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Qualitative analysis of mango cv. Langra influenced by various postharvest treatments

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Abstract
To evaluate the influence of various postharvest treatments on the chemical characteristics of mango cv. Langra, the present laboratory investigation was carried during 2016-17. Disease and bruises free, fresh fruits of uniform size, shape and colour were harvested at physiological mature stage and were given various postharvest treatment of sodium hypochlorite (NaOCl: 100, 150, 200ppm), 6-benzyladenine (BA: 50, 100, 150ppm) and hot water (52 to 55° C) for 5, 10 and 15 minutes. The fruits were subjected to air dried and kept in 5 ply corrugated boxes (5% ventilation) with newspaper lining and stored in ambient conditions. The fruits were evaluated after 3, 6, 9 and 12 days of storage. Total soluble solids (TSS) and sugars content of the fruits increased steadily up to 9 days and thereafter declined gradually whereas, sugar acid ratio (SAR) increased linearly during storage. Titratable acidity and ascorbic acid content gradually decreased linearly whereas, beta carotene content of fruits increased linearly during storage. Fruits treated with BA @ 100ppm and HWT for 5 minutes significantly maintained higher TSS, sugars and antioxidants content of the fruits and remained acceptable up to 12 days under ambient storage conditions.

Keywords: Mango, NaOCl, BA, hot water, biochemical quality, ambient storage

Introduction
Mango (*Mangifera indica* L.), the most celebrated and luscious fruit crop of tropics are believed to be originated in the Indo-Burma region (Yonemori *et al*., 2002) [53] and gradually spread to the other regions of the world. It is one of the oldest and important fruits in the world in terms of production and consumer acceptance (Vela *et al*., 2003; FAO STAT, 2005) [51, 17] for its nutritional (Pandey and Dinesh, 2010) [34] and excellent overall eating characteristics (Shinde *et al*., 2013) [45]. It can be consumed in all its stage as fresh fruit, dessert, preserved, dried and processed. Despite of having rich source of ascorbic acid and carotenoids (Ribeiro *et al*., 2007; Pritwani and Mathur, 2017) [40, 37], this climacteric fruits have short and limited shelf life under ambient temperatures storage (Ketsa *et al*., 2000; Kim *et al*., 2007; Djioua *et al*., 2009) [26, 27, 16] because of its perishable nature (Mitra and Baldwin, 1997) [32]. Respiration and ethylene production of harvested mango increases at the onset of ripening followed by a gradual decline (Tharanathan *et al*., 2006; Bernardes-Silva *et al*., 2008) [50, 8] which resulted in steadily increased and gradual decline of biochemical compounds during storage. So, it is very important to increase the shelf-life of fruits with proper postharvest treatment and storage. Earlier, Beyers *et al*. (1979) [9] reported mangoes fruits to suffer from severe shelf life problems after harvesting as ripening process advances. This shelf life problem resulted into a considerable amount of mango fruits losses (including quality losses) every year during harvest and postharvest which comes up to an average of 9.16% (Jha *et al.,* 2015) [23]. Appropriate postharvest treatment, storage and processing methods in fruit can curtail the postharvest losses up to 30% and make the quality fruit available for longer periods (Goyal *et al*., 2008; Singh *et al*., 2009) [18, 46]. The nutritional and biochemical qualities of the fruits are the critical factors to consumer acceptance in the market which can be positively affected by the application of various postharvest treatments during storage (Azad *et al*., 2009) [7]. Proper postharvest treatments and packaging are required for maintaining better quality, extended shelf life and having access to international markets (Anwar and Malik, 2007) [5]. Postharvest treatment of hot water and sodium hypochlorite are recommended for increasing shelf life and maintaining physicochemical quality in mango (APEDA, 2007) [6] whereas, postharvest treatment of BA delays the senescence and increased the shelf life of harvested mango (Reddy, 2002; Prassana, 2005) [38, 36]. Mango cv. Langra is a mid season cultivar indigenous to Uttar

Pradesh. It is the choicest variety in the Indian market for its excellent quality (Anonymous, 2018) [4] having a medium shelf life and poor storage quality. Thus, to increase the shelf life and to maintain the biochemical quality of harvested mango fruits during storage, the present investigation was undertaken to study the effect of various postharvest treatments on the biochemical characteristics of mango cv. Langra under ambient storage conditions.

Materials and Methods

Site of the study

The present investigation was carried out in the postharvest laboratory of the Department of Horticulture and Postharvest technology, Institute of Agriculture, Visva-Bharati, Sriniketan from 2016 to 2017. The experimental region is located at an elevation of 40m above mean sea level at 23º 42' N latitudes and 87º 47'30" E longitudes, representing humid sub-tropical region under 'Red lateritic' region of West Bengal.

Harvesting, postharvest treatments, storage and observations

Disease and bruises free, fresh fruits of uniform size, shape and colour were harvested at the physiological mature stage during the morning hours and brought to the laboratory. After various handling chain, the fruits were dipped treated in an aqueous solution of a different concentration of sodium hypochlorite (NaOCl: 100, 150, 200ppm) and 6-benzyladenine (BA: 50, 100, 150ppm). Hot water treatments (HWT) were given in a water bath (automatic control) at a temperature of 52 to 55 ºC at different time intervals (5, 10 and 15 minutes). The fruits were air dried and packed in 5 ply corrugated boxes (5% ventilation) with newspaper lining and stored in ambient conditions. A control lot of fruits (kept in 5 ply corrugated box without any treatment) were also stored in the same condition. Observations were taken at an interval of 3 days up to 12 days.

Total soluble solids (ºB), titratable acidity (%) and sugar acid ratio

The total soluble solids (TSS) level of the fruits was determined using a digital refractometer (AR-2008, Kruss, Germany) according to the method of Daramola and Asunni, (2007) [14]. The measured value was expressed as °Brix. Titratable acidity was determined according to AOAC (2000) [1]. From the values of TSS and titratable acidity, sugar acid ratio (SAR) was evaluated.

Sugars (%) and antioxidant (mg/100g) contents

Sugars and ascorbic acid content were determined from juices extract according to the standard methods in AOAC (2000) [1]. Total carotenoids content were estimated following the method of Lalel *et al*. (2003) [29] and were expressed as mg/100g of β-carotene equivalent from a standard curve of β-carotene.

Statistical analysis

The experiment was carried out in a completely randomized block design and each treatment was replicated thrice. The data obtained from various treatments were analysed statistically using OPSTAT ANOVA and means were compared for significance using CD at 5% level (Sheoran *et al*., 1998) [44].

Result and Discussion

All the postharvest treatments significantly improved the shelf life of fruits as compared to control and resulted in the corresponding improvement of the biochemical characteristics (Figures and tables) of mango fruits during ambient storage conditions.

Changes in total soluble solids (ºB), titratable acidity (%) and sugar acid ratio

Total soluble solids (TSS) of the fruits increased steadily up to 9 days of storage which may be due to the hydrolysis of insoluble polysaccharide into simple sugars (Paull *et al*., 1984; Chan *et al*., 1975) [35, 11] and thereafter declined gradually which may be due to decline in the amount of carbohydrates and pectin, partial hydrolysis of protein and decomposition of glycosides into subunits during respiration (Fig. 1). The similar findings are reported by Karuna *et al*. (2015) [24] in mango cv. Langra and by Gupta and Jain (2014) [19] in mango cv. Dashehari in ambient storage conditions. At each interval of analyses, the maximum TSS retention was recorded in BA @ 100ppm treated fruits (Fig. 1). The increased in TSS content with endogenous cytokinin (i.e. BA) application may be attributed to early ripening induced by cytokinin due to more ethylene evolution (Costa *et al*., 1997) [12]. The results obtained in the present investigation are in close conformity with those of Reddy *et al*. (2014) [39] who reported BA @ 100ppm resulted in maximum TSS retention in guava fruit at each interval of analyses during storage.

Titratable acidity of mango fruits experiences a linear decline as the storage period advanced in all the treatments (Fig. 2). The decrease in titratable acidity content under prolonged storage might be due to the rapid utilization of organic acid during respiration (Albertini *et al*., 2006) [2]. The fruits treated with HWT (5 minutes) and control resulted in lower acidity as the storage period advances followed by BA's treatments. Similar results of declining in acidity with heat treatment during storage were earlier reported by Klein and Lurie (1990) [28] in apple, D'hallewin *et al*. (1994) [13]; Shellie and Mangan (1996) [43] in citrus and Yousef *et al*. (2012) [54] in mango.

The fruits treated with hot water (5 minutes) resulted in higher sugar acid ratio (SAR) during storage (Fig. 3). The TSS value and reduction in acidity during ripening plays a great part in the SAR balance and consequently in influencing the taste and flavour of the mango fruit. Earlier similar results on SAR influence by HWT were reported by Angasu *et al*. (2014) [3] in mango and Reddy *et al*. (2014) [39] in guava.

Changes in sugars (%) content

Sugars content of the fruits increased steadily up to 9 days of storage and thereafter declined gradually. A perusal of data in Table 1, the maximum sugars content were observed in hot water (5 minutes) treatment in early intervals of storage but as the storage period advanced, BA (50 and 100ppm) treated fruits expressed maximum sugars content. The increase in sugar content during storage depends upon respiration rate and on a complex series of enzymatically controlled biochemical reaction such as conversion of starch. The initial increase in sugars content in hot water treatment could be due to the breakdown of polysaccharides into water soluble sugar. A similar result has been reported by Tefera *et al.* (2008) [49] in mango. As the storage advances free radical quenching property of BA might inhibit ethylene biosynthesis resulting in retardation of senescence and facilitated gradual build up of sugars in fruits (Sharma and Dashora, 2001; Jayachandran *et al*., 2007; Meena *et al*., 2008) [42, 21, 31]. Similar results have been earlier reported by Deepthi *et al*. (2015) [15] in guava when treated with BA.

Changes in antioxidants (mg/100g) content

The continuous decrease in ascorbic acid content with the advancement of storage period was observed in all the treatments. During storage, oxidizing enzymes like ascorbic acid oxidase, peroxidase, catalase and polyphenol oxidase oxidised the ascorbic acid to dehydroascorbic acid (Singh *et al*., 2005 [47]; Mazurek and Pankiewiez, 2012) [30]. BA @ 100ppm might reduce the activities of the oxidizing enzymes during storage resulting in higher ascorbic acid content of the fruits at each interval of analyses. This finding is in accordance with the finding of Venkatram *et al.* (2013) [52] in custard apple, Hemlata *et al*. (2015) [20] in orange and Jayachandran (2000) [22]; Deepthi *et al*. (2015) [15] in guava who recorded maximum ascorbic acid content in fruits treated with BA.

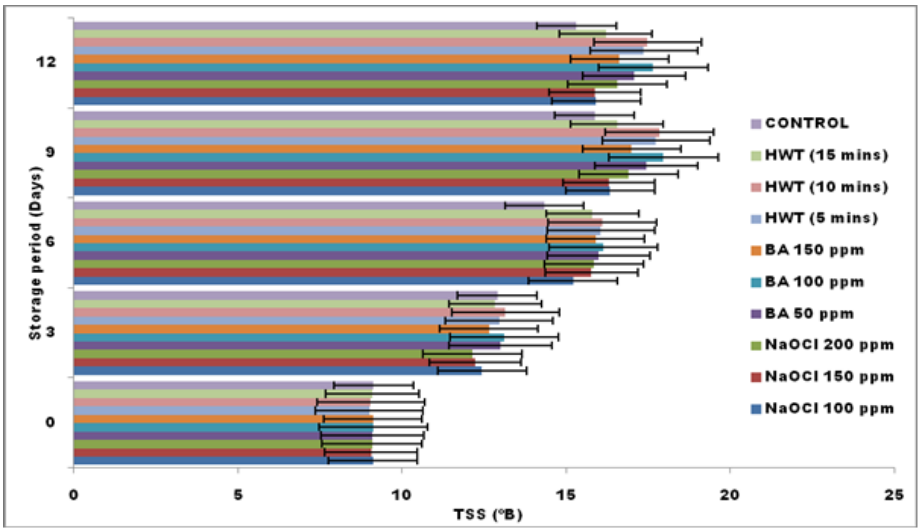

Fig 1: Effect of postharvest treatments on TSS (°B) content of mango cv. Langra under ambient conditions storage

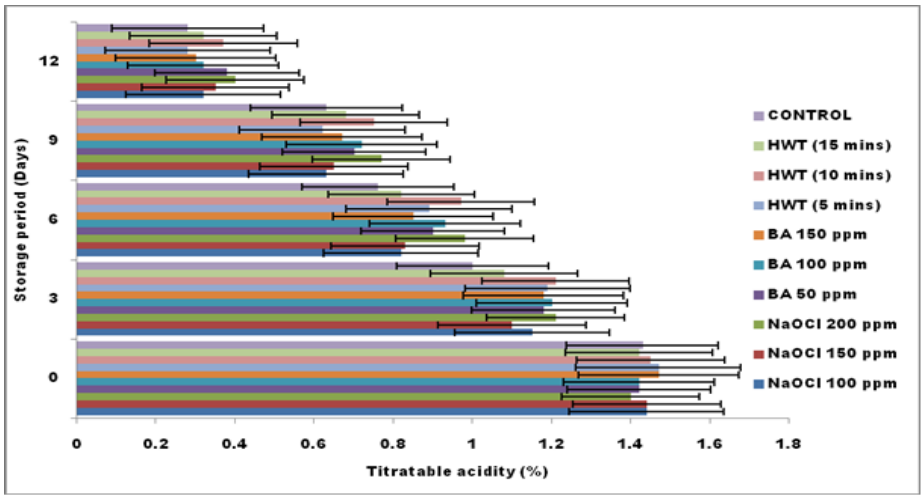

Fig 2: Effect of postharvest treatments on tritatable acidity (%) content of mango cv. Langra under ambient conditions storage

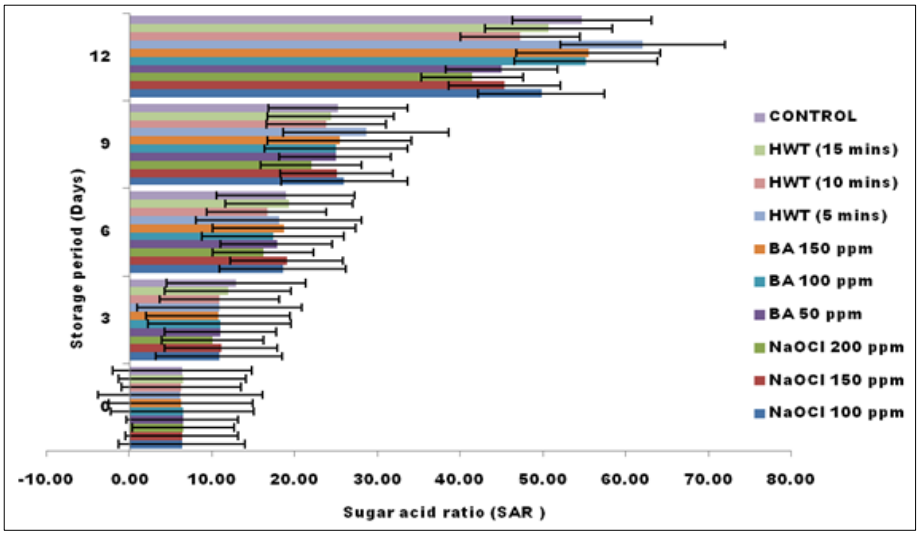

Fig 3: Effect of postharvest treatments on suagr acid ration (SAR) of mango cv. Langra under ambient conditions storage

Table 1: Effect of postharvest treatments on sugars (%) content of mango cv. Langra under ambient conditions storage

Treatments	Total sugar (%)					Reducing sugar (%)				
	Storage period (Days)					Storage period (Days)				
	0	3	6	9	12	0	3	6	9	12
NaOCl 100 ppm	6.60	8.41	11.68	12.32	11.97	3.15	3.30	3.98	4.88	4.44
NaOCl 150 ppm	6.53	8.12	11.78	12.30	11.96	3.10	3.19	4.08	4.87	4.41
NaOCl 200 ppm	6.58	8.48	11.80	12.45	12.12	3.18	3.37	4.10	4.92	4.47
BA 50 ppm	6.62	8.86	12.08	13.00	12.74	3.13	3.47	4.15	5.10	4.64
BA 100 ppm	6.63	8.70	12.00	12.90	12.56	3.12	3.48	4.21	5.12	4.76
BA 150 ppm	6.62	8.65	11.85	12.72	12.40	3.18	3.43	4.11	4.96	4.47
HWT (5 mins)	6.53	8.78	12.02	12.88	12.51	3.11	3.48	4.18	5.08	4.65
HWT (10 mins)	6.56	8.95	12.13	12.92	12.62	3.11	3.50	4.20	5.11	4.67
HWT (15 mins)	6.56	8.58	11.92	12.76	12.47	3.15	3.40	4.15	5.00	4.55
CONTROL	6.55	8.33	10.13	11.12	10.53	3.16	3.30	3.72	4.65	4.12
CD (*P=0.05*)	N/A	0.11	0.11	0.11	0.12	N/A	0.08	0.08	0.09	0.14
SEm ±	0.04	0.04	0.04	0.04	0.04	0.02	0.03	0.03	0.03	0.05

Table 2: Effect of postharvest treatments on antioxidant content of mango cv. Langra under ambient conditions storage

Treatments	Ascorbic acid (mg/100g)					β-carotene (mg/100g)				
	Storage period (Days)					Storage period (Days)				
	0	3	6	9	12	0	3	6	9	12
NaOCl 100 ppm	87.97	70.65	60.78	48.28	40.93	0.62	2.70	3.45	4.56	5.33
NaOCl 150 ppm	87.44	70.88	61.55	48.55	40.81	0.58	2.72	3.47	4.45	5.24
NaOCl 200 ppm	88.76	70.80	61.23	48.87	41.13	0.61	2.76	3.54	4.73	5.46
BA 50 ppm	88.45	71.56	62.89	50.12	42.36	0.60	2.95	3.62	4.97	5.76
BA 100 ppm	87.45	71.65	63.70	50.77	43.12	0.57	2.82	3.55	4.92	5.63
BA 150 ppm	88.34	70.92	62.76	49.67	41.78	0.58	2.76	3.48	4.67	5.44
HWT (5 mins)	89.05	71.89	63.89	50.63	42.92	0.58	2.96	3.92	5.21	5.98
HWT (10 mins)	87.60	72.00	63.72	50.54	42.75	0.62	2.95	3.70	5.07	5.82
HWT (15 mins)	87.65	70.96	62.88	49.95	42.12	0.56	2.97	3.78	5.18	5.95
CONTROL	87.65	70.84	58.92	41.56	30.16	0.60	2.63	3.26	3.76	4.12
CD (*P=0.05*)	N/A	0.38	0.71	0.27	0.23	N/A	0.20	0.28	0.28	0.19
SEm ±	0.65	0.13	0.24	0.09	0.08	0.05	0.07	0.09	0.09	0.07

With the advancement of storage periods, the β-carotene content of the harvested fruits was increased. During storage, the ripening process advanced and the transition of chlorophyll into carotenoids are responsible for the increase in carotenoids content of mango fruits Kays (1991) [25]; Bustamante *et al*. (1997) [10]. Saltveit (1999) [41] also reported that the increased in carotenoids content with fruit ripening during storage is associated with the climacteric increase in respiration and ethylene production. As the perusal of data in Table 2, hot water (5 minutes) treatment resulted in maximum β-carotene content of mango fruits under ambient storage conditions. Similar results with heat treatment were earlier reported by Talcott *et al*. (2005) [48]; Anwar and Malik (2007) [5]; Niranjana *et al*. (2009) [33] in different mango cultivars.

On the basis of the qualitative analysis, it might be concluded that mango cv. Langra treated with BA @ 100ppm and HWT @ 5 minutes significantly maintained higher TSS, sugars and antioxidants content of the fruits and remained acceptable up to 12 days under ambient storage conditions.

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