidity showed a constant decrease during the storage period. The lowest degree of decrease was recorded in fruits treated with T_3 ($CaCl_2$ 1.5% wrapping with polythene bag under room temperature) (Table.4). The results are in concurrence with the finding obtained by Vala (2002) and Sakhale *et al.* (2009). These results are in agreement with the findings of An *et al.* (2007) in peach, Laxman and Mukesh (2011) in mango, Elham Shirzadesh *et al.* (2011) in apple.

The ascorbic acid showed a constant decrease during the storage periods. Higher level of ascorbic acid in fruits treated with T_3 ($CaCl_2$ 1.5% wrapping with polythene bag under room temperature) might be due to less utilization of organic acids in respiration and there by slower the rate of ethylene production, which delayed ripening (Table.4). Similar result was found by Vala (2002). The loss in ascorbic acid content with the progress of storage

Table 4: Effect of post-harvest treatment and packages on reducing sugars (%) and non reducing sugars (%) in mango cvs. Sendhura and Neelum under room temperature

T.No	Titrable acidity (%)								Ascorbic acid content (mg/100 g pulp)							
	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	1.50	0.72	0.57	0.37	1.32	0.60	0.48	0.31	63.64	45.55	29.38	22.33	69.04	56.79	37.51	28.99
T_2	1.30	0.57	0.47	0.27	1.22	0.55	0.43	0.21	55.94	36.95	24.33	17.68	63.74	48.24	29.86	23.79
T_3	1.58	0.78	0.61	0.41	1.36	0.62	0.50	0.35	66.72	48.99	31.40	24.19	71.16	60.21	40.57	31.07
T_4	1.26	0.54	0.45	0.25	1.20	0.54	0.42	0.19	54.40	35.23	23.32	16.75	62.68	46.53	28.33	22.75
T_5	1.54	0.75	0.59	0.39	1.34	0.61	0.49	0.33	65.18	47.27	30.39	23.26	70.10	58.50	39.04	30.03
T_6	1.34	0.60	0.49	0.29	1.24	0.56	0.44	0.23	57.48	38.67	25.34	18.61	64.80	49.95	31.39	24.83
T_7	1.46	0.69	0.55	0.35	1.30	0.59	0.47	0.29	62.10	43.83	28.37	21.40	67.98	55.08	35.98	27.95
T_8	1.14	0.45	0.39	0.05	1.14	0.51	0.39	0.13	49.78	30.07	20.29	13.96	59.50	41.40	23.74	19.63
T_9	1.42	0.66	0.53	0.33	1.28	0.58	0.46	0.27	60.56	42.11	27.36	20.47	66.92	53.37	34.45	26.91
T_{10}	1.22	0.51	0.43	0.09	1.18	0.53	0.41	0.17	52.86	33.51	22.31	15.82	61.62	44.82	26.80	21.71
T_{11}	1.38	0.63	0.51	0.31	1.26	0.57	0.45	0.25	59.02	40.39	26.35	19.54	65.86	51.66	32.92	25.87
T_{12}	1.18	0.48	0.41	0.07	1.16	0.52	0.40	0.15	51.32	31.79	21.30	14.89	60.56	43.11	25.27	20.67
T_{13}	1.10	0.42	0.37	0.03	1.12	0.50	0.38	0.11	48.24	28.35	19.28	13.03	58.44	39.69	22.21	18.59
S.Ed.	0.01	0.005	0.01	0.01	0.01	0.005	0.005	0.01	0.67	0.76	0.40	0.36	0.43	0.75	0.66	0.42
CD (p = 0.05)	0.02	0.01	0.02	0.02	0.02	0.01	0.01	0.02	1.34	1.52	0.81	0.73	0.86	1.51	1.33	0.84

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

period could be attributed to rapid conversion of L-ascorbic acid into dihydro-ascorbic acid in the presence of L-ascorbic acid oxidase (Bashir and Abu-Goukh 2002). The minimum mean ascorbic acid content was found in control fruits. This similar findings with, Dhumal *et al.* (2008), Singh *et al.* (2008) in aonla , Laxman Kukanoor and Mukesh (2011) in mango fruit, Ram *et al.* (2011) in anola, Hussain *et al.* (2012) in apple.

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