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STUDIES ON BEHAVIOR OF CHAUNSA MANGO DURING COOL STORAGE AND RIPENING

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ABSTRACT

Mature green mangoes cv. Chaunsa were desapped after harvesting and subjected to different treatments viz. chlorine wash (100ppm), hot water (53 ± 1°C for 5 minutes), hot Bavistin dip (500ppm at 53 ± 1°C for 5 minutes). The fruits were air dried, packed either in CFB boxes or plastic crates and stored at 11 ± 0.5°C and 90-95% RH. One lot of the fruits was removed after two weeks of storage and ripened using ethylene gas (100ppm) in ripening chamber maintained at 23 ± 2°C and 90-95% RH, while, subsequent lots were removed after third and fourth weeks of storage and ripened using ethephon (500ppm) dip treatment for 5 minutes followed by air drying and storage at ambient temperature (28 ± 2°C and 55-70% RH). Observations on spoilage, physiological loss in weight, fruit firmness, total soluble solids and acidity were recorded, upon removal from cold store as well as after ripening. Though hot water and hot Bavistin dip treatments proved beneficial in maintaining the firmness, TSS, acidity and prolonging the storage life up to 2-3 weeks, but were ineffective to check the spoilage during post storage ripening process. The spoilage was maximum in chlorine washed fruits in both CFB boxes and crates and ranged between 50-80% and 58-80% upon ripening in fruits stored for two or four weeks, respectively, followed by hot water treatment where level of spoilage was 40-60% and 53-60%. The rot free post-storage ripening emerged as a major problem in long-term storage of Chaunsa mango. Ripening with ethylene gas takes minimum of 5 days. Even after such a long period, the peel carotenogenesis remains incomplete resulting in uneven ripening. This problem was considerably reduced by ripening at ambient temperature, but this would increase the weight loss and spoilage substantially. Alternative methods need to be investigated for post cold storage ripening of Chaunsa mangoes.

Key words: Chlorine wash, hot water, hot Bavistin treatment, ripening, storage, quality.

INTRODUCTION

The mango (*Mangifera indica* L.) is considered one of the choicest fruits of the world, because of attractive colour, delicious taste and excellent nutritional properties. It is the largest subtropical fruit crop in India, where it occupies an area of 1.17 million ha with a production of 9.64 million tonnes (Mitra and Baldwin, 1997). The world fruit trade is expanding but mango

sales are restricted by improper handling, inadequate transport facilities and higher incidence of diseases and rapid ripening of fruits leading to short storage life (Mootoo, 1991). Chaunsa happens to be an important late season commercial cultivar of north India and faces all these problems after harvest. In spite of these problems, this cultivar fetches good market price, which almost doubles towards the end of mango season. Thus long-term storage of Chaunsa mangoes for a period of three to four weeks is crucial to derive maximum benefits in the off-season. Apart from this Chaunsa fruits are in demand in the international market due to their flavour and taste. However export of these fruits to different countries is presently being done by air transportation, which is a costly affair. To reduce these costs, sea-transportation is the only alternative, but movement by sea takes longer time and fruits are to be maintained in green condition for more than three weeks. Keeping in view the requirements of domestic and export trade a semi-commercial cool storage study was carried out to develop suitable protocol for long-term storage of Chaunsa mangoes.

MATERIALS AND METHODS

Mature green Chaunsa mangoes were harvested with secateur retaining 3-4 cm long stalk to prevent staining on the fruit from flow of sap. The fruits were packed in crates and transported overnight to Punjab Horticultural Postharvest Technology Centre, PAU, Ludhiana. The bruised and damaged fruits were sorted out. The healthy and uniform sized fruits were desapped by cutting the stalk below the first node and keeping the fruits inverted for two hours. These fruits were subsequently subjected to different pre-treatments prior to storage viz. Chlorine wash (100ppm) + Hot water dip (53 ± 1ºC for 5 minutes) + CFB box (T_1), Chlorine wash (100ppm) + CFB box (T_2), Chlorine wash (100ppm) + Hot water dip (53 ± 1 ºC for 5 minutes) + Crate (T_3), Chlorine wash (100ppm) + Crate (T_4), Chlorine wash (100ppm) + Hot Bavistin dip (500ppm at 53 ± 1^0C for 5 minutes) + CFB box (T_5). The fruits were stored at 11 ± 0.5 ºC and 90-95% RH. There were three replications and three storage intervals for each treatment in a randomized block design. Each replication was comprised of six boxes and crates (5 Kg) and at each storage interval three boxes and crates were taken out and observed for storage and ripening behavior.

Hot water treatment

Hot water treatment was given by immersing the fruits in lab scale hot water treatment plant fitted with temperature adjustment and constant water circulation. The water temperature was maintained at 53 ± 1 ºC. The fruits were dipped for five minutes and air dried to remove the surface moisture. These fruits were later packed in CFB boxes and crates and stored in cold storage. In case of hot Bavistin treatment, a 500ppm solution was made in hot water tank and thoroughly mixed prior to fruit dip at 53 ± 1 ºC for five minutes.

Ripening

One lot of the fruits was removed after two weeks of storage and ripened using ethylene gas (100ppm) in ripening chamber maintained at 23 ± 2 ºC and 90-95% RH, while, subsequent lots were removed after third and fourth weeks of storage and ripened using ethephon (500ppm) dip treatment for 5 minutes, air-dried to remove surface moisture and stored at ambient temperature (28 ± 2 ºC and 55-70% RH). Observations on spoilage, physiological loss in weight (PLW), fruit firmness, total soluble solids (TSS) and acidity were recorded initially, upon removal from cold store and after ripening.

The spoilage was recorded by counting the number of rotten fruits from each lot at each storage and ripening interval and expressed in percent. The physiological loss in weight (PLW) of fruit was calculated on initial weight basis and expressed in percent. The firmness of the fruit was measured with Texture Analyzer (Model: TA- HDi Make, Stable Microsystems, UK) using 75 mm compression platen and results were expressed in Kg force. The TSS of the fruit was estimated with hand refractometer (Model: ERMA Inc., Tokyo, Japan) and correction at 20 ºC was applied. The results were expressed in ºBrix. The acidity of fruit was calculated by titrating the known quantity of juice against N/10 NaOH and expressed in percent malic acid.

RESULTS AND DISCUSSION

Spoilage

The spoilage of mango fruits, increased during storage, irrespective of the treatment. However, marked differences were observed among the treatments for control of spoilage (Table 1). Simple chlorine wash (T_2 & T_4) recorded 20 and 13% spoilage, respectively after two weeks of storage, as compared to no spoilage in hot water treatment. However, on subsequent storage, the hot water dip treatment did not help to control rotting and 20% and 40% spoilage was recorded after 3rd and 4th week of storage, respectively. Dip in hot Bavistin, which was found quite effective in checking the spoilage till 3 weeks, but after 4 weeks of storage, 30% spoilage of fruits was recorded.

The ripening of fruits after each subsequent storage interval also showed marked increase in spoilage under each treatment (Table 1). However, spoilage was maximum under chlorine wash (T_2 & T_4) where it ranged between 40-60% and 58 to 80% upon ripening after two to four weeks of storage followed by hot water dip treatment (T_1 & T_3), where level of spoilage was 40-60% and 53 to 60%. In hot Bavistin dip treatment (T_5) the level of spoilage was found to be 30-40% during ripening after 2 to 4 weeks of storage. In the present investigation it was noticed that none of the treatment could check the occurrence of anthracnose and stem-end rot, during post storage ripening. Barkai-Golan and Phillips (1991) reported that hot water treatment in mango is not effective against stem-end rot. Jacobi and Wong (1992) explained that hot water treatment cause internal and external injury in mango fruits. However, Johnson et al. (1990b) confirmed that hot water treatment containing fungicides could be effective in the control of stem-end rot. In the present studies, excessive sweating on the fruit surface was noticed when they were removed from the storage and shifted to ripening chamber or ambient condition for ripening treatments. Although fruits were air-dried, but even then, little moist patch left at the point of contact between two fruits, triggered rapid growth of fungal organisms leading to extensive rotting during ripening.

Physiological loss in weight (PLW)

A gradual rise in PLW was observed under all the treatments during storage (Table 1). However, hot Bavistin dip treatment was found to be the most effective treatment in controlling weight loss during storage and subsequent ripening as compared to chlorine wash or hot water dip treatment. Fruits stored in crates showed slightly higher amount of weight loss as compared to CFB boxes. A drastic increase in weight loss was observed in all the treatments upon ripening, which can be attributed to higher temperature and lower relative humidity during ambient ripening. The weight loss levels were considerably high at the end of ripening after 3 weeks of storage, which is unacceptable from commercial marketing point of view.

Firmness

A considerable loss of firmness of mango fruits during cold storage and subsequent ripening was noticed (Table 2). However, the rate of softening was faster after three weeks of storage, which is clearly evident from the reduction of compression force recorded under all the treatments. Hot water dip treatment (T_1, T_3, and T_5) helped to retain fruit firmness at higher levels, compared to chlorine treatments (T_2 & T_4). Fruit firmness is one of the crucial factors in determining the keeping ability of fruits during market handling (Roe and Bruemmer, 1981). Softening of fruits is caused either by breakdown of insoluble protopectin into soluble pectin or by cellular disintegration leading to membrane permeability (Lazan et al., 1986; Mitcham and McDonald, 1992). The decline in firmness during storage and ripening is obviously due to excessive moisture loss and breakdown of pulp tissues and senescence of fruits.

Total soluble solids (TSS)

The TSS content of fruits showed an increasing trend during storage (Table 3). The fruits subjected to chlorine wash and stored in CFB boxes (T_2) showed the highest TSS levels. TSS content increased further upon ripening under all the treatments. However, the highest TSS levels upon ripening were observed in hot Bavistin treated fruits (T_5), while the lowest was observed in

chlorine washed fruits stored in crates (T_4). The increase in TSS during storage or ripening may be due to hydrolysis of starch into sugars. The hydrolysis of starch granules in the chloroplast continues until ripening (Medlicott et al., 1986; Selvaraj et al., 1989)

Acidity

A linear decline in acidity of mango fruits was observed during storage and subsequent ripening (Table 3). However, the acidity level was best retained by hot Bavistin dip treated fruits (T_5) during cold storage and even after ripening. The lowest acidity levels upon ripening were observed in chlorine washed and hot water dipped fruits stored in CFB boxes. The decrease in acidity during storage and ripening could be attributed to the use of organic acid as respiratory substrate (Ulrich, 1974).

CONCLUSIONS

Though pre-storage treatments like hot water, hot Bavistin dip proved beneficial in prolonging the storage life of mango fruits up to 2-3 weeks, but these treatments could not check the spoilage in the post-storage ripening process, which may interfere with marketing of fruits. Long-term storage of mangoes and their subsequent ripening does not seem to be economically viable with available technologies because of latent infection of anthracnose and stem-end-rot, as the spores resting deep in lenticels are not completely killed by chlorine wash and hot water or hot Bavistin dip and once the fruits are taken out from cold storage and put to ripening, free surface moisture (sweating) and high temperature favours rapid growth of these fungal organisms leading to extensive rotting.

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TABLES

Table 1: Effect of pre-storage treatments on spoilage and physiological weight loss in Chaunsa mangoes during cool storage and after ripening

	Spoilage							PLW (%)						
	Initial	Storage period (days)						Initial	Storage period (days)					
		14 DAH	AR*	21 DAH	AR**	28 DAH	AR**		14 DAH	AR*	21 DAH	AR**	28 DAH	AR**
T_1	0	0	40	20	50	43	60	0	3.54	11.14	5.80	13.63	6.35	15.69
T_2	0	20	50	40	60	53	80	0	3.67	12.29	6.19	15.31	7.28	17.72
T_3	0	0	53	20	50	40	60	0	3.96	12.66	6.89	15.61	7.62	18.15
T_4	0	13	58	33	63	50	80	0	3.82	12.81	7.22	15.91	7.76	18.69
T_5	0	0	30	0	40	30	40	0	2.79	9.89	5.10	12.75	6.08	15.01
CD (0.05)	-	5.2	4.0	6.5	5.0	7.3	7.0	-	0.20	1.50	0.60	1.70	0.65	1.77

DAH: Days after harvesting
*After Ripening- Ripening done at 23 ± 2 °C and RH: 90-95% for five days
**After Ripening- Ripening done at ambient (28±2 °C and RH: 55-70%) for three days

Table 2: Effect of pre-storage treatments on firmness and sensory score of Chaunsa mangoes during cool storage and after ripening

	Initial	Firmness (Compression-Kg force) Storage period (days)					
		14 DAH	AR*	21 DAH	AR**	28 DAH	AR**
T_1	8.035	4.683	0.966	3.627	0.872	0.884	0.310
T_2	8.035	2.635	0.714	1.848	0.899	0.547	0.235
T_3	8.035	4.834	1.072	3.829	1.013	0.964	0.346
T_4	8.035	2.845	0.852	2.244	0.954	0.601	0.256
T_5	8.035	5.143	1.290	3.959	1.078	1.017	0.421
CD (0.05)	NS	0.70	0.45	0.27	0.55	0.42	0.15

DAH: Days after harvesting
*After Ripening- Ripening done at 23 ± 2 °C and RH: 90-95% for five days
**After Ripening- Ripening done at ambient (28±2 °C and RH: 55-70%) for three days

Table 3: Effect of pre-storage treatments on total soluble solids and acidity of Chaunsa mangoes during cool storage and after ripening

	Total Soluble Solids (°Brix)							Acidity (%)						
	Initial	Storage period (days)						Initial	Storage period (days)					
		14 DAH	AR*	21 DAH	AR**	28 DAH	AR**		14 DAH	AR*	21 DAH	AR**	28 DAH	AR**
T_1	9.06	19.40	23.60	20.60	23.88	20.20	23.76	0.64	0.40	0.12	0.27	0.12	0.18	0.08
T_2	9.06	19.73	22.80	20.83	23.03	21.80	23.13	0.64	0.30	0.14	0.26	0.13	0.13	0.10
T_3	9.06	18.73	23.46	19.86	23.66	20.20	23.06	0.64	0.33	0.20	0.28	0.18	0.20	0.11
T_4	9.06	18.80	22.93	19.86	23.13	21.20	23.00	0.64	0.29	0.19	0.23	0.15	0.15	0.12
T_5	9.06	17.53	23.86	18.66	24.16	19.80	23.80	0.64	0.44	0.19	0.32	0.16	0.22	0.16
CD (0.05)	NS	0.16	0.25	0.18	0.30	0.15	0.35	NS	0.05	NS	NS	NS	NS	NS

DAH: Days after harvesting

*After Ripening- Ripening done at 23 ± 2 °C and RH: 90-95% for five days

**After Ripening- Ripening done at ambient (28±2 °C and RH: 55-70%) for three days