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Different bio-chemical changes at low temperature storage on chilling injury and storage life of commercial cultivars of mango *Mangifera indica* L.

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Abstract
An experiment was conducted at Fruit Research Station, Sangareddy, Medak, Telangana to study the effect of low temperature storage on chilling injury and storage life of different commercial cultivars of mango (*Mangifera indica* L.) *viz.,* Banganpalli, Dashehari, Peddarasam, Chinnarasam and Totapari stored at 8ºC ± 1º C. The experimental design followed is completely randomized design with factorial concept with four replications per treatment.Various biochemical parameters like TSS, titratable acidity, ascorbic acid, reducing sugars, non reducing sugars and electrolyte leakage. The highest T.S.S. (15.35) was recorded in mango cv. Peddarasam, Among all interactions, the highest TSS (16.75) was recorded on 55^{th} day with the mango cv. Peddarasam. The lowest acidity (0.70) was recorded in mango cv. Chinnarasam and the highest acidity (1.00) was recorded in cv. Totapari. The lowest brix acid ratio (10.04) was noticed in mango cv. Totapari. The highest (23.53) was recorded in mango cv. Peddarasam. The treated fruits were significantly influenced by low temperature with lowest reducing sugars (2.11) recorded in mango cv. Totapari. The highest total sugars (6.51) were recorded in mango cv. Peddarasam. The lowest total sugars (4.40) were recorded in mango cv. Totapari. The treated fruits differed significantly with highest vitamin-C (17.07) was recorded in mango cv Peddarasam while the lowest vitamin-C (9.67) recorded in mango cv. Banganpalli. The treated fruits differed significantly with lowest electrolyte leakage (13.85) recorded in mango cv. Totapari.

Keywords: Ascorbic acid, electrolyte leakage, non reducing sugars, reducing sugars, TSS and titratable acidity

Introduction
Mango (*Mangifera indica* L.) is one of the most popular fruits and commonly known as 'King of fruits' in Asian countries. Because of its delicious taste and pleasant flavour, it is ranked as one of the choicest fruits in the National and International market. Mango is a climacteric fruit and hence, ripe and deteriorate very fast when stored at ambient temperature, which leads to reduction in shelf life. Its each part like pulp, peel, seed, leaves, flowers and the bark are important due to their medicinal uses. Different part of mango contains many biotic compounds like polyphenolics which can control many degenerative diseases due to their antioxidant activities. Hence, it is gaining more importance in medicinal and pharmaceutical industries. Therefore, low-temperature storage is necessary to slow down the metabolic processes and decay development but, when this fruit is stored at temperature below 13 ºC, it develops chilling injury (CI) which further limits its shelf life during low-temperature storage and subsequently lead to rapid spoilage. The chilling injury symptoms in mango manifest as discoloration and pitting of the peel, sunken lesions, lenticels spotting, shriveling, uneven ripening, poor colour, off-flavour development and increased susceptibility to decay resulting in the reduction of market value of the fruit (Nunez *et al.*, 2007) [19].

In India, post-harvest losses of fruits and vegetables are estimated to be 30-35 per cent which amount to losses to the extent of Rs.3000 crores (Mitbander 1990) [18]. Post-harvest losses can be minimized by adopting proper post-harvest handling practices and better understanding of bio-chemical control of fruit ripening. Post-harvest life of fruits and vegetables can be extended by low temperature storage, modified atmosphere packaging and by biochemical treatments.

Mangoes are reported to ripen satisfactorily (with acceptable eating quality) between 21 °C and 24 °C (Medlicott *et al.*, 1990) [13]. About 12-13 °C is generally considered optimum for mango storage (Kader, 1992; Medlicott *et al*., 1990) [13, 17]. However, for long distance transport through sea, storage of mangoes below 12-13 °C is necessary.
Chilling injury in mango has been reported to occur over a range of temperatures, differing slightly between cultivars (Cheema *et al*., 1939) [7] and being further influenced by factors such as fruit maturity (Thompson, 1971; Lam and Ng, 1984) [26, 16] and temperature conditioning (Lam and Ng, 1984; Thomas and Joshi, 1988) [26, 24]. Symptoms of chilling vary slightly between cultivars, although skin browning appears to be the most well-known (Snowdon, 1990) [22]. In cv. Kensington, the principal cultivar grown in Australia, chilling injury has been reported as being most prominently manifested by skin browning, poor pulp color development, and an increase in the titrable acidity of ripe fruit (Chaplin *et al.*, 1991) [5]. In order to avoid these symptoms, storage temperatures of 13 °C and above are currently recommended for this cultivar (Hubbert and Lebger, 1988) [11].
In view of the scanty literature on the chilling injury of mango cultivars, the present experiment was undertaken to study the effect of low temperature on prolonging the storage life.

Material and Methods
The experiment was carried out during 2014-15 at Fruit Research Station, Sangareddy, Medak. There were five treatments (varieties) replicated four times with 50 fruits per each replication. The mango cultivars used were Banganpalli, Totapari, Dashehari, Chinnarasam and Peddarasam, procured from the Fruit Research Station, Sangareddy. The experimental design followed was CRD with factorial concept. The fruits were harvested at 3/4th mature stage. Data were recorded at 5 days interval. The fruits were stored at a temperature of 8 °C + 1 °C. Physico chemical parameters like TSS, titrable acidity, ascorbic acid, reducing sugars, non reducing sugars were also estimated and subjected to statistical analysis.

Results and Discussion
The following objects were observed in different commercial mango varieties.

TSS (%)
The highest T.S.S. (15.35) was recorded in mango cv. Peddarasam while the lowest TSS (9.08) was recorded in cv. Totapari (Table 1). The TSS in mango cv. Dashehari (12.53) was on par with that of cv. Chinnarasam (12.32). There were significant differences in TSS among different commercial varieties of mango at all the days of storage. The TSS increased significantly from 25th day (9.13) to 55th day (13.55). Among all interactions, the highest TSS (16.75) was recorded on 55th day with the mango cv. Peddarasam, while the lowest TSS (7.42) was recorded with the mango cv. Totapari on 25th day of storage.
The TSS increased even in the low temperature storage indicating that the ripening process was progressing. However, the increase in TSS was more pronounced from 50th day to 55th day. The increase in TSS during the initial stages may be attributed to the conversion of starch and other polysaccharides into soluble forms of sugars (Satyan *et al*., 1992) [20] indicating that the ripening process has started. Similar results were reported by Singh *et al.* (2012) in mango and Jayachandran *et al.* (2007) [12] in guava.

Acidity (% Citric acid)
The lowest acidity (0.70) was recorded in mango cv. Chinnarasam and the highest acidity (1.00) was recorded in cv. Totapari (Table 2). while cv. Banganpalli (0.80) was on par with Paddarasam (0.81). The acidity decreased significantly from 25th day (1.31) to 55th day (0.39). Among all interactions, the lowest acidity (0.26) was recorded with the mango cv. Dashehari on 55th day of storage whereas; the highest acidity (1.45) was recorded with cv. Totapari on both 25th and 30th day of storage.
In the present investigation, the acidity has decreased with the progression of the storage period. This could be attributed to the conversion of acids, into sugar (Pool *et al*., 1972) and utilization of organic acid during respiration (Srivastava *et al.*, 1961) [23]. Similar decrease in acidity content of sapota fruits with increase in storage period and utilization of organic acid during respiration were reported by Kumbhar and Desai (1986). Further, among different mango varieties, Totapari has recorded highest acidity indicating slow ripening process when compared to other mango varieties. Totapari which has recorded highest acidity incidentally has lowest chilling injury index and electrolyte leakage.

Brix: acid ratio
The lowest brix acid ratio (10.04) was noticed in mango cv. Totapari. The highest (23.53) was recorded in mango cv. Peddarasam (Table 3). There were significant differences in brix acid ratio among different commercial varieties of mango at all the days of storage due to low temperature. The brix acid ratio increased significantly from 25th day (5.61) to 55th day (39.03). The interaction between different mango cultivars and storage period indicated that the highest brix acid ratio (47.85) was recorded with the mango cv. Totapari on 55th day of storage.
Similar results were reported by Jayachandran *et al*. (2007) [12] in guava fruits. All the treatments recorded the increased brix-acid ratio with the increase in storage period which may be attributed to decrease in TSS comprised mostly of sugars, which are subjected to degradation during respiration (Amerine and Cruess, 1960) [1].

Reducing sugars (%)
The treated fruits were significantly influenced by low temperature with lowest reducing sugars (2.11) recorded in mango cv. Totapari (Table 4). The highest reducing sugars (2.97) were recorded in mango cv. Peddarasam. The reducing sugars increased significantly from 25th day (1.41) to 55th day (3.59). The interaction effect between different mango cultivars and storage periods revealed that the highest reducing sugars (3.99) were recorded with the mango cv. Dashehari on 55th day. The lowest reducing sugars (1.11) were recorded with the mango cv. Totapari on 25th day of storage.
In the present investigation, the reducing sugars increased throughout the storage period irrespective of the mango varieties. Hosakote *et al.* (2006) [10] reported that the ripening of mango was characterized by change in biochemical constituents such as disappearance of starch, breakdown of insoluble form of polyuronides to a more soluble form, and concomitant increase in total soluble sugars but decrease in titrable acidity.

Total sugars (%)
The highest total sugars (6.51) were recorded in mango cv. Peddarasam. The lowest total sugars (4.40) were recorded in

mango cv. Totapari (Table 5). The total sugars increased significantly from 25th day (2.32) to 55th day (9.48). The interaction effect on total sugars among different mango cultivars and storage periods indicated that the highest total sugars (10.44) were recorded with the mango cv. Banganpalli on 55th day of storage and the lowest total sugars (2.06) was recorded with the mango cv. Totapari on 25th day of storage.
Upadhyay and Tripathi (1985) [27] reported that total sugar content was augmented gradually, when stored for 6 days at room temperature. These results are in conformity with the findings of Shahjahan *et al*. (1994) [21].

Vitamin-C (mg/100g pulp)
The treated fruits differed significantly with highest vitamin-C (17.07) was recorded in mango cv Peddarasam while the lowest vitamin-C (9.67) recorded in mango cv. Banganpalli which was onpar with Chinnarasam (10.67) (Table 6). There were significant differences in vitamin-C among different commercial varieties of mango during all the days of storage. The vitamin-C decreased significantly from 25th day (16.45) to 55th day (8.05).
Among the interactions, the highest total Vitamin-C (25.50) on 25th day of storage was recorded with the mango cv. Peddarasam while the lowest (7.00) was recorded with cv. Banganpalli on 55th day of storage. These findings are in agreement with those of Chaudhary and Farooqui (1969) [6] and Tripathi (1989). Similar results were reported in guava by Jayachandran *et al.* (2007) [12], Kumar and Hoda (1974) [15] and Bhagwan and Reddy (1998) in tomato. The decline in ascorbic acid during storage may be attributed to conversion of ascorbic acid into dehydroascorbic acid.

Electrolyte leakage (%)
The treated fruits differed significantly with lowest electrolyte leakage (13.85) recorded in mango cv. Totapari (Table 5). The highest electrolyte conductivity (24.76) was recorded in mango cv. Chinnarasam. The electrolyte leakage increased significantly from 25th day (17.26) to 55th day (21.95).
In the present investigation, the electrolyte leakage increased with the increase in storage period irrespective of the mango variety. Further, the chilling injury also increased with progression of the storage period. Electrolyte leakage is considered as the internal measure of the chilling injury index. Due to the chilling injury, the membrane permeability increases (Waskar *et al*., 1999), ultimately leading to increase in leakage of electrolytes (Chanikan *et al.*, 2012) [4]. Mango cv. Totapari and Peddarasam which are relatively resistant to the chilling injury have also recorded relatively less electrolyte leakage.

Table 1: Effect of low temperature storage on total soluble sugars (%) of commercial varieties of mango at different storage\periods

Treatments	25 day	30 day	35 day	40 day	45 day	50 day	55 day	Means	60 day	65 day	70 day	75 day	80 day
T_1- Banganpalli	8.75	10.50	11.00	11.75	11.75	12.00	12.25	11.14^b	-	-	-	-	-
T_2 – Dashehari	8.25	12.00	13.25	13.25	13.25	14.00	13.75	12.53^c	-	-	-	-	-
T_3- Chinnarasam	8.75	9.50	12.25	13.50	11.50	14.00	14.75	12.32^c	-	-	-	-	-
T_4 – Peddarasam	8.50	14.00	15.75	16.00	16.00	16.50	16.75	15.35^d	16.75	17.00	17.00	-	-
T_5- Totapari	7.42	8.20	8.50	9.00	10.00	10.25	10.25	9.08^a	10.50	12.50	12.50	13.00	13.80
Means	9.13^a	10.84^b	12.15^c	12.70^c	12.90^c	13.35^d	13.55^d	-					
	F-Test		SEM		CD								
For Treatments	**		0.164		0.460								
For Days	**		0.194		0.544								
For T X D	**		0.434		1.218								

Table 2: Effects of low temperature storage on acidity (% citric acid) of commercial varieties of mango at different storage periods

Treatments	25 day	30 day	35 day	40 day	45 day	50 day	55 day	Means	60 day	65 day	70 day	75 day	80 day
T_1- Banganpalli	1.36	1.36	0.76	0.74	0.61	0.44	0.34	0.80^c	-	-	-	-	-
T_2 – Dashehari	1.31	1.31	0.74	0.72	0.60	0.43	0.26	0.76^b	-	-	-	-	-
T_3- Chinnarasam	1.04	1.04	0.75	0.72	0.58	0.42	0.32	0.70^a	-	-	-	-	-
T_4 – Peddarasam	1.39	1.39	0.73	0.71	0.66	0.45	0.35	0.81^c	0.27	0.26	0.23	-	-
T_5- Totapari	1.45	1.45	0.94	0.93	0.83	0.76	0.67	1.00^d	0.63	0.85	0.82	0.69	0.51
Means	1.31^a	1.31^a	0.78^b	0.76^b	0.65^c	0.50^d	0.39^e						
	F-Test		SEM		CD								
For Treatments	**		0.013		0.038								
For Days	**		0.016		0.045								
For T X D	**		0.036		0.103								

Table 3: Effects of low temperature storage on Brix to acid ratio of commercial varieties of mango

Treatments	25 day	30 day	35 day	40 day	45 day	50 day	55 day	Means	60 day	65 day	70 day	75 day	80 day
T_1- Banganpalli	6.43	7.72	14.47	15.87	19.26	27.27	36.02	18.15^b	-	-	-	-	-
T_2 – Dashehari	6.29	9.16	17.90	18.40	22.08	32.55	52.88	22.75^d	-	-	-	-	-
T_3- Chinnarasam	8.41	9.13	16.33	18.75	19.82	33.33	46.09	21.69^c	-	-	-	-	-
T_4 – Peddarasam	1.79	10.07	21.57	22.53	24.24	36.66	47.85	23.53^e	62.03	65.38	73.91	-	-
T_5- Totapari	5.11	5.65	9.04	9.67	12.04	13.48	15.29	10.04^a	16.66	14.70	15.24	18.84	27.05
Means	5.61^a	8.34^b	15.86^c	17.04^d	19.49^e	28.66^f	39.63^g						
	F-Test		SEM		CD								
For Treatments	**		0.133		0.388								
For Days	**		0.163		0.455								
For T X D	**		0.368		1.074								

Table 4: Effects of low temperature storage on reducing sugars (%) of commercial varieties of mango at different storage periods

Treatments	25 day	30 day	35 day	40 day	45 day	50 day	55 day	Means	60 day	65 day	70 day	75 day	80 day
T_1- Banganpalli	1.24	1.84	2.02	2.79	2.72	2.86	3.86	2.48^{b}	-	-	-	-	-
T_2 – Dashehari	1.33	1.88	2.54	2.82	3.39	3.44	3.99	2.77^{c}	-	-	-	-	-
T_3- Chinnarasam	1.56	1.88	2.26	2.79	3.32	3.42	3.88	2.73^{c}	-	-	-	-	-
T_4 – Peddarasam	1.80	1.91	2.73	3.37	3.70	3.81	3.49	2.97^{d}	3.66	3.71	3.89	-	-
T_5- Totapari	1.11	1.38	1.92	2.38	2.60	2.68	3.73	2.11^{a}	2.14	2.50	2.52	2.60	2.70
Means	1.41^{a}	1.78^{b}	2.30^{c}	2.83^{d}	3.14^{e}	3.24^{e}	3.59^{f}						
	F-Test		SEM		CD								
For Treatments	**		0.041		0.115								
For Days	**		0.048		0.137								
For T X D	**		0.109		0.306								

Table 5: Effects of low temperature storage on total sugars (%) of commercial varieties of mango at different storage periods.

Treatments	25 day	30 day	35 day	40 day	45 day	50 day	55 day	Means	60 day	65 day	70 day	75 day	80 day
T_1- Banganpalli	2.29	2.50	4.58	6.75	8.37	9.34	10.44	6.32^{b}	-	-	-	-	-
T_2 – Dashehari	2.33	2.45	4.26	6.64	8.76	9.46	10.25	6.31^{b}	-	-	-	-	-
T_3- Chinnarasam	2.26	2.44	4.83	6.58	8.69	9.50	10.32	6.37^{b}	-	-	-	-	-
T_4 – Peddarasam	2.68	2.85	4.81	6.91	8.70	9.60	10.30	6.51^{c}	10.48	10.68	10.86	-	-
T_5- Totapari	2.06	3.07	3.02	4.65	5.29	6.37	6.37	4.40^{a}	6.92	7.05	7.15	8.38	8.50
Means	2.32^{a}	2.66^{b}	4.30^{c}	6.30^{d}	7.96^{e}	8.86^{f}	9.48^{g}						
	F-Test		SEM		CD								
For Treatments	**		0.080		0.226								
For Days	**		0.095		0.267								
For T X D	**		0.213		0.598								

Table 6: Effects of low temperature storage on vitamin C (mg/100 g pulp) of commercial varieties of mango

Treatments	25 day	30 day	35 day	40 day	45 day	50 day	55 day	Means	60 day	65 day	70 day	75 day	80 day
T_1- Banganpalli	14.00	11.75	10.50	9.00	8.25	7.25	7.00	9.67^{a}	-	-	-	-	-
T_2 - Dashehari	13.00	13.00	12.00	10.75	10.25	10.25	7.25	10.92^{b}	-	-	-	-	-
T_3- Chinnarasam	14.00	12.25	11.50	10.50	9.50	9.00	8.00	10.67^{a}	-	-	-	-	-
T_4 - Peddarasam	25.50	23.00	21.00	19.50	11.50	9.75	9.25	17.07^{d}	7.75	7.00	7.00	-	-
T_5- Totapari	15.75	15.50	15.00	11.25	10.25	9.75	8.75	12.32^{c}	7.25	7.75	7.75	6.75	6.25
Means	16.45^{e}	15.10^{d}	14.00^{d}	12.20^{c}	9.95^{b}	9.20^{a}	8.05^{a}						
	F-Test		SEM		CD								
For Treatments	**		0.414		1.162								
For Days	**		0.490		1.375								
For T X D	**		1.096		3.076								

Table 7: Effects of low temperature storage on electrolyte leakage (%) of commercial verities of mango at different storage periods

Treatments	Days of storage												
	25	30	35	40	45	50	55	Means	60	65	70	75	80
T_1- Banganpalli	14.25	15.00	15.50	16.00	16.25	17.75	19.00	16.25^{a}	-	-	-	-	-
T_2 – Dashehari	21.82	22.75	24.00	25.00	26.00	26.75	27.00	23.90^{d}	-	-	-	-	-
T_3- Chinnarasam	21.50	22.25	22.50	23.52	24.25	25.50	26.50	24.76^{e}	-	-	-	-	-
T_4 – Peddarasam	17.00	17.75	18.00	19.00	19.75	20.25	20.75	18.92^{a}	21.50	22.00	23.25	-	-
T_5- Totapari	11.75	12.25	13.00	13.50	14.25	15.75	16.50	13.85^{a}	18.75	19.25	20.50	21.25	22.25
Means	17.26^{a}	18.00^{a}	18.60^{a}	19.35^{b}	20.10b	21.20^{b}	21.95^{c}						
	F-Test	SEM	CD										
For Treatments (T)	**	0.275	0.772										
For Days (D)	**	0.325	0.913										
For T X D	NS	0.728	-										

Conclusion

Significantly lowest chilling injury was recorded in mango cv Totapari followed by Peddarasam. Significantly highest chilling injury was recorded in the mango cv Chinnarasam. In the varieties where chilling injury was highest, significantly maximum electrolyte leakage was recorded. Irrespective of the variety, storage at low temperature has significantly delayed the ripening process. The various physico chemical parameters indicated reduced chilling injury symptoms in mango cv. Totapari.

References

1. Amerine MA, Cruess WV. The technology of wine making west port. AVI publishing company Inc. Connecticut 1960.
2. Bhagwan A, Reddy YN, Rao PV. Post harvest application of polyamines to improve the shelf life of tomato fruit. Indian Journal of Horticulture 1998;57(2):133-138.
3. Biale JB. Synthetic and degradative process in fruit ripening in Post harvest biology and handling of fruits and vegetables Eds: Haard N F and Salunkhe D K. the AVI publishing Co., Westport, Connecticut, USA 1975.
4. Chanikan J, Jamnong U, Danai B, Bualuang F, Kobkiat S. Reduction of Chilling Injury of 'Nam Dok Mai No. 4' Mango Fruit by Treatments with Salicylic Acid and

Methyl Jasmonate. Journal of Agricultural Science 2012;4(10):126-136.
5. Chaplin GR, Cole SP, Landrin M, Nuevo PA, Lam PF, Graham D. Chilling injury and storage of mango (*Mangifera indica* L.) held under low temperature. Acta Horticulturae 1991;291:461-471.
6. Chaudhary TM, Farooqui MAR. The post harvest chemical changes during the ripening of mango fruits. West Pakistan Journal of Agricultural Research 1969;7(3):78-96.
7. Cheema GS, Karmakar DV, Joshi BM. Investigations on the cold storage of mangoes. Agricultural Science 1950;20:259-262.
8. Haines W. The world of mango situation-a market perspective. Acta Horticulture 1991;291:1–11.
9. Hatton TT. Reeder WF, Campbell CW. Ripening and storage of Florida mangoes. USDA Mktg. Res. Report No.275 1965.
10. Hosakote MY, Tyakal NP, Rudrapatnam NT. Mango ripening: changes in cell wall constituents in relation to textural softening. Journal. Science for Food Agriculture 2006;86:713-721.
11. Hubbert CA, Ledger SN. Manoes; post-harvest handling system. Queensl. Department Primary Ind, Farm-note 1988.
12. Jayachandran KS, Srihari D, Reddy YN. Post harvest application of selected antioxidants to improve the shelf life of guava fruit. Acta-Horticulturae 2007;735:627-632.
13. Kader. Reduction of chilling injury in 'Tommy Atkins'mangoes during ripening 1992.
14. Kosiyacinda S, Young RE. Chilling sensitivity of avocado at different sages of the respiratory climacteric. Journal of American Society for Horticultural Science 1976;101:665-669.
15. Kumar R, Hoda NN. Fixation of maturity standards of guava (*Psidium guajava* L.). Indian Journal of Horticulture 1974;31:140-144.
16. Lam PF, Ng KH. Influence of temperature adaption and physiological stage on the storage of 'Harimanis' mangoes. Proc. First Aust. Mango Res. Work sh., Nov. 1984, Cairns, Queensl 1984, 274-277.
17. Medlicott AP, Sigrist JM, Sy O. Ripening of mangoes following low temperature storage. J Am. Soc 1990.
18. Mitbander VB. Thrust industry reaches dead end. Indian Food Packer 1990;44:3.
19. Nunez MC, Emond JP, Brecht JK, Dea S, Proulx E. Quality curves for mango fruit (cv. Tommy Atkins and Palmer) stored at chilling and nonchilling temperature. Journal of food quality 2007;30:104-120.
20. Satyan S, Scott KJ, Graham D. Storage of banana bunches in sealed polyethylene tubes. Journal of Horticulture Science 1992;67(2):51-53.
21. Shahjahan MS, Sheel MA. Zaman MA, Sakur MA. Optimization of harvesting maturities for major mango cultivars in Bangladesh. Bangladesh Journal Science Research 1994;12(22):209-215.
22. Snowdon AL. A colour atlas of post-harvest diseases and disorders of fruit and vegetables, volume 1: general introduction and fruits, Wolfe Scientific Ltd. London, 1990, 302.
23. Srivastava HC, Kapur NS, Pala VB. Storage behavior of skin coated guavas under modified atmosphere. Food Science 1961;11:244-248.
24. Thomas P, Joshi MR. Reduction of chilling injury in ripe Alphonso mango fruit in cold storage by temperature conditioning. International Journal Food Science Technology 1988;23:447-455.
25. Thomas P, Oke MS. Improvement in quality an storage of 'Alphonso' mango by cold adaption. Science Horticulture 1983;19:257-262.
26. Thompson AK. The storage of mango fruits. Trop. Agric. (Trinidad) 1971;48:63-70.
27. Upadhyay NP, Tripathi BM. Post-harvest changes during storage and ripening of Gaurjeet mango (*Mangifera indica* L.) fruits. Progressive Horticulture 1985;17(1):25-27.