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MANGO FRUIT DESAPPING IN RELATION TO TIME OF HARVESTING

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Abstract

Sapburn injury is regarded as the most serious threat to external fruit quality of mango. When the stem (pedicel) of a mango fruit is broken, the sap exudes out; spreading over the fruit peel causes serious skin damages. This study was intended to determine the best time of harvest and desapping for maximum control of sapburn injury in mango fruits. The performance of lime [$Ca(OH)_2$] was evaluated at different times of the day in comparison with Australian industry product "*Mango Wash*". The fruits were harvested at three different times of the day: morning (7 a.m.), noon (12 p.m.) and evening (5 p.m.) and subjected to lime (@ 0.5%) and *Mango Wash* (@ 0.4%) treatments. No sap injury (0 score) was observed in the fruits harvested and de-sapped during morning whereas maximum sap injury was observed at noon in both the cases (0.5 score for lime, 0.75 score for *Mango Wash*). Both lime and *Mango Wash* showed significantly less sap injury as compared to control for all the three times of treatment application. Almost all of the physico-chemical attributes (except fruit peel colour and non-reducing sugar contents) were non-significantly affected by the desapping treatments. Fruit peel colour was slightly suppressed by *Mango Wash*. Lime was found to impart attractive appearance to the fruits; however the skin colour was not significantly improved as compared to control. The time of fruit harvest also exerted non significant effects on most of the fruit quality attributes. Significantly higher TSS value was measured in the fruit harvested at noon as compared to other times of the day. Minimum sapburn injury in the fruits harvested and desapped in the morning hours led to the conclusion that morning is the best time of harvest and desapping for the mangoes. Moreover, the potential of lime for controlling sapburn injury in mangoes was also confirmed and it was concluded that lime can be successfully used for mango fruit desapping as a substitute of highly expensive *Mango Wash*.

Introduction

Pakistan is blessed with diverse agro-ecological conditions which favour the production of a great variety of fruits and vegetables. Among fruits, mango has a prominent position in Pakistan ranking 2nd on the basis of country's production (Anonymous, 2006) and 4th in case of exports (Maqbool *et al.,* 2007). Among the world mango producers, Pakistan is considered as fifth largest producer of mango after India, China, Thailand, and Mexico (FAO, 2005). Currently, the world's mango production is 27960 thousand tons; 5.97% (1753.9 thousand tones) of which comes from Pakistan (MINFAL, 2006). Punjab and Sindh provinces contribute 66% and 32.5% respectively in total mango production of Pakistan. The remaining share (less than 2%) comes from Balochistan and NWFP (Khan, 2005). In terms of exports, Pakistan is also considered to

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be one of the leading mango exporting countries along with other major exporters being Mexico and Philippines.

Like all other fresh commodities, the potential market of mango is directly correlated with the quality of the fruits. To facilitate access to the domestic and offshore markets, mango fruit storage potential and fruit quality consistency needs to be improved (Simmons *et al.,* 1997). Mango industry of Pakistan faces several challenges, especially in postharvest management of mango fruits. Sap injury is regarded as the most serious probelm to external fruit quality of mango. When the stem (pedicel) of a mango fruit is broken, the sap exudes out; spreading over the fruit peel causes serious skin damages symptomizing as brownish black streaks or blotches over the skin (Campbell, 1992; Loveys *et al.,* 1992). Apart from the skin damages, the fruit peel colour development also seems to be interfered by the sticking of sap. Moreover, the sap also attracts soil particles and micro organisms towards it due to its sugary and sticky nature (Campbell, 1992). Ultimately, the fruit quality is affected negatively, degrading the cosmetic appeal of fruit, reducing consumer acceptance and storage life and resulting in high economic losses. Several attempts have been made in order to avoid sap burn in mango which include desapping in water, detergent and chemicals; dabbing in vegetable oil, waxes and powder (Landrigan *et al.,* 1991), keeping the fruit in inverted position on soil for some time and using of special desapping trays (Ledger, 1991). Lime [Ca $(OH)_2$] has been reported to give maximum sap burn control (Landrigan *et al.,* 1991; Maqbool and Malik, 2008). However, its potential for .controlling mango fruit sapburn injury in comparison with other commercial anti-sap chemical needs to be compared. Furthermore, mango sap dynamic studies (Maqbool *et al.*, 2007) show that the quantity of sap and its contents change from morning to evening, however, no study has been conducted as how mango fruit harvested at different times will respond to anti-sap chemical treatments.

The ultimate objective of this study was to determine the best time of harvesting and desapping in order to ensure 100% control of sap injury. Moreover, the performance of lime was also compared with *Mango Wash* (An Australian Industry practice) at different times of the day.

Materials and Methods

Selection of plant material and treatment application: Uniform sized and physiologically mature fruits of mango cv. Samar Bahisht Chaunsa were sourced from a commercial mango orchard located at Lodhran District of Punjab Province (29° 15′ 25N; 71° 32′ 60E), Pakistan. The fruits were harvested along with 4-5 cm attached stalks at three different times of the day i.e. morning (7 a.m.), noon (12 p.m.) and evening (5 p.m.). Each treatment unit comprised of 15 fruits for each time of harvesting replicated three times. Just after harvesting, the fruits were subjected to desapping treatments at the same orchard (T_1 = Lime @ 0.5% Conc., T_2 = *Mango Wash* @ 0.4% Conc. and T_3 = Control). While desapping with lime and *Mango Wash*, the attached stalks were removed inside the treatment solutions, whereas in case of control, the stalks were removed and sap was allowed to spread freely over the fruit surface.

Packaging and transport: After treatment application, the fruits were packed in corrugated cardboard boxes and transported to Postharvest Research Laboratory, Institute

of Horticultural Sciences, University of Agriculture, Faisalabad (Pakistan) and kept under ambient conditions (28± 1°C; 75-80% RH).

Data collection: On ripening (7th day of harvest), observations were made regarding the effects of treatments on sap injury, peel colour and textural softness. Sapburn injury was scored from 0 to 4 [0= no injury, 1= very mild (injury area <1 cm2), 2= mild (injury area >1<2 cm2), 3= moderate (injury area >2< 4 cm2), 4= severe (injury area >4 cm2)] (Maqbool *et al.*, 2007). Fruit peel colour was estimated by visual observations (Amin *et al.,* 2007). Fruit colour was scored from 1 to 5 (1: 100% green – 0% yellow; 2: 75% green- 25% yellow; 3: 50% green- 50% yellow; 4: 25% green-75% yellow; 5: 0% green-100% yellow). Similarly, fruit textural softness was rated from 1 to 5 (1: hard; 2: sprung; 3: slightly soft; 4: eating soft; and 5: over ripe). Moreover, the fruit were also subjected to biochemical analysis to evaluate the effects of treatments on internal fruit quality parameters (TSS, acidity, ascorbic acid, and sugar contents).

Results

Effect on sapburn injury: The application of lime and *Mango Wash* showed statistically significant reduction in fruit sap injury (0.21 & 0.32 scores respectively) as compared to control (1.97 score). Lime showed slight reduction in sap injury level as compared to *Mango Wash*, however, the effects of both chemicals were found statistically at par with each other (Table 1). Similarly, regardless of treatment solution, highly significant differences in sap injury levels were observed at different times of the day (Table 2). Minimum sap injury was observed among the fruits which were harvested in the morning (7 a.m.), whereas maximum among those harvested at noon (12 p.m.). Strong interaction was found among treatments and time of harvesting (Table 3). The fruits harvested and desapped with either chemical (lime or *Mango Wash*) during the morning times, showed no signs of sap injury as compared to control.

Effect on external fruit quality: The statistical analysis (*P≤0.01)* of the data regarding fruit peel colour showed that *Mango Wash* treatment significantly reduced the peel colour development (mean injury score = 3.53); however, non significant differences in the peel colour were calculated between the fruits treated with lime and untreated fruits (mean injury score = 3.92; for both lime and control). Significantly less peel colour development was observed in the fruits harvested during morning hours. No significant effects of desapping treatments and different times of harvesting were observed on fruit textural softness (Table 4). Highly significant interaction was observed between treatment application and time of harvest in case of fruit peel colour development. Non significant differences in treatments were found in case of textural softness (Table 5). Maximum colour development (Score = 4.00) was observed in the fruit treated with lime during morning hours as compared to other times of the day (Table 5).

Table 1: Effect of desapping on fruit sap injury

Treatments	Sap injury (Score)
T_1 (0.5% lime)	0.21b
T_2 (0.4% *Mango Wash*)	0.32b
T_3 (control)	1.97a

Any two means not sharing any letter, differ significantly (*P≤0.01)*

Table 2: Fruit sap injury at different times of harvesting

Time of Harvest	Sap injury (Score)
7:00 am	0.40c
12:00 pm	1.22a
5:00 pm	0.88b

Any two means not sharing any letter, differ significantly (*P≤0.01)*

Table 3: Effect of treatment × time of harvest interaction on fruit sap injury

Treatments	Time of harvest		
	7:00 am	12.00 pm	5:00 pm
T_1 (0.5% lime)	0.00e	0.53cd	0.10de
T_2 (0.4% *Mango Wash*)	0.00e	0.77bc	0.20de
T_3 (control)	1.20b	2.37a	2.33a

Any two means not sharing any letter, differ significantly (*P≤0.01)*

Table 4: Effect of treatment and time of harvest on external fruit quality

Treatments	Peel colour (Score)	Textural softness (Score)	Time of harvest	Peel colour (Score)	Textural softness (Score)
T_1 (0.5% lime)	3.92a	2.98	7:00 am	3.53b	2.98
T_2 (0.4% *Mango Wash*	3.53b	3.03	12:00 pm	3.94a	3.03
T_3 (control)	3.92a	3.06	5:00 pm	3.90a	3.06

Any two means not sharing any letter, differ significantly (*P≤0.01)*

Table 5: Effect of treatment × time of harvest interaction on external fruit quality

Treatments	Time of harvest	Peel colour (Score)	Textural softness (Score)
T_1 (0.5% lime)	7:00 am	4.00a	2.93
	12.00 pm	3.83a	3.00
	5:00 pm	3.93a	3.00
T_2 (0.4% *Mango Wash*)	7:00 am	2.60b	3.00
	12.00 pm	4.00a	3.08
	5:00 pm	4.00a	3.00
T_3 (control)	7:00 am	4.00a	3.00
	12.00 pm	4.00a	3.00
	5:00 pm	3.76a	3.17

Any two means not sharing any letter, differ significantly (*P≤0.01)*

Discussion

Sapburn injury in relation to desapping and time of harvest: The mango sap (latex) is highly acidic in nature (John *et al.,* 2003) which contains various enzymes (Hoffman *et al.,* 1970), oils and sugars (O'Hare and Prassad, 1991). The findings of this study led towards the fact that the detrimental effects of highly acidic mango sap (pH = 4.3) over the fruit skin can be well managed by postharvest dipping of the fruits in some basic treatment solutions like lime and *Mango Wash.* So, it can be stated that the sapburn management is nothing but neutralization of the acidic sap before it touches the fruit skin.

This study was also intended to compare the lime and *Mango Wash* in controlling sapburn injury in mango. Statistically similar performance of lime with that of *Mango Wash* indicates its potential for the mango industry. The pH of treatment solutions of 0.5% lime and 0.4% *Mango Wash* was estimated as 11.3 and 9.7 respectively which indicate that lime is more basic as compared to *Mango Wash*. Therefore it probably possesses more capability to neutralize the acidic sap which exudes out of the mango stem end. In the countries like Pakistan, the use of lime for mango fruit desapping can significantly reduce the costs of treatments rendered by the application of *Mango Wash*.

Maximum sapburn control was observed in the fruits harvested and desapped in morning hours. These findings may be correlated with previous conclusions that the sap injury level is significantly less in the time of morning as compared to other times of the day because the sap burn severity increases increasingly as the day time proceeds (Maqbool *et al.,* 2007). This seems to be due to the decrease in water contents and increase in the viscosity of the sap due to increase in oil contents with increasing temperature. The results indicate that higher be the climatic temperature, more will be the risk of sap injury in mango fruits. Moreover, differences in sapburn injury levels at different times of the day may be due to the differences in sensitivity levels of mango fruit skin towards sap injury at different times of the day. On the basis of the facts obtained from this and previous research works found in literature, an order for the severity of sap burn can be formulated as: noon>afternoon >evening>morning. Hence, to ensure better sapburn injury control, the fruit should be harvested and subjected to desapping in morning hours.

Mango fruit quality in relation to treatment application: The quality improvement has always been the major concern of researchers. Like all other fresh commodities, the potential market of mango is directly correlated with the quality of the fruits. To get higher economic returns, mango fruit quality needs to be improved (Simmons *et al.,* 1997). In this study, observations were made regarding the effects of desapping treatments on internal and external quality attributes. Previously, calcium compounds have been reported to improve the fruit quality by enhancing the fruit firmness (Poovaiah, 1986) and imparting attractive appearance to the fruits (Murillo and Adimilson, 1999). However, results of this study indicated non-significant effects of lime (which is a calcium compound) on the external and internal mango fruit quality as compared to control. Similar observations were made in case of *Mango Wash*. Significant peel colour reduction by *Mango Wash* treatment indicates the relationship of its components with physiological phenomenon involved in colour development. Non significant changes in the fruit biochemical characteristics may be due to very short exposure of the fruits to the treatment solutions (i.e. for 2-3 minutes). Slight changes in the reducing sugar contents of juice indicate that the treatment solutions were readily absorbed by the treated fruits. TSS of the fruits harvested at noon seems to be caused by more heat influx with reduced water contents inside the fruit as reported in previous studies (Maqbool and Malik, 2008).

Conclusion: On the basis of the findings of this study, it can be concluded that desapping of mango fruits with lime and *Mango Wash* can induce better returns to the stakeholders by controlling sap injury and improving the cosmetic look of mango fruits. Critical observations of control fruits showed that the severity of sap injury was less in morning

Table 6: Effect of treatment solutions on internal fruit quality

Treatments	TSS (°Brix)	Titratable Acidity (%)	Ascorbic acid (mg/100ml)	Sugar Contents		
				Total (%)	Reducing (%)	Non reducing (%)
T_1 (0.5% lime)	24.85	0.24	17.23	21.15	2.30a	18.87
T_2 (0.4% *Mango Wash*	25.10	0.23	14.45	20.95	2.28a	18.65
T_3 (control)	26.58	0.22	13.32	20.71	2.83a	17.92

Any two means not sharing any letter, differ significantly (*P≤0.01)*

Table. 7. Effect of time of harvest on internal fruit quality

Time of harvest	TSS (°Brix)	Titratable Acidity (%)	Ascorbic acid (mg/100ml)	Sugar Contents		
				Total (%)	Reducing (%)	Non reducing (%)
7:00 am	24.77b	0.24	16.10	20.92	1.95b	18.95
12:00 pm	26.78a	0.25	13.90	22.00	2.82a	19.22
5:00 pm	24.98ab	0.21	15.00	19.90	2.65a	17.27

Any two means not sharing any letter, differ significantly (*P≤0.01)*

Table 8: Effect of treatment × time of harvest interaction on internal fruit quality

Treatments	Time of harvest	TSS (°Brix)	Titratable Acidity (%)	Ascorbic acid (mg/100ml)	Sugar Contents		
					Total (%)	Reducing (%)	Non reducing (%)
T_1 (0.5% lime)	7:00 am	24.65bc	0.29	16.65	20.90	1.90	19.00
	12.00 pm	24.15c	0.25	16.70	23.35	2.75	20.65
	5:00 pm	25.75abc	0.17	18.35	19.20	2.25	16.95
T_2 (0.4% *Mango Wash*)	7:00 am	24.70bc	0.23	20.00	19.30	2.00	17.25
	12.00 pm	27.40ab	0.24	10.00	23.30	2.40	20.90
	5:00 pm	23.20c	0.22	13.35	20.25	2.45	17.80
T_3 (control)	7:00 am	24.95bc	0.20	11.65	22.55	1.95	20.60
	12.00 pm	28.80a	0.25	15.00	19.35	3.30	16.10
	5:00 pm	26.00abc	0.22	13.30	20.25	3.25	17.05

Any two means not sharing any letter, differ significantly (*P≤0.01)*

as compared to other times of the day. So, maximum benefit of desapping can only be obtained, if the fruits are harvested and desapped during morning hours. Moreover, almost similar performance of lime to that of *Mango Wash* in controlling sap injury suggests that the lime can be used as a substitute of *Mango Wash* to control postharvest sap injury in mango fruits.

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