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Effect of Different Precooling and Storage Temperatures on Shelf Life of Mango cv. Alphonso

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ABSTRACT

An experiment was conducted to study the effect of different precooling and storage temperatures on shelf life of mango cv. Alphonso. The experiment was carried out during the season May 2016 at R.F.R.S., Vengurle, Dr. Balasaheb Sawant Konkankrishividyaapeeth, Dapoli with five precooling temperatures (P_1 – Control, P_2 – $21 \pm 2^\circ\text{C}$, P_3 – $18 \pm 2^\circ\text{C}$, P_4 – $15 \pm 2^\circ\text{C}$ and P_5 – $12 \pm 2^\circ\text{C}$) and four storage temperatures (S_1 – Ambient temperature ($27-30^\circ\text{C}$), S_2 – $18 \pm 2^\circ\text{C}$, S_3 – $15 \pm 2^\circ\text{C}$ and S_4 – $12 \pm 2^\circ\text{C}$). After precooling fruits were store for 21 days at different storage temperatures and after 21 days again brought to above precooling temperature by air cooling. Then the cooled fruits are kept for ripening for seven days at room temperature. The experiment was laid out in FCRD with two replications. The interaction P_5S_4 (Precooling at $12 \pm 2^\circ\text{C}$ and storage at $15 \pm 2^\circ\text{C}$), showed the minimum physiological loss in weight (PLW) (9.11 %) followed by P_5S_3 (11.48 %), the interaction P_5S_3 recorded minimum shrivelling (0.00 %) and the interaction P_5S_4 recorded minimum spoilage (4.00 %) at 28 days of storage. The interaction P_5S_3 and P_5S_4 observed the maximum shelf life (28 days). The interaction P_5S_3 and P_5S_4 was significantly superior over others.

Keywords

Precooling, Storage, Temperature and Shelf life.

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Introduction

Mango (*Mangifera indica* L.) is the oldest and ‘National Fruit of India’ and rightly known as ‘King of Fruits’ owing to its nutritional richness, unique taste, pleasant aroma and religious and medicinal importance. Mango is believed to be originated to South East Asia, Indo-Burma region, in foot hills of the Himalayas (Mukherjee, 1951). India is the largest producer of mango in the world and ranks first in area and production. The total production of mango in India is 18.832 million MT from about 2.218 million ha area with the productivity of 8.49 MT/ha (Anon., 2015 a). In Maharashtra, mango is occupying

an area of 0.156 million ha with annual production of 0.876 million MT and productivity of 5.60 MT/ha (Anon., 2015b). Post-harvest handling is the problem of mango as due to climacteric nature of the fruit. So, post-harvest handling can play a major role to reduce the losses. The post-harvest losses in mango are about 25 to 30 per cent post-harvest losses. This is mainly due to the non-availability of commercial low temperature store houses, lack of cool chain during transport and storage (Krishnamurthy and Rao, 2001). Temperature is the most important environmental factor that will

influence the deterioration of harvested fruits, hence its management during various postharvest operations like pre-cooling, handling and storage plays a major role for extending the shelf-life. Padhye (1997) observed that the mango fruit cv. Alphonso stored at cold storage (12.7-15.0°C and 85-89 % RH) condition had maximum shelf life (24-26 days). Alphonso is premium export cultivar and the export by air is very costly. Hence, if shelf life of fruits increased up to about 30 days, it can be exported through sea route. This will reduce the freight cost and will boost the export of fresh fruits. The research work on prolonging the self-life is of utmost importance for reducing the freight charges of air and fetch higher revenue for mango growers. Cold storage facility help in regulating market supply and stabilize the rates. Similarly, to extend shelf life, precooling after harvest is necessary. However, harvested mango fruits, are kept in cold storage with or without precooling. After storage they are directly brought to ambient temperature for ripening. This affects the quality of fruits and cause losses. In order to reduce these losses, it is necessary to standardize precooling and storage methods at different temperatures. Most of the work was done on storage and precooling separately but combine effect of both precooling and storage was not studied. In view of this, the present study was envisaged to study the effect of different precooling and storage temperatures on shelf life of mango cv. Alphonso.

Materials and Methods

Physiologically mature, hard green fruits at optimum maturity of mango Cv. Alphonso were harvested with the help of Nutan Zela with keeping 2.5 to 3.5 cm stalk during morning hours from the Regional Fruit Research Station, Vengurle Dist. Sindhudurg (Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli) during May 2016. After harvesting, the fruits were treated with 0.1%

carbendazine and kept under shade for 1-2 hours in order to dry them. The experiment was laid out in Factorial Completely Randomized Design (FCRD) with two replications. Initial observation was recorded and fruits were kept in forced air cooling chamber for the pre-cooling at P_1 – Control, $P_2 - 21 \pm 2^\circ\text{C}$, $P_3 - 18 \pm 2^\circ\text{C}$, $P_4 - 15 \pm 2^\circ\text{C}$ and $P_5 - 12 \pm 2^\circ\text{C}$. The precool temperature was checked by using thermometer which was inserted in the pulp of the fruit and the constant temperature maintained. Precooled fruits were stored for 21 days at different storage temperature like S_1 -Ambient temperature (27-30 °C), $S_2 - 18 \pm 2^\circ\text{C}$, $S_3 - 15 \pm 2^\circ\text{C}$ and $S_4 - 12 \pm 2^\circ\text{C}$. After 21 days storage, fruits were again brought to above precooling temperature by forced air cooling and kept for ripening for 7 days at room temperature.

Results and Discussion

Physiological loss in weight (PLW) (%)

It is observed from Table 1 and Figure 1 the PLW of mango fruits increased continuously throughout the storage period, irrespective of precooling and storage temperatures. At 7th day the lowest (0.84 %) PLW was observed in storage temperature $15 \pm 2^\circ\text{C}$ (S_3) and was superior over rest of the storage temperatures. The storage temperature $15 \pm 2^\circ\text{C}$ (S_3) recorded significantly the lowest PLW (5.19 %) and minimum PLW were recorded in interaction P_5S_3 (3.22 %) which was at par with P_1S_3 (4.15 %), and P_2S_3 (4.02 %) on 21st day of storage. At 28th day of storage in interactions the minimum increase in PLW was observed in P_5S_4 (9.11 %) followed by P_5S_3 (11.48 %). In case of storage conditions, fruits stored in cold storage showed minimum increase in PLW as compared to ambient temperature. The continuous increase in PLW in both the storage conditions and precooling could be due to loss of moisture from the skin of fruits through respiration and transpiration.

Table.1 Effect of precooling and storage temperatures on PLW (%) (physiological loss in weight) of mango fruits during storage

Treat- ment	0 Days						7 Days						14 Days					
	P1	P2	P3	P4	P5	Mean	P1	P2	P3	P4	P5	Mean	P1	P2	P3	P4	P5	Mean
S1	0	0	0	0	0	0	7.62	8.53	6.44	8.29	8.78	7.93	15.82	17.26	16.08	17.24	20.23	17.33
S2	0	0	0	0	0	0	4.03	1.62	0.90	1.53	1.28	1.87	3.11	3.63	1.70	4.72	4.27	3.49
S3	0	0	0	0	0	0	0.37	0.68	1.35	1.07	0.75	0.84	2.40	2.25	3.35	3.94	0.98	2.58
S4	0	0	0	0	0	0	1.30	1.40	1.40	1.39	0.80	1.26	3.73	4.70	3.25	3.80	4.25	3.94
Mean	0	0	0	0	0	0	3.33	3.06	2.52	3.07	2.90	2.98	6.26	6.96	6.10	7.42	7.43	6.83
	S.Em+			C.D. @1%			S.Em+			C. D.@ 1%			S.Em+			C.D.@ 1%		
S	-			-			0.05			0.19			0.23			0.91		
P	-			-			0.05			0.21			0.25			1.02		
SxP	-			-			0.11			0.43			0.51			2.04		
Treat- ment	21 Days						28 Days											
	P1	P2	P3	P4	P5	Mean	P1	P2	P3	P4	P5	Mean						
S1	23.77	24.22	22.69	27.12	25.72	24.70	-	-	-	-	-	-						
S2	6.77	5.60	6.08	5.73	6.09	6.05	16.46	13.43	18.97	15.64	14.27	15.75						
S3	4.15	4.02	8.56	5.98	3.22	5.19	13.88	13.73	16.16	18.95	11.48	14.84						
S4	7.77	6.67	6.52	6.59	6.40	6.79	15.08	15.44	15.57	17.51	9.11	14.54						
Mean	10.62	10.13	10.96	11.36	10.36	10.68	-	-	-	-	-	-						
	S.Em+			C. D. @1%			S.Em+			C.D. @1%								
S	0.14			0.57			-			-								
P	0.16			0.64			-			-								
SxP	0.32			1.28			-			-								

Precooling temperature: - 1) P₁ – Control, 2) P₂ – 21 ± 2°C, 3) P₃ – 18 ± 2°C, 4) P₄ – 15 ± 2°C, 5) P₅ – 12 ± 2°C

Storage temperature: - 1) S₁ – Ambient temperature, 2) S₂ – 18 ± 2°C, 3) S₃ – 15 ± 2°C, 4) S₄ – 12 ± 2°C

SxP: -Interaction (Storage x Precooling), NS: - Non Significant

(At 28 days storage, fruits at ambient temperature (S₁) with different precooling temperatures were found to be spoiled, hence reading were not taken.)

Table.2 Effect of precooling and storage temperature on shrivelling (%) of mango fruits during storage

Treat- ment	0 Days						7 Days						14 Days					
	P1	P2	P3	P4	P5	Mean	P1	P2	P3	P4	P5	Mean	P1	P2	P3	P4	P5	Mean
S1	0	0	0	0	0	0	0	0	0	0	0	0	14	10	10	10	8	10.4
S2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0.4
S3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	0	0	0	0	0	0	0	0	0	0	0	0	4	2.5	2.5	2.5	2	2.7
	S.Em+			C.D. @1%			S.Em+			C. D.@ 1%			S.Em+			C.D.@ 1%		
S	-			-			-			-			0.447			1.8		
P	-			-			-			-			0.5			NS		
SxP	-			-			-			-			1			NS		
Treat- ment	21 Days						28 Days											
	P1	P2	P3	P4	P5	Mean	P1	P2	P3	P4	P5	Mean						
S1	46	64	62	70	48	58	-	-	-	-	-	-						
S2	6	4	2	4	2	3.6	4	6	8	2	0	4						
S3	2	0	0	0	0	0.4	6	2	4	0	0	2.4						
S4	2	0	0	0	0	0.4	4	2	2	2	2	2.4						
Mean	14	17	16	18.5	12.5	15.6	-	-	-	-	-	-						
	S.Em+			C. D. @1%			S.Em+			C.D.@ 1%								
S	0.80			3.22			-			-								
P	0.89			3.60			-			-								
SxP	1.79			7.20			-			-								

Precooling temperature: - 1) P₁ – Control, 2) P₂ – 21 ± 2°C, 3) P₃ – 18 ± 2°C, 4) P₄ – 15 ± 2°C, 5) P₅ – 12 ± 2°C

Storage temperature: - 1) S₁ – Ambient temperature, 2) S₂ – 18 ± 2°C, 3) S₃ – 15 ± 2°C, 4) S₄ – 12 ± 2°C

SxP: -Interaction (Storage x Precooling), NS: - Non Significant

Table.3 Effect of precooling and storage temperatures on spoilage (%) of mango fruits during storage

Treat- ment	0 Days						7 Days						14 Days					
	P1	P2	P3	P4	P5	Mean	P1	P2	P3	P4	P5	Mean	P1	P2	P3	P4	P5	Mean
S1	0	0	0	0	0	0	0	0	0	0	0	0	10	6	10	4	2	6.4
S2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0.4
S3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	0	0	0	0	0	0	0	0	0	0	0	0	3	1.5	2.5	1	0.5	1.7
	S.Em+			C.D.@ 1%			S.Em+			C. D. @1%			S.Em+			C.D. @1%		
S	-			-			-			-			0.447			1.8		
P	-			-			-			-			0.5			NS		
SxP	-			-			-			-			1			NS		
Treat- ment	21 Days						28 Days											
	P1	P2	P3	P4	P5	Mean	P1	P2	P3	P4	P5	Mean						
S1	14	18	10	8	6	11.2	-	-	-	-	-	-						
S2	10	10	6	4	2	6.4	16	14	12	10	8	12						
S3	2	0	0	0	0	0.4	10	8	10	6	6	8						
S4	0	0	0	0	0	0	8	12	10	6	4	8						
Mean	6.5	7	4	3	2	4.5	-	-	-	-	-	-						
	S.Em+			C. D. @1%			S.Em+			C.D. @1%								
S	0.60			2.41			-			-								
P	0.67			2.70			-			-								
SxP	1.34			5.40			-			-								

Precooling temperature: - 1) P₁ – Control, 2) P₂ – 21 ± 2°C, 3) P₃ – 18 ± 2°C, 4) P₄ – 15 ± 2°C, 5) P₅ – 12 ± 2°C

Storage temperature: - 1) S₁ – Ambient temperature, 2) S₂ – 18 ± 2°C, 3) S₃ – 15 ± 2°C, 4) S₄ – 12 ± 2°C

SxP: -Interaction (Storage x Precooling), NS: - Non Significant

Table.4 Effect of precooling and storage temperatures on shelf life (Days) of mango fruits during storage

Treatments	Shelf Life (Days)
P ₁ S ₁	Between 7 to 14
P ₂ S ₁	Between 7 to 14
P ₃ S ₁	Between 7 to 14
P ₄ S ₁	Between 7 to 14
P ₅ S ₁	Between 7 to 14
P ₁ S ₂	Between 21 to 28
P ₂ S ₂	Between 21 to 28
P ₃ S ₂	Between 21 to 28
P ₄ S ₂	Between 21 to 28
P ₅ S ₂	Between 21 to 28
P ₁ S ₃	Between 21 to 28
P ₂ S ₃	Between 21 to 28
P ₃ S ₃	Between 21 to 28
P ₄ S ₃	Between 21 to 28
P ₅ S ₃	Above 28
P ₁ S ₄	Between 21 to 28
P ₂ S ₄	Between 21 to 28
P ₃ S ₄	Between 21 to 28
P ₄ S ₄	Between 21 to 28
P ₅ S ₄	Above 28

Fig.1 Effect of precooling and storage temperatures on PLW (%) of mango fruits during storage

Precooling temperature: - 1) P₁ – Control, 2) P₂ – 21 ± 2°C, 3) P₃ – 18 ± 2°C, 4) P₄ – 15 ± 2°C, 5) P₅ – 12 ± 2°C

Storage temperature: - 1) S₁ – Ambient temperature, 2) S₂ – 18 ± 2°C, 3) S₃ – 15 ± 2°C, 4) S₄ – 12 ± 2°C

Fig.2 Effect of precooling and storage temperatures on shriveling (%) of mango fruits during storage

Precooling temperature: - 1) P₁ – Control, 2) P₂ – 21 ± 2°C, 3) P₃ – 18 ± 2°C, 4) P₄ – 15 ± 2°C, 5) P₅ – 12 ± 2°C

Storage temperature: - 1) S₁ – Ambient temperature, 2) S₂ – 18 ± 2°C, 3) S₃ – 15 ± 2°C, 4) S₄ – 12 ± 2°C

Fig.3 Effect of precooling and storage temperatures on spoilage (%) of mango fruits

Precooling temperature: - 1) P₁ – Control, 2) P₂ – 21 ± 2°C, 3) P₃ – 18 ± 2°C, 4) P₄ – 15 ± 2°C, 5) P₅ – 12 ± 2°C

Storage temperature: - 1) S₁ – Ambient temperature, 2) S₂ – 18 ± 2°C, 3) S₃ – 15 ± 2°C, 4) S₄ – 12 ± 2°C

Findings of this study are supported by Padhye (1997) and Devani *et al.*, (2011) in mango.

Shriveling (%)

It is seen from Table 2 and Figure 2 that fruits started shriveling on 14th and 21st days under ambient and cold storage, respectively. Fruits stored at ambient temperature (S_1) recorded 10.4 per cent shriveling and cold storage S_2 (0.4 %), S_3 and S_4 fruits recorded 0.00 per cent shriveling on 14th days of storage. At 21st days of storage the fruits stored at 12±2°C (S_4) and 15±2°C (S_3) temperatures showed significantly lowest (0.40 %) shriveling however, it was found on par with S_2 (3.60 %). The minimum shrivelling of mango fruits (12.5 %) was observed at precooling temperature 12±2°C (P_5) which was at par with P_1 (14 %) and P_3 (16 %).

Minimum increase in shriveling was noticed in S_3 and S_4 (2.40 %). In interactions the minimum increase in shrivelling was observed in P_5S_2 , P_4S_3 and P_5S_3 (0.00 %) on the 28th days of storage. The fruits stored at cold storage remained firm which resulted in minimum shrivelling as compared with ambient temperature storage. Such reduction in shrivelling was due to low temperature and high humidity conditions under cold storage. Similar results were reported by Badar (1990), Padhye (1997) and Kshirsagar (2004) in mango, which supported the present findings.

Spoilage (%)

It is presented in Table 3 and Figure 3 that fruits spoilage started on 14th and 21st day under ambient and cold storage, respectively. Percentage of spoilage was in increasing order throughout the storage period in both the storage conditions. The fruits stored at ambient temperature (S_1) recorded 6.4 per

cent spoilage, cold storage S_2 recorded 0.4 per cent while, S_3 and S_4 fruits recorded 0.00 per cent spoilage, irrespective of precooling. Maximum spoilage was found in P_1 (3 %) while minimum was found in P_5 (0.5 %), irrespective of storage temperatures during the 14th days of storage. At 21st days of storage, 0.00 per cent spoilage was recorded in S_4 treatment (12±2°C), which was at par with S_3 (0.40 %). The minimum increase in spoilage was observed in P_5 (2 %), which was at par with P_3 (4 %), and P_4 (3 %). Minimum increase in spoilage was noticed in S_3 and S_4 (8 %) and in interactions, the minimum increase in spoilage was observed in P_5S_4 (4.00 %) on the 28th days of storage. It was noticed from the data that the maximum spoilage was recorded in ambient storage as compared to cold storage. It may be due to high temperature congenial for growth of microorganism was available at ambient storage. Present findings are in agreement with the results reported by Khanbarad *et al.*, (2013) and Makwana *et al.*, (2014) in mango.

Shelf Life (Days)

With respect to shelf life, cold storage fruits recorded maximum shelf life as compared to ambient temperature stored fruits that is recorded in Table 4. Among the different interactions tried, maximum shelf life (28 days) was observed in P_5S_3 (12±2 °C precooling and 15±2 °C storage temperature) and P_5S_4 (12±2 °C precooling and storage temperature) as these fruits recorded less PLW and spoilage.

This might be due to the reduction in field heat in shortest possible time, lower moisture loss, restricted metabolic and respiratory activities and inhibition in water loss and reduction in ethylene production in fruits (Hardenberg *et al.*, 1990). The similar finding reported by Padhye (1997), Devani *et al.*, (2011) and Khanbarad *et al.*, (2013).

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