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Effect of pre-storage treatments on quality and shelf life of mango (*Mangifera indica* L.)

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ABSTRACT

Mango is one of the choicest fruit in the world due to its delicious taste, appealing aroma and pleasant flavour. The fruit is highly perishable in nature having shelf life of only 4 – 8 days at ambient condition. The present experiment was carried out in the Department of Horticulture, Udai Pratap Autonomous College,Varanasi during 2013-2014 to study the effect of different pre-storage treatments on post harvest quality and shelf life of mango cv. Dashehari. In this study, physiologically mature mango fruits of cv. Dashehari were treated with cold water (4±1°C) and hot water (50±1°C) immediately after harvest before their storage at 7±1°C and 85-90% RH for 30 days while, another lot of fruits were stored at room temperature (36°C) for 2 days.Control fruits was stored without any treatments. Results revealed that the fruits treated with cold water had minimum weight loss and loss due to spoilage up to 30 days of storage. Maximum firmness (11.33 kg/cm^2), total soluble solids (22.12°B), reducing sugar (6.13%), total sugar (20.1.%), ascorbic acid (16.30 mg/100 g) and minimum acidity (0.121%) was also retained in cold water treated mango fruits up to the end of the experiment. After 30 days of storage, maximum acceptability of fruits in terms of appearance, taste, flavour, colour and texture was observed which were treated with cold water. The maximum loss of these quality attributes with minimum acceptability of fruits was noted in control and those which were stored at room temperature.

Key words: Mango, postharvest, quality, shelf life

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most popular fruit among million of people across the globe, particularly in India where it is deemed to be the preferred of all indigenous fruits. Owing of its delicious taste and appealing aroma, it is ranked as one of the choicest fruit in the national and international market. India is the largest producer of mango in the world contributing about 50% of total world production. However, because of climacteric in mature mangoes ripen rapidly after harvest, showing respiration and ethylene evolution peaks 3-4 days of harvest at ambient condition. Mango is highly perishable in nature having shelf life of only 4 – 8 days at ambient temperatures (Barman *et al.*, 2017). Apart from this, mango is highly susceptible to several postharvest diseases which cause enormous loss during transit or storage. Among these, anthracnose caused by *Colletotrichum gloeosporioides* and stem-end rot caused by *Lasiodiplodia theobromae* are the most important which remain as latent infection at the time of harvest. Symptoms of these diseases appear with the onset of ripening. To extend shelf life of mango and maintain postharvest quality several chemicals are being used now-a-days. But, due to increased health concern, consumers prefer fruits and vegetables which are free from harmful pesticide residues (Zeng *et al.*, 2006). Therefore, a study was carried out to investigate the effect of pre-storage water treatment of different temperatures on shelf life and postharvest quality of mango during storage.

MATERIALS AND METHODS

Mango fruits of cv. Dashehari were harvested at physiological maturity stage and immediately brought to the laboratory of the Department of Horticulture, Udai Pratap Autonomous College, Varanasi during 2013-2014. After that fruits of uniform size, shape, colour and free from bruises, injury, blemishes, diseases and pests were selected for the experiment. Following that fruits were washed with running tap water and graded by density gradation method to select fruits of uniform maturity and only water sinker fruits were used for storage studies. The selected fruits were then divided into four lots containing same number of fruits in each lot. After that fruits were subjected to treatments namely, T1- Control (no pre-storage treatment), T2- Dipping fruits in cold water (4±1°C) for 2 min., T3- Dipping fruits in hot water (50±1°C) for 5 min. and T4- Keeping fruits at room temperature (36°C) for 2 days. After treatment application, fruits were stored at 7±1°C and 85-90% RH for 30 days. At 10 days interval, fruits from each treatment were sampled at random and subjected to analysis for different physico-chemical attributes.

Physical parameters

Physiological loss in weight of fruits was determined on the basis of initial weight of the fruits and by how much loss in the fruit weight occurred at every ten days interval and results were expressed in per cent (%). Spoilage loss was expressed in per cent (%) on the basis of fruit showing symptom of rots irrespective of severity out of total number of fruits in each treatment. Firmness of mango was recorded by fruit hardness tester OSK2712 (Ogawa Saiki Company Ltd., Japan) using cylindrical plunger of 5Ø × 10 mm and results were expressed as kg/cm^2.

Biochemical parameters

The total soluble solids (TSS) of fruits were determined with the help of hand refractometer. Titratable acidity was determined by using titration method (AOAC, 1994). To do that, 10 g of fruit pulp was blended with 100 ml distilled water plus a few drops of phenolphthalein solution as indicator and titrated with N/10 NaOH. The results were expressed in per cent as citric acid. Reducing sugar and total sugars content in the fruit was estimated as per the method of AOAC (1994) and the results were expressed as per cent. Ascorbic acid was estimated as per method of AOAC (1994). Five gram of fruit pulp was blended with 3% metaphosphoric acid (MPA) solution. It was then filtered and volume was adjusted up to 50 ml with 3% MPA solution. Then, an aliquot of 5 ml was titrated against standard 2,6-dichlorophenol indophenol dye until pink colour appeared and persisted at least for 15 seconds. The results were expressed as mg/100g of pulp.

Sensory evaluation

The external appearance (visual appeal, free from microbial spoilage), uniformity of ripening, colour, texture, taste and flavour were evaluated visually and organoleptically by a panel of five judges who scored on a nine point hedonic scale (Amerin *et al.*, 1965) as follows: 1, dislike extremely; 2, dislike very much; 3, dislike moderately; 4, dislike slightly; 5, neither like nor dislike; 6, like slightly; 7, like moderately; 8, like very much and 9, like extremely.

Statistical analysis

The experiment was conducted in a Completely Randomized Design (CRD) with four treatments and five replications. The data obtained under different treatments in respect to various parameters during storage were subjected to analysis of variance (ANOVA). The significance of the effects of treatments was judged with the help of 'F' test and the significant differences among treatments were compared by the respective C.D. values at 5 per cent level. The variance on account of days as a factor in the experimentation was also worked out.

RESULTS AND DISCUSSION

Weight loss

The weight loss of fruits during storage is presented in Table 1. The data revealed that the effect of cold water was more pronounced in minimizing loss in weight of fruit than other treatments. Hot water treatment was found to be significantly superior in reducing weight loss than fruits stored at room temperature and control. Among the treatments, cold water (22.76%) and hot water treatments (24.38%) gave the best results after 30^{th} days of storage. However, maximum loss (28.21%) occurred in fruits stored at room temperature after 30^{th} days of storage. The high loss in weight of fruit under control might be due to maximum loss of moisture caused by higher rate of transpiration and respiration through uninterrupted atmospheric column. Whereas the lower loss in weight in cold water treated fruits might be due to minimum loss in moisture caused by slow rate of transpiration and respiration. These results are in agreement with findings of Manzano Mendez (1995) in mango and Singh *et al.* (1992) in Zardalu mango.

Spoilage loss

In this study, maximum spoilage (11.11%) was recorded in fruits stored at room temperature (Table 1). Fruits treated with cold water showed minimum (8.68%) spoilage loss which was followed by hot water treatment (9.98%). It was recorded that spoilage of fruits started from 10th day and reached maximum at 30th day of storage. However, cold water treated fruit showed minimum (13.30%) spoilage losses at 30th day of storage than other treatments while maximum spoilage loss (17.42%) was observed in fruits stored at room temperature. The maximum percentage of spoilage at room temperature might be due to high temperature leading to rapid spoilage of fruits. In addition to this, fruits kept at room temperature were readily exposed to atmospheric pathogens which might have caused spoilage (Barth *et al.*, 2009). However, in cold water treated fruits, tissues have shown to induce changes in the composition of membrane lipids due to which spoilage of fruits was delayed.

Table 1: Effect of pre-storage treatments on physical quality attributes of mango cv. Dashehari

Parameters	Treatments	Days after storage (DAS)		
		10 DAS	20 DAS	30 DAS
Weight loss (%)	Control	2.66	15.38	27.43
	Cold water treatment	5.47	12.53	22.76
	Hot water treatment	2.94	13.38	24.38
	Room temperature	3.28	15.31	28.21
	SEm±	0.08	0.07	0.14
	CD (P=0.05)	0.23	0.20	0.40
Spoilage loss (%)	Control	3.77	11.05	16.48
	Cold water treatment	2.72	10.01	13.30
	Hot water treatment	3.34	11.00	15.60
	Room temperature	3.89	12.04	17.42
	SEm±	0.17	0.15	0.30
	CD (P=0.05)	0.50	0.43	0.86
Firmness (kg/cm^2)	Control	11.28	10.54	9.73
	Cold water treatment	12.52	12.05	11.33
	Hot water treatment	11.52	11.14	10.18
	Room temperature	9.94	9.29	8.44
	SEm±	0.069	0.060	0.120
	CD (P=0.05)	0.198	0.171	N/A

Fruit firmness

It is evident from Table 1 that pre-storage treatments significantly affected firmness of fruit during storage. With the advancement of storage period, firmness of fruits declined irrespective of treatments. The maximum fruit firmness (11.96 kg/cm^2) retained in cold water treatment which was followed by hot water treatment (10.94 kg/cm^2) after 30 days of storage. However, it was minimum (9.22 kg/cm^2) in fruits which were stored at room temperature. The retention of higher firmness in cold water treated fruit might be due to low temperature treatment. It was also reported that firmness is highly dependent on storage temperature and increase in temperature accelerated ripening which reduced firmness, while due to lower temperature or cold water treatment fruit firmness maintained at higher level during 30 days of storage. Illangantileke and Salonkhe (1990) and Singh (1990) reported that in mango, gradual conversions of carbohydrate into sugar led to the decrease in firmness along with change in cell wall, polysaccharides and uronic acid. Decline in alkali soluble pectin and increase in polygalactouranase activity was found to be correlated with the loss of firmness. The reduction in firmness during storage might be due to the breakdown of insoluble pectic substances to soluble forms by a series of physico-chemical changes that caused by the action of pectic enzymes during ripening (Barman *et al.*, 2011).

Total and reducing sugar content

Irrespective of treatments, total sugar increased with the storage period (Table 2). The maximum total sugar content (16.13%) was recorded in cold water treated fruits which were followed by fruits kept at room temperature.

Minimum (15.14%) content of total sugar was noted in hot water treated fruits. Likewise, maximum reducing sugar content (5.31%) was observed in cold water treated fruits followed by room temperature-stored (4.26%) and hot water treated fruits (3.93%). However, control fruits were showed to contain minimum (3.13%) reducing sugar. Increase in reducing sugar content with the advancement of storage period was recorded in all the treated fruits (Table 2). After 30 days of storage, maximum reducing sugar (6.13%) in cold water treated fruits while it was recorded minimum (3.75%) in control fruits. The increasing trend of reducing sugar content during storage might be due to release of sugar during starch hydrolysis and liberating reducing sugars (Islam *et al.*, 2013). It was also observed that reducing sugars and total sugar content reduced in the later periods of storage. This may be due to their rapid utilization in respiration (Makwana *et al.*, 2014).

Table 2: Effect of pre-storage treatments on biochemical quality attributes of mango cv. Dashehari

Parameters	Treatments	Days after storage (DAS)		
		10 DAS	20 DAS	30 DAS
TSS (°B)	Control	12.35	17.73	21.21
	Cold water treatment	12.79	19.14	22.12
	Hot water treatment	11.43	18.04	20.87
	Room temperature	12.67	18.78	21.54
	SEm±	0.14	0.12	0.25
	CD (P=0.05)	0.42	0.36	N/A
Titratable acidity (%)	Control	0.583	0.319	0.146
	Cold water treatment	0.533	0.305	0.121
	Hot water treatment	0.544	0.316	0.138
	Room temperature	0.568	0.316	0.133
	SEm±	0.001	0.001	0.001
	CD (P=0.05)	0.002	0.002	0.004
Reducing sugar (%)	Control	2.08	3.56	3.75
	Cold water treatment	4.07	5.72	6.13
	Hot water treatment	2.36	4.11	5.32
	Room temperature	3.37	4.49	4.93
	SEm±	0.07	0.06	0.12
	CD (P=0.05)	0.20	0.17	0.34
Total sugar (%)	Control	10.33	15.73	19.58
	Cold water treatment	10.86	17.42	20.10
	Hot water treatment	9.99	16.00	19.42
	Room temperature	10.59	16.77	18.84
	SEm±	0.16	0.14	0.28
	CD (P=0.05)	0.46	0.39	0.79
Ascorbic acid (mg/100 g)	Control	61.30	26.09	13.45
	Cold water treatment	63.26	31.42	16.30
	Hot water treatment	61.40	28.62	14.36
	Room temperature	62.04	29.28	15.30
	SEm±	0.16	0.13	0.27
	CD (P=0.05)	0.45	0.39	0.79

Total soluble solids and titratable acidity

The TSS content of the treated fruits increased gradually with the increase in storage period (Table 2). After 30 days of storage, cold water treated fruits showed maximum TSS content (22.12°B) which was closely followed by fruits stored at room temperature (21.54°B). However, minimum (20.87°B) TSS content was noted in hot water treated fruits. Fruits treated with cold water were found to be effective in retaining higher TSS over other treatments and control after 30 days of storage. However, minimum TSS was noted in hot water treatment. These findings are on similar line of Kacha and Patel (2009). The increase in TSS might be due to conversion of pectic substances, starch and other polysaccharides into soluble sugar.

Reduction in TSS in some treatments might be due to degradation of soluble solids during storage. Further, slow but gradual rise in TSS of fruits treated with cold water might be due to delayed ripening and senescence (Verma *et al.* 1986; Medlicott *et al.*, 1990).

In case of titratable acidity, irrespective of treatments a declining trend in acidity was noted during storage (Table 2). Faster decline in acidity was recorded in cold water treated fruits. At 30th day of storage, lowest titratable acidity (0.121%) was recorded in cold stored fruits while it was maximum (0.146%) in control. The decrease in titratable acidity during storage might be due to the breakdown of organic acids which could be attributed to increased activity of citric acid glyoxylase during ripening and its conversion into sugars and their further utilization in metabolic process in the fruit (Rathore *et al.*, 2007). The cold water treatment might be responsible for slower conversion of acids into sugars and its utilization in respiration. These findings are in the line of Makwana *et al.* (2014) in mango.

Table 3: Effect of pre-storage treatments on sensory quality attributes of mango cv. Dashehari

Treatments	Sensory quality attributes					
	Appearance	Taste	Flavour	Uniform ripening	Pulp colour	Pulp texture
Control	6.42	7.22	7.42	6.58	6.20	6.56
Cold water treatment	8.58	8.18	8.14	8.0	8.24	8.12
Hot water treatment	7.20	7.52	8.12	7.44	7.98	7.30
Room temperature	5.50	5.70	6.18	6.08	6.24	5.10

Ascorbic acid content

In this study, ascorbic acid content in fruits decreased progressively with increase in storage period (Table 2). Among the treatments, maximum destruction of ascorbic acid was recorded in control fruits. At 30th day of storage, cold water treated fruits retained highest ascorbic acid (16.30 mg/100g) which was closely followed by fruits stored at room temperature (15.30 mg/100g). Among the treatments, lowest ascorbic acid (13.45 mg/100g) at the end of the experiment was noted in control fruits. The cold water treatment might have retarded the ripening process and showed down the respiration of fruits thereby higher level of ascorbic acid was retained. In other treatments, faster decline in ascorbic acid during storage may be due to rapid conversion of ascorbic acid in to dehydro-ascorbic acid in the presence of enzyme ascorbinase with different level of oxidation in different treatments (Kumar and Babu, 2014).

Sensory quality

It was found that fruits stored at room temperature had the minimum organoleptic value at 30th day of storage (5.80). The maximum acceptability (8.21) of fruits was those treated with cold water which had very sweet taste, excellent flavour and very good appearance along with uniform ripening, good pulp colour and fine texture (Table 3). This was followed by fruits which were treated with hot water. Maximum acceptability of cold water treated fruits was due to retention of higher firmness and good flavour than other treatments. Similar trend was also reported by Singh *et al.* (2003) in which cold water treatment delayed the alteration of flavour by reducing the rate of biochemical changes and conversion of complex organic compound into esters, aldehyde, acids, alcohols, ketones that contributed significantly to the aroma or flavour development (Mcwilliam, 1989). These fruits also developed good appealing colour due to destruction of chlorophyll and formation of carotenoid pigments. Cold water treated fruits also had better taste than other treatments which was due to maintaining higher sugar acid ratio.

The findings of the study revealed that pre-storage cold water treatment (4±1°C) for 2 minutes followed by storage at 7±1°C and 85-90% RH could be adopted for preserving postharvest nutritional and sensory quality, reducing spoilage and extending shelf life of ‘Dashehari’ mango fruits up to 30 days without any adverse effects on human health and environment.

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