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Effect of Wrapping Materials Combination of Growth Regulators on Physical Characters and Storage Life of Papaya (*Carica papaya* L.) cv Red Lady

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ABSTRACT

The experiment was conducted to assess the effect of different wrapping materials and growth regulators on physical characters, storage life and quality of papaya cv Red lady was stored at room temperature during the investigated. The fruits are harvested best treatment of INM (i.e 75% RDF+10 kg vermicompost + 100 g *Azotobacter* + 100 g PSB plant^{-1}) fruits harvested dipped in different growth regulators and combined with packaging materials imposed in the present investigation showed lowest loss in weight (PLW) in fruits treated with $CaCl_2$ @ 3.0% and packed with news paper (7.65%), whereas, highest PLW was found in control (38.93%). Maximum fruit firmness was observed in the fruits treated with T_1- $CaCl_2$ @ 3.0% and wrapping with news paper (2.03 kg cm^{-2}) and T_1 recorded significantly minimum spoilage (23.34%) over other treatments. Maximum TSS recorded in T_7 control (10.80 ^{O}Brix). The storage life was found maximum in T_1 - fruits dipped in $CaCl_2$ @ 3.0% and wrapping with news paper (17.58 days) and followed by T_3- GA_3 @ 100 ppm and wrapping with news paper (16.25 days). However, control has shown poor storage life (9.00 days).

Keywords *Carica papaya*, Post-harvest management, Calcium chloride, Growth regulators, Storage life.

INTRODUCTION

Papaya (*Carica papaya* L.) is evergreen herbaceous commercial fruit crop of tropical and subtropical region. It belongs to family Caricaceae is an important fruit crop among fruit crops and attained unprecedented popularity in recent years, due to largely its ease of cultivation quick returns and adoptability to diverse soil and climate conditions. Moreover, papaya fruit is attractive, delicious and also rich in vitamins and minerals. The ripe fruits are used for desert purpose, preparation of jam, jelly, soft drinks, ice cream, flavoring, crystallized fruits, canned in syrup and fruits salad. Papaya is highly perishable fruit and can be stored only for four days at room temperature. Ripening in fleshy fruits is preceded by a shift in metabolism which leads to characteristic changes

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in their composition, texture and color. Papaya has a high level of post harvest loss viz., 10-90%, due to its high unpreserved nature and thus reduces the per capita availability. The principal causes for post - harvest losses, include harvesting fruits at full ripened stage, inadequate packing and poor post-harvest handling. Further, the shelf life of fruit is also directly related to the rate of respiration. Bio-chemically and physiologically post-harvest technology is mainly concerned with slowing down the rate of respiration of the produce.

MATERIALS AND METHODS

The present experiment was carried out at SKLTSHU, Department of Fruit science, Rajendranagar, Hyderabad. The experiments were conducted with integrated nutrient management, postharvest treatments and shelf life of papaya with chemicals and growth regulators and packaging. The fruits were harvested from the best treatment of integrated nutrient management (ie. 75% RDF + 10 kg vermicompost + 100g *Azotobacter* + 100 g PSB plant^{-1}). The fruits of papaya which were physiologically mature and have attained the full size, light green with a tinge of yellow at apical end were harvested. The fruits were washed with water, dipped for 30 seconds in 0.01% Bavistin, dried with muslin cloth and then used for the study.

Preparation of treatment solutions Calcium chloride ($CaCl_2$) at 1.0%, 2.0% and 3.0% concentrations were prepared by dissolving 50, 100 and 150 of Calcium chloride in five liters of distilled water and made the volume of required quantity for application. 100 mg, 200 mg and 300 mg of GA_3 was weighed and dissolved in small amount of ethanol at slight warm state and made up to one liter with distilled water to get 100 ppm, 200 ppm and 300 ppm solution. The experiment was laid out in Completely Randomized Design with 7 treatments and 3 replications. The treatment details are follows. T_1 - Fruits dipped in $CaCl_2$ @ 3.0 % + wrapped with news paper, T_2 - Fruits dipped in $CaCl_2$ @ 3.0 % + wrapped with tissues paper (Kimwipes), T_3 - Fruits dipped in GA_3 @ 200 ppm + wrapped with news paper, T_4 - Fruits dipped in GA_3 @ 200 ppm + wrapped with tissue paper (Kimwipes), T_5 - Undipped fruits + wrapped with news paper, T_6 – Un dipped fruits+ wrapped with tissue paper (Kimwipes), T_7 - Control (No dipped and no pack). The fruits sampled were assessed for fruit weight loss (%), firmness (kg cm^{-2}), Spoilage (%), TSS (^{O}Brix) and shelf life (Days).

RESULTS AND DISCUSSION

Physiological loss in weight (%)

The data on physiological loss in weight (PLW) as influenced by combination of different packaging materials and growth regulators on papaya cv Red lady stored at room temperature is presented in Table 1. The mean physiological loss in weight increased significantly with each successive storage interval from 3rd day (5.10%) to end of storage day.

The physiological loss in weight of any treatment increased significantly with successive storage interval. At any given interval, on 3rd day fruits treated with T_1 - $CaCl_2$ @3.0% and wrapped with news paper recorded significantly lower weight loss (4.42%) and which was followed by T_3 treatment (4.75%) and it was on par with T_2 treatment (4.91%) treatment. The weight loss was significantly recorded higher in T_4 treatment (6.07%) and followed by T_7 treatment (5.27%).

On 6th day higher weight loss was recorded in T_6 treatment (6.07%) and followed by T_7 treatment (5.55%). Lower weight loss recorded in T_1 treatment (4.85%) which was on par with T_3 treatment (5.01%).

On 9th day of storage higher weight loss was recorded in T_7 treatment (6.65%) and followed by T_6 treatment (6.35%). Lower weight loss was recorded in T_1 treatment (5.16 %) followed by T_3 treatment (5.50%). On 12th day of storage higher weight loss was recorded in T_5 treatment (11.15%) and followed by T_2 treatment (7.75%) treatment. Lower weight loss recorded in T_1 treatment (6.68%) and followed by T_3 treatment (6.70%). On 15th higher weight recorded in T_4 treatment (8.85%) and lowest recorded in T_1 treatment (7.85%). On 18th day of storage higher weight loss recorded in T_4 (24.43%) and lowest recorded in treatment T_1 (16.35%).

The lowest weight loss was recorded in fruits

Table 1. Effect of wrapping materials and growth regulators on physiological loss in weight (%) of papaya cv Red Lady - Fruits spoiled.

Treatments	Physiological loss in weight (%)					
	3rd day	6th day	9th day	12th day	15th day	18th day
T_1 - Fruits dipped in $CaCl_2$ 3.0% + wrapped with news paper	4.42	4.85	5.16	6.68	7.85	16.35
T_2 - Fruits dipped in $CaCl_2$ 3.0% + wrapped with tissue paper	4.91	5.13	5.76	7.75	8.34	20.25
T_3 - Fruits dipped in GA_3 200 ppm + wrapped with news paper	4.75	5.01	5.75	6.70	7.98	17.41
T_4 - Fruits dipped in GA_3 200 ppm + wrapped with tissue paper	6.07	5.45	6.25	7.26	8.85	24.43
T_5 - Undipped fruits + wrapped with news paper	5.07	5.25	5.82	11.50	-	-
T_6 - Undipped fruits+ wrapped with tissue paper	5.19	6.07	6.35	-	-	-
T_7 - Control (No dipped and no pack)	5.27	5.55	6.65	-	-	-
Mean	**5.10**	**5.33**	**5.96**	**7.97**	**8.26**	**19.61**
SEm ±	0.07	0.08	0.11			
CD at 5%	0.20	0.24	0.33			

wrapped with news paper and fruits dipped in $CaCl_2$ @ 3.0% may be possible due to slow rate of transpiration caused by wrapping with news paper because they reduce the temperature between outer and inner atmosphere. Reduction in the rate of transpiration is one of the major criteria for reducing weight loss and extending the post harvest life of fruits (Singh *et al*. 2012) in papaya and similar results (Singh and Rao 2005) reported lower weight loss in shrink wrapped papaya fruits during storage.

Firmness (kg cm^{-2})

The data on firmness is influenced by combination of different packaging materials and growth regulators on papaya cv Red lady stored at room temperature is presented in Table 2.

The mean firmness decreased significantly with each successive storage interval from 3rd day (2.70 kg cm^{-2}) to 18th day (0.47 kg cm^{-2}).

The firmness any treatment decreased significantly with successive storage interval. On 3rd day of storage fruits treated with T_1 - $CaCl_2$ @ 3.0%

Table 2. Effect of wrapping materials and growth regulators on firmness (kg cm^{-2}) of papaya cv Red Lady. - Fruits spoiled.

Treatments	Firmness (kg cm^{-2})					
	3rd day	6th day	9th day	12th day	15th day	18th day
T_1 - Fruits dipped in $CaCl_2$ 3.0 % + wrapped with news paper	3.09	2.99	2.28	1.75	1.21	0.87
T_2 - Fruits dipped in $CaCl_2$ 3.0 % + wrapped with tissue paper	2.90	2.55	2.18	1.02	0.95	0.29
T_3 - Fruits dipped in GA_3 200 ppm + wrapped with news paper	2.85	2.72	2.20	0.96	0.68	0.45
T_4 - Fruits dipped in GA_3 200 ppm + wrapped with tissue paper	2.75	2.45	2.14	0.87	0.65	0.25
T_5 - Undipped fruits + wrapped with news paper	2.65	2.45	2.07	0.82	-	-
T_6 - Undipped fruits+ wrapped with tissue paper	2.55	2.13	2.04	-	-	-
T_7 - Control (No. dipped and no pack)	2.12	1.86	1.19	-	-	-
Mean	**2.70**	**2.45**	**2.01**	**1.08**	**0.87**	**0.47**
SEm±	0.05	0.09	0.05			
CD at 5%	0.16	0.27	0.15			

Table 3. Effect of wrapping materials and growth regulators on spoilage (%) of papaya cv Red Lady- Fruits spoiled.

Treatments	Spoilage (%)					
	3rd day	6th day	9th day	12th day	15th day	18th day
T_1 - Fruits dipped in $CaCl_2$ 3.0 % + wrapped with news paper	0.00	4.60	10.35	24.72	48.79	51.56
T_2 - Fruits dipped in $CaCl_2$ 3.0 % + wrapped with tissue paper	0.00	5.29	16.55	36.68	51.98	58.90
T_3 - Fruits dipped in GA_3 200 ppm + wrapped with news paper	0.00	4.93	14.82	33.62	50.95	54.34
T_4 - Fruits dipped in GA_3 200 ppm + wrapped with tissue paper	0.00	5.75	16.68	42.32	55.45	60.70
T_5 - Undipped fruits + wrapped with news paper	0.00	5.98	24.30	50.11	-	-
T_6 - Undipped fruits+ wrapped with tissue paper	0.00	7.90	30.98	-	-	-
T_7 - Control (No dipped and no pack)	0.00	8.18	30.24	-	-	-
Mean	**0.00**	**6.09**	**20.56**	**37.49**	**51.79**	**56.37**
SEm ±	0.00	0.12	0.37			
CD at 5%	0.00	0.37	1.11			

and wrapped with news paper recorded significantly higher firmness (3.09 kg cm^{-2}) and which was on par with T_2 (2.90 kg cm^{-2}), T_3 and T_4 and the firmness was significantly recorded lower in control (2.12 kg cm^{-2}).

On 6th day higher firmness was recorded in T_1 treatment (2.99 kg cm^{-2}) which was on par with T_3 treatment (2.72 kg cm^{-2}) and lower firmness was recorded in control (1.86 kg cm^{-2}) followed by T_6 treatment (2.13 kg cm^{-2}). Similar trend of firmness was recorded on 9th day. On 12th days of storage lower firmness was recorded in T_5 treatment (0.82 kg cm^{-2}), higher firmness was recorded in T_1 treatment (1.75 kg cm^{-2}). On 15th day higher firmness was recorded in T_1 treatment (1.21 kg cm^{-2}) and 18th day higher firmness was recorded in T_1 treatment (0.87 kg cm^{-2}) and lowest firmness was recorded in treatment T_2 treatment (0.25 kg cm^{-2}) of storage.

The variation in firmness of fruits was also observed, significant and highest firmness was recorded in $CaCl_2$ 3.0% and wrapped with news paper. The newspaper also maintained firmness of papaya fruits better than the control. These effects of packaging materials may be attributed to their retardation effects of ripening and reduction of water loss (Yamashital

Table 4. Effect of wrapping materials and growth regulators on total soluble solids (°Brix) of papaya cv Red Lady - Fruits spoiled.

Treatments	TSS (°Brix)					
	3rd day	6th day	9th day	12th day	15th day	18th day
T_1 - Fruits dipped in $CaCl_2$ 3.0% + wrapped with news paper	8.85	9.42	10.15	11.65	9.98	9.55
T_2 - Fruits dipped in $CaCl_2$ 3.0% + wrapped with tissue paper	9.23	9.85	9.75	11.32	9.23	9.42
T_3 - Fruits dipped in GA_3 200 ppm + wrapped with news paper	9.19	9.75	10.08	10.95	9.19	9.10
T_4 - Fruits dipped in GA_3 200 ppm + wrapped with tissue paper	9.55	9.98	10.42	10.85	9.85	8.85
T_5 - Undipped fruits + wrapped with news paper	9.12	9.55	10.09	11.75	-	-
T_6 - Undipped fruits+ wrapped with tissue paper	9.68	10.03	10.68	-	-	-
T_7 - Control (No dipped and no pack)	10.05	10.35	11.34	-	-	-
Mean	**9.38**	**9.85**	**10.36**	**11.30**	**9.56**	**9.23**
SEm±	0.05	0.06	0.06			
CD at 5%	0.16	0.20	0.33			

Table 5. Effect of wrapping materials and growth regulators on shelf life (days) of papaya cv Red Lady.

Treatments	Shelf life (days)
T_1 - Fruits dipped in $CaCl_2$ 3.0 % + wrapped with news paper	**17.58**
T_2 - Fruits dipped in $CaCl_2$ 3.0 % + wrapped with tissue paper	14.03
T_3 - Fruits dipped in GA_3 200 ppm + wrapped with news paper	**16.25**
T_4 - Fruits dipped in GA_3 200 ppm + wrapped with tissue paper	13.23
T_5 - Undipped fruits + wrapped with news paper	12.00
T_6 - Undipped fruits+ wrapped with tissue paper	9.58
T_7 - Control (No dipped and no pack)	**9.00**
SEm±	0.20
CD at 5%	0.61

et al. 2002, Manrique and Lajolo 2004).

Spoilage (%)

The data on spoilage is influenced by combination of different packaging materials and growth regulators on papaya cv Red lady stored at room temperature is presented in Table 3.

The mean spoilage increased significantly with each successive storage interval from 6th day (6.09%) to 18th day (56.37%). The spoilage of any treatment increased significantly with successive storage of interval. On 3rd day no spoilage was recorded.

On 6th day of storage higher spoilage was recorded in T_7 treatment (8.18%) on par with T_6 treatment (7.90%) and lower spoilage was recorded in T_1 treatment (4.60%) which was on par with T_3 treatment (4.93%). On 9th day of storage higher spoilage was recorded in T_6 treatment (30.98%) on par with T_7 treatment (30.24%) and lower spoilage was recorded in T_1 treatment (10.35%) which was followed by T_3 treatment (14.82 %).

On 12th day of storage higher spoilage was recorded in T_5 treatment (50.11%) and lower spoilage was recorded in T_1 treatment (24.72%). On 15th day of storage higher spoilage was recorded in T_4 treatment (55.45%) and lower spoilage was recorded in T_1 treatment (48.79%) and lower spoilage was recorded in (51.56%), higher spoilage was recorded in T_4 treatment (60.70%) on 18th days of storage.

The variation in spoiled fruits was also observed significant and lowest spoiled fruits was recorded in T_1 - $CaCl_2$ @ 3.0% and wrapped with news paper. This may be due to treatment effect which might have retarded ripening and reduced weight loss through controlled transpiration and respiration rate and delayed the disintegration of spoilage. The similar findings were reported by Yadav *et al.* (2006) in Mandarin and Patel *et al.* (2011) in custard apple.

Total soluble solids (^{O}Brix)

The data on total soluble solids is influenced by combination of different packaging materials and growth regulators on papaya cv Red lady stored at room temperature is presented in Table 4.

The mean total soluble solids increased significantly with each successive storage interval from 3rd day (9.38 ^{O}Brix) to 12th day (11.30 ^{O}Brix) and then it was decreased trends follows upto storage life.

On 3rd day significantly higher total soluble solids recorded in T_7 treatment (10.05 ^{O}Brix) and which was followed by T_6 treatment (9.68 ^{O}Brix) it was on par with T_2 and T_4 and the total soluble solids was significantly recorded lower in fruits treated with $CaCl_2$ @ 3.0% and wrapped with news paper (8.85 ^{O}Brix) which was on par with T_5 treatment (9.12 ^{O}Brix). Similar trend of total soluble solids was recorded on 6th day.

On 9th days of storage significantly higher total soluble solids recorded in T_7 treatment (11.34 ^{O}Brix) and which was followed by T_6 treatment (10.68 ^{O}Brix) it was on par with T_1 and T_4 treatment. The total soluble solids were significantly recorded lower in T_2 treatment (9.75 ^{O}Brix) which was on par with T_3 treatment (10.08 ^{O}Brix).

On 12th day higher total soluble solids were re-

corded in T_5 treatment (11.75 ^{O}Brix) and lower total soluble solids were recorded in T_4 treatment (10.85 ^{O}Brix). On 15th day higher total soluble solids were recorded in T_1 treatment (9.98 ^{O}Brix), whereas lower total soluble solids were recorded in T_3 treatment (9.19 ^{O}Brix). On 18th day of storage higher total soluble solids were recorded in T_1 treatment (9.55 ^{O}Brix) and lower total soluble solids were recorded in T_4 treatment (8.85 ^{O}Brix).

The total soluble solids showed a progressive increasing trend upto 12th day after storage. Thereafter decline in total soluble solids was observed. The fruits wrapped with news paper and dipped in $CaCl_2$ @ 3.0% had shown the maximum total soluble solids might be due to increase in sugar during storage and it may possibly due to break down of complex organic metabolites into sugars. The decline in the sugar content at the later stage of the storage may be due attributed to the reason after completion of hydrolysis of starch, no further increase in sugars occurred and subsequently a decline in these parameters is predictable as they along with their organic acids are primary substrate for respiration (Kodikara *et al.* 1996). The results of papaya TSS were similar to results obtained by Singh *et al.* (2012) in papaya fruits.

Shelf life (days)

The data on shelf life as influenced by combination of different packaging materials and growth regulators or treatments on papaya cv Red lady stored at room temperature is presented in Table 5.

There were significant differences among the treatments for shelf life with the fruits and fruits wrapped with news paper which was dipped in $CaCl_2$ @ 3% recorded higher storage (17.58 days) which was on par with fruits treated with GA_3 @ 200 ppm and wrapped with tissues paper (16.25 days). The fruits under control recorded the minimum shelf life of (9.00 days).

The fruits dipped in $CaCl_2$ @ 3% wrapped with news paper improved the shelf life (17.58 days) by maintaining the physico-chemical characters of the fruit, which are important for the fruits quality. Similarly, application of the growth regulator GA_3 @ 200 ppm also increased shelf life in papaya fruits upto 16.25 days, with the best physical and physico-chemical attributes.

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