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EFFECT OF POLYAMINES ON SHELF LIFE AND CHILLING INJURY OF MANGO CV.DASHEHARI

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ABSTRACT

The effect of post-harvest application of polyamines on shelf life and prevention of chilling injury of fruits of mango was studied. Mature fruits of mango cv. Dashehari were dipped in putricine (0.5 and 1 mM), spermine (0.5 and 1 mM) and spermidine (0.5 and 1mM), for 10 minutes. The fruits were surface dried and placed in cardboard cartons for storage under room and refrigerated conditions. Mango fruits treated with polyamines could be stored for longer duration in refrigerated storage without any sign of chilling injury. Fruits treated with putricine (1.0 mM) resulted in the lowest physiological loss in weight (11.77 %) compared to 18.49 in the control while spoilage was significantly reduced to 3.3 percent in mango fruits treated with 0.5mM putrecine compared to 13.3 percent in control after 28 days of storage under refrigerated condition . After four weeks of refrigerated storage chilling injury index was the lowest (0.86) in mango fruits treated with 1mM putricine whereas it was highest (4.0) in control. Storage life was extended to 4 weeks in mango fruits treated with 1 mM putricine compared to 2 weeks in control under refrigerated condition.

INTRODUCTION

Mango is a climacteric fruit, often harvested at the mature, hard green pre-climacteric stage and it undergoes numerous biochemical changes during ripening within 9-12 days at ambient temperature. The short ripening period and low temperature sensitivity (below 13°C) limits its potential for distant market. Ripening of fruits is triggered by ethylene, whether derived from endogenous or exogenous sources (Wills *et al.,* 1989). Polyamines (spermine, spermidine and putrescine) and ethylene production are interrelated, since they share a common precursor s-adenosyl methionine (SAM) for their biosynthesis but have antagonistic functions in fruit ripening and senescence (Malik *et al.,* 2005). Therefore, there is a possibility that polyamines (PAs) may regulate the process of fruit ripening and storage.

Polyamines form a class of aliphatic amines that have been implicated in a wide range of biological processes including plant growth and development (Kumar *et al.,* 1997). Galston and Kaur-Sawhney (1990) also pointed out that the accumulation of putrescine is a general response to stress and it is possible that the level of polyamines could be linked to the senescence process. Postharvest application of polyamines has been shown to retard softening in apples, papaya and mango (Purwoko *et al.*, 1998) and inhibits the development of CI in zucchini squash (Kramer and Wang, 1989). Exogenous application of polyamines may extend the storage life of fruits by inhibiting ethylene production (Malik and Singh, 2005). A substantial reduction in CI symptoms with pre storage exogenous application of polyamines indicates that CI development in mango fruits seems to be associated with the biosynthesis of polyamines. PAs have been determined to delay senescence in a number of plant tissues by inhibiting ACC synthase biosynthesis and modulate fruit ripening and senescence. Hence the present investigations were conducted to study the effectiveness of polyamines on shelf life and chilling injury of mango fruits.

MATERIALS AND METHODS

Uniformly mature green fruits of mango cv Dashehari were harvested from university orchard of SKUAST, Jammu, India. Fruits free from visual symptoms of blemishes and any disease were dipped for 10 minutes in aqueous solutions containing a surfactant Tween 80 (0.01 %) and different concentrations of putricine (0.5 and 1 mM), spermine (0.5 and 1mM) and spermidine (0.5 and 1mM) following the method of Nair and Singh (2004). Following the treatments the fruits were surface dried and placed in cartons for storage under room and refrigerated conditions (8-9°C). There were 30 fruits in each treatment with 10 fruits in each replication.

Physiological weight and spoilage during storage

Physiological weight during storage was calculated from the difference in initial and final fruit weight (g) of stored fruits and expressed as physiological (%) weight loss. Unmarketable fruits including visual chilling injury symptoms were considered as decayed.

Decay % = Number of decayed fruits at the time of sampling x 100

Initial number of fruits

Table 1: Effect of polyamines on physiological weight loss (%) of mangoes cv. Dashehari under refrigerated storage

Treatments	Storage interval (days)				
	7	14	21	28	35
T1- Putrecine 0.5mM	1.21	2.66	6.85	8.29	13.30
T2- Putrecine 1.0 mM	1.80	3.30	6.67	7.92	11.77
T3- Spermine 0.5 mM	1.20	3.34	6.11	8.47	12.8
T4- Spermine 1.0 mM	1.95	3.73	6.21	8.69	13.50
T5- Spermidine 0.5 mM	2.19	3.49	6.29	7.58	13.45
T6- Spermidine 1.0 mM	2.0	3.61	6.60	8.94	12.0
T7- Control	3.80	6.78	8.95	12.80	18.49

Table 2: Effect of polyamines on physiological weight loss (%) of mangoes cv.Dashehari under room temperature

	Storage interval (days)	
Treatments	7	14
T1- Putrecine 0.5mM	8.84	28.15
T2- Putrecine 1.0 mM	8.93	26.25
T3- Spermine 0.5 mM	8.10	28.5
T4- Spermine 1.0 mM	8.65	27.85
T5- Spermidine 0.5 mM	7.93	29.05
T6- Spermidine 1.0 mM	8.60	27.5
T7- Control	9.04	33.4

Total soluble solids (TSS)

TSS were determined using a hand refractometer and expressed as Brix (°B).

Chilling injury index (CI)

CI symptoms on whole fruits were assessed using a subjective scale of 0 to 4 (0 = no damage, 1= very light damage, 2= light damage, 3= moderate damage and 4= very severe damage) according to Lederman *et al.* (1997) and CI index was calculated as:

CI index = (Injury level) x (number of fruits at that level)

Total number of fruits

RESULTS AND DISCUSSION

Pre-storage exogenous application of polyamines including putricine, spermine and spermidine in mango has substantially reduced chilling injury symptoms and weight loss during storage with putricine (1.0 mM) resulting in the lowest physiological loss in weight (11.77 %) compared to 18.49 in the control (Table 1). Physiological loss in weight and spoilage was significantly reduced under refrigerated condition as compared to ambient condition. However the general trend was an increase in weight loss with time for all the treatments. Weight loss is an important index of post harvest storage life in the fresh produce. It is mainly attributed to the loss of water during metabolic processes like respiration and transpiration. The reduced weight loss due to PA- treatments during storage may be due to comparatively lower rates of respiration in treated fruits compared to control. These results are in conformity with the findings of Valero *et al.* (1998), Kramer and Wang (1990) and Bhagwan *et al*. (2000). Weight loss was more under room temperature where shelf- life was over only after one week than under refrigerated storage (Table 2). Total soluble solids revealed highly significant results and fruits treated polyamines had lower TSS than untreated fruits. There was a general trend of increase in TSS with time upto 28 days under refrigerated condition whereas under room temperature TSS increased (from 10.0° B after harvest) upto 7th day after which it declined in all the treatments. Fruits treated polyamines had lower TSS than untreated fruits. This might be due to slow metabolic transformation in soluble components and conversion to sugars resulting in slow buildup of sugars and TSS due to retarded ripening process. Earlier, pre-storage infiltrations by polyamines have been reported to reduce fruit softness and colour development in lemons (Valero *et al.*, 1998) and in apricot (Martinez- Romero *et al.*, 2001). There was more conversion of polysaccharides into simple sugars resulting in higher TSS in fruits at room temperature than under refrigerated storage after only one week possibly due to higher temperature and respiration rate. Under refrigerated condition no decay was observed upto 21st day whereas on 28th day 13.3 % decay was observed in control and it was lesser in other treatments. Under room temperature after one week decay was lesser in polyamine treated fruits as compared to control; however after two weeks 100 percent decay was observed in all the treatments. The effect of polyamines on maintaining fruit firmness can be attributed to their cross-linkages to the $-COO^-$ group of pectic substances in the cell wall , blocking the access of degrading enzymes thus reducing the rate of softening during storage (Valero *et al.,* 2002). Jawandha *et al.* (2012) revealed that fruits of mango cv Langra treated with putrescine at 2.0 mmol/L retained the best quality in terms of high palatability rating, good blend of total soluble solids (TSS) and acidity and low physiological loss in weight and spoilage percentage. Polyamines have substantially reduced CI symptoms in mango fruits, which were stored for four weeks at 8-9°C. No sign of chilling injury was observed in any fruit upto two weeks under refrigerated condition. However when observed after three weeks, CI index was highest (0.73) in control and lowest (0.33) in fruits treated with 0.5mM spermidine. After four weeks of refrigerated storage chilling injury index was lowest (0.86) in mango fruits treated with 1mM putricine whereas it was highest (4) in control (Table 5). Storage life was extended up to 4 weeks in mango fruits treated with 1 mM putricine compared to 2 weeks in control under refrigerated condition. Mango fruits treated with polyamines could be stored for longer duration in refrigerated storage without any sign of chilling injury (CI). The reduction in CI may be attributed to the antioxidant activity and the membrane stabilizing effect of polyamines. Our results are consistent with observations in other fruits in which postharvest treatments that elevate the content of polyamines before cold storage are effective in reducing CI (Serrano *et al.,* 1996). It has been reported that under chilling conditions, changes in cell

Table 3: Effect of polyamines on TSS (%) of mangoes cv.Dashehari during storage

Treatments	Storage interval (days)(Refrigerated storage)				Storage interval (days)(Room temperature)	
	7	14	21	28	7	14
T1- Putrecine 0.5mM	12.20	13.35	16.32	18.5	19.25	18.89
T2- Putrecine 1.0 mM	12.55	13.52	16.60	18.27	18.30	18.20
T3- Spermine 0.5 mM	13.20	14.3	15.24	17.89	18.55	19.60
T4- Spermine 1.0 mM	11.80	13.80	17.52	18.20	19.40	18.10
T5- Spermidine 0.5 mM	13.25	14.37	15.62	17.70	18.25	18.50
T6- Spermidine 1.0 mM	12.60	14.20	16.45	19.70	19.70	19.20
T7- Control	13.80	16.73	19.10	22.20	20.80	17.40

Table 4: Effect of polyamines on spoilage (%) of mangoes cv.Dashehari during storage

Treatments	Storage interval (days)Refrigerated storage					Storage interval (days)Room temperature	
	7	14	21	28	35	7	14
T1- Putrecine 0.5mM	-	-	-	3.3	23.3	6.6	100
T2- Putrecine 1.0 mM	-	-	-	6.6	20.0	3.3	100
T3- Spermine 0.5 mM	-	-	-	3.3	16.6	10.0	100
T4- Spermine 1.0 mM	-	-	-	10.0	20.0	6.7	100
T5- Spermidine 0.5 mM	-	-	-	10.0	23.3	10.0	100
T6- Spermidine 1.0 mM	-	-	-	3.3	20.0	6.6	100
T7- Control	-	-	-	13.3	40.0	16.6	100

Table 5: Effect of polyamines on chilling injury index of mangoes cv. Dashehari under refrigerated storage..

Treatments	Storage interval (days)			
	7	14	21	28
T1- Putrecine 0.5mM	-	-	0.5	0.9
T2- Putrecine 1.0 mM	-	-	0.6	0.86
T3- Spermine 0.5 mM	-	-	0.6	1.0
T4- Spermine 1.0 mM	-	-	0.33	1.6
T5- Spermidine 0.5 mM	-	-	0.33	1.46
T6- Spermidine 1.0 mM	-	-	0.46	1.3
T7- Control	-	-	0.73	4.0

membrane lipids lead to an increase in membrane permeability and leakage of ions (Stanley, 1991). With the aim of reducing CI in pomegranate fruit (*Punica granatum* L,) , treatment of fruits with putrescine ,or spermidine at 1mM prior to storege at low tempertature (2°C) was effective in reducing CI severity while non- treated fruit developed rapidly CI with main symptoms being skin browning, electrolyte leakage and weight loss (Mirdehghan *et al.,* 2007). During senescence of melons, polyamines treatment resulted in less membrane peroxidation and higher retention of chlorophyll (Lester, 2000). In two apricot cultivars ('Lasgerdi' and 'Shahrodi') harvested at the commercial ripening stage and immerged in 4 mM putrescine Davarynejad *et al.* (2013) observed that the quality of apricot fruits was improved by the use of putrescine treatment due to its effect on delaying the ripening processes. In conclusion mango fruits treated with polyamines could be stored for longer duration in refrigerated storage without any sign of chilling injury. After four weeks of refrigerated storage chilling injury index was the lowest (0.86) in mango fruits treated with 1mM putricine whereas it was highest (4.0) in control.

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